CHARACTERIZATION OF THE NUTRITIONAL VALUE OF ALFALFA HARVESTED AT DIFFERENT STAGES OF VEGETATION USING CELL WALLS CONTENT BASED METHODS

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Abstract

The purpose of this paper was to nutritionally characterize the alfalfa vegetal mass through the assessment of its cell walls content, differentiated in NDF (cellulose, hemicelluloses, lignin), ADF (cellulose and lignin) and Li (lignin). Chemical analysis was performed using the classical method (Weende) and Van Soest method, on average samples taken from green alfalfa harvested during different stages, from SCPCB Dancu Iaşi. Comparison of the achieved results indicated that conventional methods underestimated approximately 40 % the cell walls content in feed (37% in bud stage and 42% during full flowering). Nutritionally, alfalfa harvesting phase induced increased cell walls content, which caused diminution of protein and energy levels, from 1306 kcal NEm/kg DM and 20.50% CP (bud stage) till la 1150 kcal NEm/kg DM and 14.30% CP (flowering).

Key words: nutritional value, cell walls, alfalfa, vegetation stages

INTRODUCTION

Feedstuffs quality is a very complex notion, which comprises data related to their raw chemical composition, digestibility and nutritional value. It also reveals feeds aptitude to fulfill animals nutritional requirements. The notion of quality itself, the diversity and complexity of assessments to be considered in order to qualitative depict feedstuffs became wider [4]. Modern methods and techniques arise nowadays after longtime usage of raw chemical composition and nutritional value analyses different researches related to feedstuff quality [7]. Investigation and fine tuning of certain more accurate systems on nutritional value assessment are motivated by marvelous phytotechnology achievements during last decades, which induced alterations in feedstuffs quality [6]. They are also required by the visionary development of feedstuff quality approaching, based on its characterization through certain indicators: total cell walls content (NDF), ligno-cellulose complex (ADF) and cellular content, as well [1].

Plants and feedstuffs cell walls content is highly variable and influenced by certain factors, such as: species, vegetation stage at harvest or usage, methods and technologies applied in preservation or preparation. Generally, it could be noticed that cell walls content is conversely correlated to plant nutritional value. Therefore, feedstuffs that are rich in cell walls prove to be of poor quality, having thus low productive effect. Meanwhile, there is an optimal level of cell walls content to be included in feed ration, for each animal species and category, in order to provide good functioning conditions for the digestive tract. These reasons imposed as compulsory the proper dosage of feed cell walls content [7].

This paper main goal was to nutritionally characterize the green alfalfa, through the assessment of its cell walls content, differentiated as NDF (cellulose, hemicelluloses, lignin), ADF (cellulose and lignin) and Li (lignin), compared with the

conventional approach results (crude fibber based method).

MATERIAL AND METHOD

Chemical composition and nutritional value assessments have been carried out on alfalfa samples, harvested during bud and early flowering stages, from SCPCB Dancu Iaşi. Samples harvesting, preservation and analyses were done in accordance with certain ISO agreed standards:

- ISO 6497/2001 Feedstuffs. Sampling.
- ISO 6498/2001 Feedstuffs. Sample preparation for analysis.
- ISO 6496/2001 Feedstuffs. Moisture and other volatile compounds assessment.
- ISO 5984/2001 Feedstuffs. Crude ash content.
- EN ISO 5983-2 (AOAC 2001:11) Feedstuffs. Crude ash content. Nitrogen content and protein content computation
- ISO 6492/2001 Feedstuffs. Fat content assessment.
- SR EN ISO 6865/2000 Feedstuffs. Crude fiber content assessment – conventional method (Weende).
- EN ISO 16475 (AOAC 2002:04). Feedstuffs. Neutral detergent fiber (NDF) content assessment (Van Soest method).
- EN ISO 13906: 2008 (AOAC 97318) Feedstuffs. Acid detergent fiber (ADF) and lignin contents assessment (Van Soest method).

Computation of main cell wall structural components was made using the relations:

Hemicellulose=NDF-ADF

Cellulose=ADF-Li

Organic matter has been calculated through differentiation, the crude ash being subtracted from dry matter [7].

Nitrogen free extract (NFE) was mathematically appreciated, as difference between organic matters values and analytically assessed organic compounds [7].

dOM (digestibility of organic matters) have been achieved by original digestibility experiments, organized at SCPCB Dancu Iaşi.

Regression equations used in energetic value computation, according to NRC (2001) specifications, are based on ADF content (lingo-cellulose) (%) in analyzed feedstuff. Thus, in green alfalfa samples, the used relation is that recommended fro green leguminous plants [5]:

NEm (Mcal/kg)=2.181 – (0.0290 x ADF)

In order to assess the nutritional value of the studied feedstuff, the INRA systems have been utilized: UF (UFL, UFC)–energy content and PDI (PDIA, PDIN, PDIE)–protein content [3].

RESULTS AND DISCUSSIONS

The results related to cell walls content in green alfalfa commonly used in ruminants feeding are presented in Table 1.

Table 1-Dynamics of cell walls content in green alfalfa, as influenced by vegetation stage

Vegetation stage	% din DM					
	CF	NDF	ADF	Hemicelluloses	Cellulose	Lignin
Bud	30.6	42.0	32.2	9.8	23.2	9.0
12 days after bud (early flowering)	32.6	45.0	34.8	10.1	25.7	9.7
17 days after bud (full flowering)	33.9	48.3	37.5	10.8	27.2	10.3

Therefore, certain aspects could be noticed:

- total content of cell wall was influenced by plants age at harvesting. Thus, in alfalfa samples, NDF values increased from 42.0% during bud, to 45.0 % at early flowering, respectively till 48.3 % during full flowering (+ 5.3 percentage points from bud moment);

- as plants turned old, cellulose and lignin proportion increased, while hemicelluloses decreased; ADF content increased from 32.2% (bud) till 37.5% (full flowering) (Table 1).

If a comparison between the results of Weende and Van Soest analytical methods would be done, it could be found that conventional methodology underestimate

environ 40% the cell walls content from the studied feedstuff (37% at bud, 38% at early flowering and 42% during full flowering). An explanation could be given for these differences: the reagents used in crude fiber conventional methods strongly dissolve the hemicelluloses, even certain part of lignin. Consequently, CF content will always be lower than cell walls content.

From raw chemical composition analyses, certain decrease of nutritional substances from cell content could be noticed, accompanied by an increase of cell walls content, therefore a diminution of organic matters digestibility; alfalfa harvested during bud stage presented 20.50% CP proportion, which decreased till 14.30 % CP (full flowering) (Table 2).

Table 2-Dynamics of green alfalfa raw chemical composition, induced by vegetation stage

Vegetation stage	% from DM					OMD (%)
	OM	CP	EE	NFE	CF	
Bud	88.58	20.50	33.7	34.11	30.60	69
3 days after bud	89.20	19.68	32.4	35.42	30.86	68
6 days after bud	89.69	18.56	30.0	36.90	31.23	67
9 days after bud	89.95	17.40	28.9	38.05	31.51	66
12 days after bud (early flowering)	90.00	16.29	28.3	38.32	32.56	65
14 days after bud	90.19	15.45	28.0	38.94	33.00	64
17 days after bud (full flowering)	90.50	14.30	28.6	39.44	33.90	63

DM – dry matter; OM – organic matter; CP – crude protein; CF– crude fiber; EE – ether extract (crude fat); NFE - Nitrogen free extracts; OMD – organic matter digestibility;

Nutritional value of the studied feedstuff was calculated using original data from chemical composition analyses and organic matter digestibility coefficients, introduced in regression equations proposed by certain modern systems of nutritional value evaluation (INRA, NRC). The acquired results are presented in Tables 3, 4 and 5.

Table 3-Energetic value computation in green alfalfa samples, related to vegetative stage (INRA system, CF based method)

Vegetative stage	Kcal /kg DM				
	NEL	NEC	UFL	UFC	q*
bud	1306	1263	0.77	0.69	0.51
3 days after bud	1317	1277	0.77	0.70	0.51
6 days after bud	1314	1275	0.77	0.70	0.51
9 days after bud	1314	1276	0.77	0.70	0.51
12 days after bud (early flowering)	1290	1246	0.76	0.68	0.51
14 days after bud	1218	1157	0.72	0.64	0.48
17 days after bud (full flowering)	1150	1072	0.68	0.59	0.46

**concentraţie EM*

Energetic value dynamics, assessed through INRA system (Table 3), indicated 12% decrease of NEm from bud stage (1306 kcal/kg DM) till full flowering (1150 kcal/kg DM); the decrease was more effective (15%) when energy content for meat production was computed, respectively from 1263 kcal/kg DM till 1072 kcal/kg DM (Table 3).

Content in Net Energy for milk production, computed on ADF feedstuff content basis presented lower values in bud stage (-4.3%), during early flowering (-9.3%) or at full flowering moment (-5%), compared to the values achieved on conventional methods basis (Table 4).

Table 4-Energetic value computation in alfalfa samples, related to CF and ADF contents

Harvesting stage	NEm/kg DM			
	INRA System (GF)		NRC System (ADF)	
	kcal	%	kcal	% (INRA=100%)
Bud	1306	100	1250	95.75
12 days after bud (early flowering)	1290	100	1170	90.70
17 days after bud (full flowering)	1150	100	1093	95.04

Energetic value assessment, using the cell walls content data, revealed that energy (NEm) in green alfalfa, computed on lignin-cellulose complex (ADF) basis, was lower than energy content, estimated on crude fiber quantity (CF) basis (fig. 1).

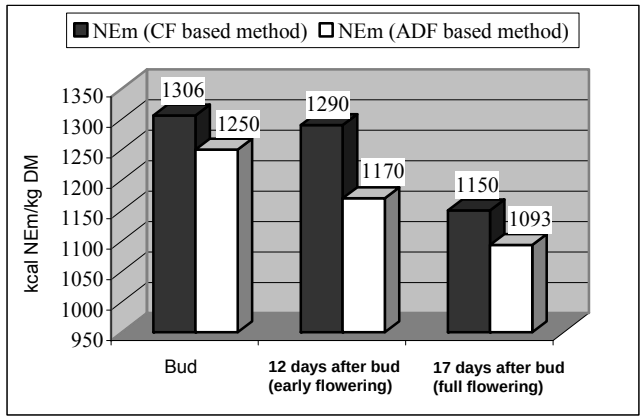

Fig. 1-Variation of energetic content (NEm) in green alfalfa, as influenced by applied analytical method

Decrease of crude protein content, as plants developed and matured, induced a depreciation of digestible protein content in gut. Certain decrease of gut feed originated protein content (PDIA) was noticed during the studied period (bud till full flowering), which meant 30% less, from 45.5 g/kg DM till 31.7 g /kg DM (Table 5).

Table 5-Results related to alfalfa protein content, as influenced by vegetative status

Vegetative stage	g/kg DM		
	PDIA	PDIN	PDIE
bud	45.5	124.3	95.8
3 days after bud	43.7	119.3	94.3
6 days after bud	44.5	119.4	94.8
9 days after bud	41.7	111.9	93.4
12 days after bud (early flowering)	36.2	101.9	86.4
14 days after bud	34.3	96.9	84.0
17 days after bud (full flowering)	31.7	89.4	82.0

CONCLUSIONS

Conventional methods applied in cell walls content assessment requires the separation of each structural component, followed by their quantitative dosage. These steps involve certain lab equipments and high quantities of chemical reagents. On the other hand, modern methods are more precisely and easier to use; analysis duration is shortened, thus time and reagents are saved.

Feed inner NEm, assessed through its ADF content, revealed lower values

(-4…-9%), compared to those issued from Crude Fibber conventional method (INRA system).

Increase of cell walls content was straightly related to the vegetative stage and induced nutritional consequences: decrease of energy and protein contents, from 1306 kcal NEm/kg DM and 20.50% CP (bud stage) till 1150 kcal NEm/kg DM and 14.30% CP (flowering stage).

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