Istituto di Scienze degli Alimenti e della Nutrizione

DEHYDRATED ALFALFA

Nutritional characterization of dehydrated alfalfa hay produced by - Gruppo Carli farms

Scientific Study Manager: Antonio Gallo, Department of Animal Science, Food and Nutrition (DIANA). Facoltà di Scienze Agrarie, Alimentari e Ambientali, Università Cattolica del Sacro Cuore, Via Emilia Parmense, 84, 29122 Piacenza, Italy. Email: antonio.gallo@unicatt.it

Sponsor Rappresentative: Davide Carli and Andreea Macchia, Ufficio Commerciale Sicem Srl - Gruppo Carli, Via Torello, 13, 47865 Pietracuta di San Leo (RN) – Italy. EM: Andreea Macchia andreea.macchia@gruppocarli.com

Key words: alfalfa, dehydrated, ruminants, biological

1. *Introduction*

Alfalfa is particularly suitable for all herbivorous species and has always been considered “the Queen” of forages, as it is characterized by high production of protein per hectare of cultivated area. Alfalfa, in association with cereals, can represent 90% of the diet of cattle even at a very high level of specialization.

The alfalfa protein mowed before flowering has a high biological value and is suitable for all herbivorous species. The fiber has remarkable dietary properties and ensures balanced mineral supplies, stimulates the physiological functions of rumination and helps to maintain an optimal level of pH both in the rumen and in the intestine. It is also rich in pectin, a very useful fraction for the entire digestive system, which benefits by improving the absorption of nutrients during digestion and safeguarding the health of the intestine. In addition, fresh alfalfa is rich in sugars and organic acids (malic, citric, fumaric), important for the palatability of the forage and for the stimulation of beneficial fermentations that occur in the digestive system of herbivores. Talking about vitamin, alfalfa provides various anti-free radical substances: beta-carotene, xanthophyll and vitamin E.

If properly cultivated, harvested and stored, alfalfa is a formidable tool that can improve the health status and production performance of the animals.

Dehydrated alfalfa is characterized by important nutritional properties: the high intake of protein, that allows to reduce the use of protein concentrates (soybean, gluten, semolina, etc..) in the the ration, and the moderate content NDF that allows to increase the share of forage in the ration without depressing excessively animal’s digestibility and ingestion.

A correct dehydration process is the best way to preserve this forage. In fact, losses compared to haymaking in the field are reduced and the forage obtained maintains a major quantity of nutrients. Dehydrated alfalfa is also safe from a microbiological point of view, with a reduction in the risk of fungal contamination from which very dangerous toxins originate.

In this research project, 4 samples of dehydrated alfalfa produced by Carli Group farms in the 2018 agricultural year were analyzed and characterized by chemical-nutritional aspects. These hays were produced under organic agriculture management and without irrigation, in a natural area in Italy, where the cultivation of GMOs is not allowed

2. Chemical composition and biological characteristics (ruminal and intestinal degradability) of dehydrated hay.

Table 1 shows the main chemical characterizations carried out on the 4 dehydrated alfalfa samples, namely: dehydrated alfalfa pellets (MPME 230818), dehydrated first cut hay (FBME 230818), dehydrated alfalfa hay (MBME 230818) and dehydrated alfalfa bale (MBME 3230818).

The crude protein (CP) values were found to be in the normal range for this type of forage, underlining that on the sample MPME 230818 the CP was found below 20% dm. The soluble protein (SOLP) content is regular for this type of forage, while it results inferior to the maximum limit found in other Italian alfalfa samples, analyzed in previous years. The values of ash and ethereal extract (crude lipids) do not show anomalous data. The NDF content, measured using the method recommended by NRC (2001), which requires the use of amylase and sodium sulphite and the correction of the value of the ash attached to the NDF, were less than 40% dm in sample MPME 230818 and sample MPME 3230818, higher in the other samples. ADF and ADL contents were similar among the analyzed dehydrated alfalfa samples. For the latter, probably due to the presence of grasses, the value of lignin was lower and equal to 5.07 % dm in the sample FBME 230818.

The proportion of degradable NDF after 48 hours of ruminal incubation in fistulaed cows (48h NDFD, % NDF or 48h dNDF, % ss) and the proportion of indigestible NDF after 240 hours of ruminal incubation (uNDF, % ss) were characterised on the four samples of dehydrated alfalfa. While the values of 48h dNDF were found to be normal for this type of forage, the uNDF content can be defined as low, although it falls within the normal ranges found in other Italian forage samples previously analyzed.

The good proportion of NDF degraded at 48 hours together with the low proportion of uNDF characterizes these dehydrated alfalfa forages for high rates of hourly degradation of NDF, with values ranging from 5.31 %/h for MBME 230818 to values above 10%/h for MPME 230818 and FBME 230818.

It was analyzed the proportion of degradable protein in the rumen after 16 hours of ruminal incubation (RDP, % PG), its difference at 100 representing the proportion of PG capable of bypassing the rumen (RUP, % PG) and the proportion of RUP available for intestinal digestion (dIntRUP, % PG) were also characterized. The values of these parameters are in line with the ranges of this type of fodder, with RUP values close to the maximum limits previously found on Italian fodder. The intestinal digestibility values of the RUP are good for all dehydrated alfalfa. Examining in depth, two other parameters often used to evaluate thermal treatments of soy, such as the solubility of the protein in aqueous solution (PDI) and in potash (KOH) show that the drying treatment did not cause the onset of Maillard reactions.

The presence of vitamins such as Vitamin E and the precursor of Vitamin A, beta-carotene, were found to be in the normal range reported for this type of forage by foreign authors. Lutein and Triacontanol levels are also good.

All dehydrated alfalfa samples has been evaluated for the Relative Forage Quality (RFQ) and Relative Feed Value (RFV) indices, showing values perfectly in the international ranges, but they resulted excellent comparing with Italian alfalfa samples previously analyzed.

Good levels of net energy milk calculated according to NRC (2001) and to the FORAGE Energy Index, which in the case of the sample MBME 3230818 showed values above 100.

UNIVERSITÀ CATTOLICA del Sacro Cuore

Istituto di Scienze degli Alimenti e della Nutrizione

Table 1. Chemical composition and biological characteristics of 4 hay of dehydrated alfalfa Sicem Srl - Gruppo Carli

Parameter	dehydrated alfalfa pellets MPME 230818		dehydrated hay first cut FBME 230818		dehydrated alfalfa ballon MBME 230818		dehydrated alfalfa ballon MBME 3230818		Reference range (with bibliography)	
	mean	st. dev	mean	st. dev	mean	st. dev	mean	st. dev		
Dry matter %	91.27	0.87	88.97	1.10	89.53	1.05	89.51	1.05	82,9-94,1	Gallo et al., 2013
PG, % ss	22.81	2.28	14.46	1.45	17.04	1.70	18.06	1.81	9,9-24,4	Gallo et al., 2013
PG sol, % PG	29.96	0.70	20.75	1.50	9.21	0.24	9.77	0.45	7,7-42,2	Gallo et al., 2013
PG sol/Pg tot, %	31.28	3.10	40.95	1.40	36.10	1.40	35.26	2.50		
Ash, % ss	11.40	1.10	10.44	0.89	10.53	1.23	9.93	0.99	5,5-14,9	Gallo et al., 2013
Ether extract, % ss	0.54	0.85	1.57	0.45	1.61	0.98	1.94	0.65	0,5-1,6	Gallo et al., 2013
$aNDF_{OM}$, % ss	39.96	0.12	44.23	0.94	43.04	0.06	36.74	0.66	32,9-62,1	Gallo et al., 2013
ADF_{OM}, % ss	31.59	0.13	32.19	0.07	32.27	0.52	29.52	0.22	24,6-47,1	Gallo et al., 2013
Lignin(sa), % ss	8.22	0.12	5.07	0.48	7.38	0.04	7.10	0.23	5,4-10,7	Gallo et al., 2013
NDICP, % ss	3.22	0.14	1.72	0.04	2.11	0.06	2.33	0.13	1,7-7,9	Gallo et al., 2013
ADICP, % ss	1.44	0.18	0.90	0.07	1.09	0.16	0.85	0.24	0,7-2,6	Gallo et al., 2013
48h NDFD, % NDF	53.77	8.18	54.78	1.39	49.18	0.09	54.72	3.15		
48h dNDF, % DM	21.49	3.27	24.23	0.62	21.17	0.04	20.11	1.16	12,8-35,8	Gallo et al., 2013
uNDF, % DM	18.74	0.97	19.76	0.63	19.79	0.29	16.10	0.03	15,6-40,4	Gallo et al., 2013
kd NDF, %/h	11.10		10.13		5.31		8.04		2,7-9,6	Gallo et al., 2013
RUP, % PG	40.27	0.77	43.67	0.64	48.59	5.98	46.21	3.64	38,9-61,5	Gallo et al., 2017
RDP, %PG	59.73	0.77	56.33	0.64	51.41	5.98	53.79	3.64	38,5-61,1	Gallo et al., 2017
kd CP, %/h	11.35		11.50		10.51		10.88		8,9-15,4	Gallo et al., 2017
dIntRUP, %PG	42.08	5.96	34.68	0.50	33.79	2.33	34.82	0.12	33,4-65,9	Gallo et al., unpublished
undigestible CP, % PG	23.32		28.53		32.17		30.12			
solubility in KOH	11.95		8.46		8.22		9.09			
Protein dispersibility index (PDI)	4.20		4.49		4.89		5.05			
Vitamin E (ppm)	5.9		14.6		9.7		22.7		28-238	Ballet et al., 2000
B carotene (ppm)	6.1		41.9		23.9		50.9		66-271	Ballet et al., 2000
Lutein (ppm)	14.9		7.8		68.9		114.8			
Triacontanol (ppm)	492.0		316.0		414.0		349.0			
Betaina (ppm)	572.0		290.0		317.0		184.0			
RFV	149.7		134.2		137.8		166.9		100-200	Ward, 2008
RFQ	157.0		141.7		135.0		179.7		50-250	Ward, 2008
ENL3x-lignin	1.309		1.285		1.293		1.371		0,92-1,37	Gallo et al., 2013
ENL3x-48hNDFD	1.336		1.306		1.315		1.411		0,80-1,50	Gallo et al., 2013
FORAGE Energy Index	90		83		85		107		0-100	Gallo et al., 2013
MEp3x(calc)	2.053		2.068		1.998		2.157			
NElp3x(calc)	1.25		1.26		1.27		1.326			

Note alla tabella: Kd NDF, calcolato con Lag fissa (2,5h) ed utilizzando un modello esponenziale di I ordine.
Undigestible CP, calcolato come 100 - RDP - (RUP * dIntRUP)

3. *Amino acid composition of dried alfalfa*

The amino acid composition, both as total and free amino acids, is typical for this type of forage. Describing the parameters in relation to the total protein content (% PC), the value of lysine is particularly high, while the methionine is normal.

Table 2. Amino acid composition of 4 samples od dehydrated alfalfa - Gruppo Carli farms

Parameter	dehydrated alfalfa pellets MPME 230818		dehydrated hay first cut FBME 230818		dehydrated alfalfa ballon MBME 230818		dehydrated alfalfa ballon MBME 3230818		Reference range (with bibliography)
	mean	st. dev	mean	st. dev	mean	st. dev	mean	st. dev	
Amino acids	**% SS**	**% PG**	**% SS**	**% PG**	**% SS**	**% PG**	**% SS**	**% PG**	**% PG**
Aspartic acid	2.48	10.85	2.29	15.85	2.24	13.16	2.27	12.56	8,33-15,93
Threonine	1.06	4.63	0.70	4.81	0.99	5.83	1.08	5.98	4,87-6,11
Serina	1.16	5.09	0.76	5.27	0.96	5.62	1.00	5.56	4,86-6,26
Glutamic acid	3.71	16.28	1.51	10.48	1.85	10.88	1.99	11.04	9,58-12,83
Proline	1.51	6.64	1.11	7.66	1.25	7.36	1.04	5.78	5,80-11,90
Glycine	1.29	5.64	0.69	4.75	0.88	5.15	0.92	5.08	4,89-6,84
Alanine	1.15	5.03	0.80	5.51	1.00	5.87	1.09	6.03	5,54-7,70
Valine	1.22	5.35	0.77	5.36	0.96	5.64	1.01	5.60	4,47-6,89
Isoleucine	0.98	4.29	0.58	4.00	0.76	4.46	0.83	4.58	4,41-5,63
Leucine	1.58	6.92	0.99	6.83	1.28	7.52	1.40	7.74	5,68-9,08
Tyrosine	0.65	2.85	0.40	2.75	0.52	3.03	0.63	3.49	2,71-4,36
Phenylalanine	1.05	4.62	0.64	4.45	0.82	4.83	0.93	5.13	4,86-6,16
Histidine	0.96	4.22	0.78	5.38	0.80	4.71	0.90	5.00	2,41-4,24
Lysine	1.00	4.39	0.76	5.28	0.94	5.51	1.07	5.90	3,52-5,92
Ammonia	0.37	1.64	0.26	1.80	0.23	1.34	0.22	1.20	
Arginine	1.56	6.84	0.69	4.75	0.90	5.28	0.97	5.36	3,90-5,93
Cystine	0.33	1.47	0.17	1.16	0.19	1.14	0.24	1.32	1,22-2,14
Methionine	0.42	1.85	0.21	1.42	0.26	1.52	0.30	1.67	1,41-2,23
Sum	**22.49**	**98.60**	**14.10**	**97.51**	**16.84**	**98.85**	**17.88**	**99.02**	
Free amino acids	**mg/100 g tq**		**mg/100 g tq**		**mg/100 g tq**		**mg/100 g tq**		
Aspartic acid	119.4		111.9		52.9		43.80		
Threonine	37.1		48.5		62.5		41.72		
Serina	50.9		83.1		93.5		73.62		
Asparagine	497.4		1533.0		1136.8		1395.20		
Glutamic acid	74.0		64.1		61.1		35.11		
Glutamine	6.7		12.0		27.7		15.92		
A-aminoadipic acid	0.0		0.0		8.0		5.24		
Proline	268.5		305.1		361.9		186.16		
Glycine	12.4		10.9		8.3		13.37		
Alanine	70.9		107.6		106.8		162.40		
A-aminobutyric acid	5.8		5.6		0.0		0.00		
Valine	53.6		77.5		72.4		56.46		
Methionine	1.7		0.3		0.6		0.43		
Cysthionine	2.2		1.7		1.0		1.27		
Isoleucine	25.2		33.8		39.3		33.01		
Leucine	23.1		34.7		48.6		36.45		
Tyrosine	8.4		13.5		15.8		16.23		
b-Alanine	10.0		11.3		16.1		11.33		
Phenylalanine	8.3		10.1		12.6		11.23		
B-Aminobutyric acid	0.0		10.6		5.7		5.72		
G-Aminobutyric acid	65.9		111.6		99.8		173.22		
Ethanolamine	0.0		6.7		6.4		7.58		
Ammonia	23.1		19.3		12.0		9.84		
Ornithine	1.2		1.2		3.9		1.66		
Lysine	15.5		12.7		26.3		20.03		
Histidine	8.6		8.2		13.9		14.08		
1-methyl-histidine	0.0		3.4		3.0		4.77		
Arginine	21.9		12.4		15.6		15.81		
AA free Total	**1411.9**		**2650.8**		**2312.3**		**2391.66**		

4. *Fatty acid composition of dehydrated alfalfa*

Table 3 shows the composition in saturated and unsaturated fatty acids of the 4 samples of dehydrated alfalfa. Good levels in omega 3 and omega 6.

Table 3. Fatty acid composition of 4 samples of dehydrated alfalfa - Gruppo Carli farms

Parameter	dehydrated alfalfa pellets MPME 230818		dehydrated hay first cut FBME 230818		dehydrated alfalfa ballon MBME 230818		dehydrated alfalfa ballon MBME 3230818	
	mean	st. dev	mean	st. dev	mean	st. dev	mean	st. dev
Fatty acids	**% DM**	**Total Fatty Acids %**	**% DM**	**Total Fatty Acids %**	**% DM**	**Total Fatty Acids %**	**% DM**	**Total Fatty Acids %**
C 4:0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C 6:0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C 8:0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C 10:0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C 11:0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C 12:0	0.00	0.36	0.00	0.33	0.00	0.51	0.00	0.43
C 13:0	0.00	0.13	0.00	0.46	0.00	0.43	0.00	0.42
C 14:0	0.01	0.72	0.01	0.81	0.00	1.00	0.00	0.08
C 14:1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C 15:0	0.00	0.30	0.00	0.48	0.00	0.35	0.00	0.33
C 15:1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C 16:0	0.26	22.38	0.18	26.32	0.11	29.15	0.26	27.47
C 16:1	0.02	1.44	0.01	2.07	0.01	2.85	0.02	1.83
C 17:0	0.00	0.35	0.00	0.36	0.00	0.44	0.00	0.47
C 17:1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C 18:0	0.05	3.99	0.02	3.04	0.02	4.46	0.04	4.27
C 18:1trans	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C 18:1n9c	0.23	20.25	0.02	3.17	0.01	3.82	0.04	4.19
C 18:1cis11	0.01	0.72	0.00	0.44	0.00	0.61	0.00	0.37
C 18:2n6t	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C 19:0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C 18:2n6c	0.37	31.79	0.13	18.87	0.06	16.83	0.19	19.44
C 18:3n6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C 18:3n3	0.18	15.29	0.28	39.95	0.13	36.24	0.36	38.01
C 20:0	0.01	0.66	0.01	0.95	0.00	0.85	0.01	0.77
C 18:2 c9,t11 CLA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C 20:1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C 21:0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C 20:2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C 20:3n6	0.00	0.18	0.00	0.66	0.00	0.24	0.00	0.32
C 20:4n6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C 20:3n3	0.00	0.04	0.00	0.05	0.00	0.10	0.00	0.08
C 22:0	0.01	0.85	0.01	1.18	0.00	1.04	0.01	0.83
C 22:1n9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C 20:5n3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C 22:2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C 24:0	0.01	0.56	0.01	0.86	0.00	1.07	0.01	0.69
C 24:1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C 22:6n3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Saturated	**0.34**	**29.45**	**0.23**	**33.61**	**0.14**	**38.28**	**0.33**	**34.93**
Unsaturated	**0.81**	**69.70**	**0.45**	**65.21**	**0.22**	**60.69**	**0.61**	**64.24**
Monounsaturated	**0.26**	**22.40**	**0.04**	**5.67**	**0.03**	**7.28**	**0.06**	**6.39**
Polyunsaturated	**0.55**	**47.30**	**0.41**	**59.53**	**0.20**	**53.41**	**0.55**	**57.85**
Omega3	**0.18**	**15.33**	**0.28**	**40.00**	**0.13**	**36.34**	**0.36**	**38.08**
Omega6	**0.37**	**31.97**	**0.14**	**19.54**	**0.06**	**17.07**	**0.19**	**19.76**
Omega6/omega3	**2.09**	**2.09**	**0.49**	**0.49**	**0.47**	**0.47**	**0.52**	**0.52**

5. *Antioxidant power of dehydrated alfalfa hay*

Table 4 shows the ORAC and FRAP evaluations for the 4 samples of dehydrated alfalfa.

Parameter	dehydrated alfalfa pellets MPME 230818		dehydrated hay first cut FBME 230818		dehydrated alfalfa ballon MBME 230818		dehydrated alfalfa ballon MBME 3230818	
	mean	st. dev	mean	st. dev	mean	st. dev	mean	st. dev
ORAC, µM trolox eq.	11250,59	1277,630	11880,82	643,918	15132,50	906,339	19406,42	300,436
FRAP, mmol Fe II/L	6,13	0,043	6,03	0,098	8,24	0,043	4,10	0,131

Scientific Study Manager:
Antonio Gallo