



## Production of alfalfa hay under different drying methods<sup>1</sup>

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**ABSTRACT** - This trial aimed at determining the dehydration curve at nine times (0, 3, 6, 9, 24, 27, 30, 33 and 46 hours after cutting of the plants); the leaf/stem ratio and number of leaves per stem in alfalfa submitted to four managements during the drying process. It was also evaluated the bromatologic composition and in vitro digestibility of the dry matter and cell wall of alfalfa hay before storage. The drying methods applied for alfalfa were the following: drying in the field until 50% DM and drying conclusion in an airy shed; drying in the field without turning; drying with only one turning and drying with two turnings. The experimental design was completely randomized with four drying methods and five replications. Leaf dehydration was faster when compared to the stems in all drying methods. Drying in the shed promoted the lesser re-hydration of the plants at night due to dew. It was also verified that alfalfa hays that remained under the sun and were turned showed the worst quality with reduction in crude protein contents and increase in NDF, ADF, NDIN and ADIN. However, in vitro dry matter digestibility and cell wall digestibility did not suffer any alteration because of the different dehydration methods (69.79 and 41.39%, respectively). There is a market fall of leaves and a reduction on the number of leaves per stem with the turnings.

Key Words: drying in field, haymaking, in vitro digestibility

## Produção de feno de alfafa sob diferentes métodos de desidratação

**RESUMO** - Os objetivos do trabalho foram estimar a curva de desidratação em nove tempos (0, 3, 6, 9, 24, 27, 30, 33 e 46 horas após o corte), a relação folha/haste, número de folhas por haste de alfafa submetida a quatro manejos no processo de secagem. Também foram avaliadas a composição bromatológica e digestibilidade in vitro da matéria seca e parede celular do feno antes do armazenamento. Os métodos de secagem da alfafa foram: secagem a campo até 50% de MS e término da secagem em galpão arejado, secagem a campo sem nenhuma viragem; secagem com apenas uma viragem; secagem com duas viragens. O delineamento experimental foi inteiramente casualizado com quatro métodos de secagem e cinco repetições. A desidratação das folhas foi mais rápida em relação às hastes em todos os métodos de secagem. A secagem em galpão promoveu menor reidratação das plantas no período noturno, promovido pelo orvalho. Verificou-se que os fenos de plantas de alfafa que permaneceram ao sol e receberam as viragens apresentaram pior qualidade com redução nos teores de proteína bruta, aumento do FDN, FDA, NIDN e NIDA entretanto a digestibilidade in vitro da matéria seca e da parede celular não sofreram alteração com os diferentes métodos de desidratação (69,79 e 41,39%, respectivamente). Há acentuada queda de folhas e redução no número de folhas por haste com as viragens.

Palavras-chave: fenação, digestibilidade in vitro, secagem campo

## Introduction

In Brazil, alfalfa is produced and traded mainly as hay and Crioula is the main cultivar used (Favero et al., 2008), its entire drying process is done under the sun. However, since it is a leguminous, an excessive drying under the sun might occur and the turnings are likely to cause fall

of the leaves, consequently, decreasing its nutritional value.

Nascimento et al. (2000) found that there was a decrease on hays quality when they remained under the sun, mainly in terms of crude protein, neutral detergent fiber, and acid detergent fiber. Apart from climatic factors and management, several factors which are intrinsic to a

forage plant such as cuticle thickness, diameter and length of stem, as well as leaf/stem ratio, among others, interfere on the drying process.

The drying curve of forage plants has a typical exponential form, so that each additional unit of water loss requires more time. Although water loss in stable environmental conditions shows a uniform pattern, the drying period can be conveniently divided into three phases, which differ in duration, rate of water loss and resistance for drying (McDonald & Clark, 1987).

The first stage of drying is fast and it involves intense loss of water. At this stage, the stomata remain open and there is a high vapor pressure deficit between forage and air, while water loss may reach 1 g/g DM/hour. In the second phase of drying, after stomata closing, water loss occurs throughout cuticle evaporation.

Thus, the structure of the leaves, plant cuticle characteristics and structure affect the duration of such drying phase. At the end of drying phase, i.e., the third phase, due to plasmolysis, the cell membrane loses its selective permeability consequently, a fast loss of water occurs. This phase begins when the plant moisture reaches nearly 45%. The third phase is less influenced by the management and more sensitive to climatic conditions than the previous phases, especially in relation to relative humidity (Moser, 1995).

Thus, in the production system of alfalfa hay, management has a primordial importance to ensure the quality of the preserved forage. As the number of turnings interferes in the early stages of drying hay, this trial aimed at evaluating the influence of different managements on drying under the sun to produce alfalfa hay, which is evaluated according to leaf/stem ratio, increase of dry matter, bromatologic analysis and in vitro digestibility to determine the most appropriate method of alfalfa haymaking.

## Material and Methods

The experiment was carried out under field conditions on Antônio Carlos dos Santos Pessoa Experimental Farm, which belongs to the Universidade Estadual do Oeste do Paraná, campus of Marechal Cândido Rondon, whose

geographic coordinates are the following: latitude 24° 33' 40'' S, longitude 54° 04' 1'' W and altitude of 420 m.

The local weather is classified according to Koppen as Cfa, subtropical with uniform rainfall distribution throughout the year and hot summers. The average temperatures of the coldest quarter vary from 17 to 18°C, while the warmest ones vary from 28 and 29°C and annual average temperature varies from 22 to 23°C.

The total annual rainfall means for the region ranges from 1,600 to 1,800 mm. And the most humid quarter showed responses ranging from 400-500 mm (IAPAR, 2006). During alfalfa drying, the climatic conditions were suitable (Table 1).

The experimental area is classified as an Eutroferic Red Latosol with the following chemical characteristics: pH in water = 5.34, P (Mehlich) = 14.53 mg/dm<sup>3</sup>; K (Mehlich) = 0.17 cmolc/dm<sup>3</sup>; Ca<sup>2+</sup> (KCl 1 mol L<sup>-1</sup>) = 4.64 cmolc/dm<sup>3</sup>; Mg<sup>2+</sup> (KCl mol/L<sup>-1</sup>) = 2.16 cmolc/dm<sup>3</sup>; Al<sup>3+</sup> (KCl 1 mol/L) = 0.00 cmol<sub>c</sub>/dm<sup>3</sup>; H + Al (calcium acetate 0.5mol/L) = 4.96 cmolc/dm<sup>3</sup>; SB = 6.99 cmolc/dm<sup>3</sup>; CTC = 11.95 cmolc/dm<sup>3</sup>; V = 58.49%; organic matter (Boyocus Method) = 25.29 g/dm<sup>3</sup> and clay = 65%.

The experiment was set in a 1.2-ha area, using the following methods for drying alfalfa: drying under field up to 50% dry matter and the last part of drying was done in airy shed; the second method was drying without turning, followed by a drying with just one turning and drying with two turnings.

In order to determine the drying curve, leaf/stem ratio and number of leaves per stem, samples were collected at 0 (time of cut), 3, 6, 9, 24, 27, 30, 33 and 46 hours after cut, based on a completely randomized and 4 × 9 factorial design (four drying methods and ten times of collection after the cut) with five replications.

For the chemical-bromatologic composition, the experimental design was completely randomized with four drying methods and three periods of evaluation (before cutting, before haymaking and after 60 days of storage). A completely randomized design was carried out with four drying methods and five replications for both in vitro dry matter and cell wall digestibility.

The plants from the experimental area were cut at 9:00 a.m., on January 8<sup>th</sup>, 2008. It was used a mower at 5 cm from

Table 1 - Climatic data for the periods of cut and drying of alfalfa plants

Date	Temperature (°C)			Relative humidity (%)			Dew point temperature (°C)			Radiation (KJ/m <sup>2</sup> )	Rainfall (mm)
	mean	maximum	minimum	mean	maximum	minimum	mean	maximum	minimum		
01/08 <sup>th</sup> /2008	25.6	32.8	19	70.2	93	34	19.2	22.5	14.1	3,0139.670	0
01/09 <sup>th</sup> /2008	26.4	32.7	21.1	68.9	84	43	19.9	23.4	17.8	2,9327.670	0
01/10 <sup>th</sup> /2008	26.2	33.9	19.8	72.1	92	40	20.3	24.0	17.4	2,7790.530	0

the soil. The production of alfalfa hay showed almost 30% of flowering. During the drying method without turning, the material was cut and spread out on the field for drying, without any turning over the haymaking period. The material was cut and submitted to one turning six hours after it was spread on the field for drying. The second management had two turnings, the first one at six hours and the second at 24 hours after the material was cut and spread on the field for drying.

The material was cut and spread on field until it reached 50% moisture for drying treatment in shed. Then, it was collected and transferred to an airy shed and spread to finish its drying in a covered space.

Two samples of alfalfa were taken from the field to determine the ideal dry matter and carried to a shed to be completely dried. The first sample was placed in a forced air circulation oven at 55°C for 72 hours and the second was used for fast determination of dry matter by the Microwave method, described by Ruggiero et al. (2002).

The sample collections were taken at 0 (at cut), 3, 6, 9, 24, 27, 30, 33 and 46 hours after cutting to determine the drying curves according to different drying methods. The samples were packed in paper bags, weighed, placed in an oven with forced ventilation and maintained at 55°C for 72 hours.

After 46 hours of drying, the alfalfa was mechanically baled in rectangular bales with an average weight of 12 kg. The bales were stored under identical conditions of temperature, light and moisture, in a shed for protection against rain and sun light.

The determination of leaf/stem ratio was done with 50-gram samples by the drying method at 0, 3, 6, 9, 24, 27, 30, 33 and 46 hours after cutting. After the collection of the material, leaves were separated from stems. Their samples were put in paper bags and dried at 55°C for 72 hours in a drying oven with forced ventilation.

The leaf/stem (L/S) ratio was obtained through the ratio between dry weight of leaves and dry weight of stems for all drying times in the four drying methods. In order to determine the number of leaves per stem, leaves from ten stems were counted per plot. And to determine the chemical-bromatologic composition, samples of alfalfa were collected at the cutting time, before baling and after 60 days of storage.

The dried samples were ground in Willey mill, with 30-mesh sieve, and stored in properly identified plastic bags, to evaluate dry matter (DM) and crude protein (CP) according to AOAC (1990), neutral detergent fiber (NDF), acid detergent fiber (ADF) according to Van Soest et al. (1991) and neutral detergent insoluble nitrogen (NDIN),

acid detergent insoluble nitrogen (ADIN), ether extract (EE), lignin and cellulose according to Silva & Queiroz (2006).

For determination of *in vitro* digestibility of DM (IVDDM) and *in vitro* digestibility of cell wall (IVDCW), samples of hay were collected before baling. The technique described by Tilley & Terry (1963) was adopted and adapted to an Artificial Rumen, as described by Holden (1999). For the collection of ruminal fluid, a B & W Holstein multiparous cow was used. The animal was not under lactation, had an average weight of 550 kg and a rumen cannula. It was confined in a tie-stall system, with rubber floor, let free in intervals of feeding in a shaded area for exercises, and it was fed diet with roughage and concentrate.

Three samples were obtained from rumen fluid at intervals of one week. A 0.25-g sample was weighed for each food, in triplicate, ground in a 1-mm sieve, put in F57 filters and packed in jars containing rumen fluid, obtained via ruminal cannula and a buffer. The material was incubated for 48 hours and at the end of this period, a solution of HCl-Pepsin (1:10,000) was added into an artificial fermenter at a 6.68-mL rate/sample, so the remaining material was kept under incubation for more 24 hours. When this phase finished, the filters were removed from the ruminal fermenter. They were washed with distilled water until a complete withdrawal of materials that were adhering to filters. Finally, they were dried in a forced air circulation oven for 8 hours at 105°C to determine the analytic dry matter.

The *in vitro* digestibility of DM was calculated by the difference between the incubated material and the residue after incubation:  $IVDDM = (DM \text{ from the initial food} - DM \text{ from residual food}) / DM \text{ from the initial food} * 100$

A methodology described by Goering & Van Soest (1975) was adopted to determine the IVDCW, requiring half of the time of the technique described by Tilley and Terry (1963). In this method, the digestion with pepsin and hydrochloric acid was abolished since the residue from the fermentation phase would be extracted with detergent.

The *in vitro* digestibility of the cell wall was calculated by the difference between the amount of incubated NDF and the residue that remained after the determination of NDF incubated material:  $IVDCW = (NDF \text{ from the initial food} - NDF \text{ of residual food}) / NDF \text{ from the initial food} * 100$ .

Data were statistically analyzed according to SAEG (UFV, 1997).

The averages of bromatologic composition and *in vitro* digestibility of DM and cell wall, leaf/stem ratio and number of leaves per tiller were compared by Tukey test at 5% probability. The data on dry matter content of the whole

plant, leaf and stem were obtained by regression analysis using SAEG program (UFV, 1997).

## Results and Discussion

The moisture content decreased after the cut with a slight increase in the early mornings as well as with its results, so there was an adjustment to the quadratic regression model (Table 2). Andrade et al. (2006) also observed a decline in the DM contents in the early morning, when it was examined three cultivars of alfalfa versus drying time.

The authors obtained average values of 83.4% DM in 73 hours of drying. On the other hand, at the 9:00 a.m. collection, the observed increase in moisture was due to the accumulated dew at night.

According to Rotz (1995), hay is hygroscopic, i.e., it can absorb or lose water to the environment, allowing relative humidity (RH) to influence on moisture content of a material exposed to the environment. So, the drying methods without turnings and with one and two turnings, when exposed to the environment, absorbed water at night and in the early morning, while the material dried in field up to 50% DM and later taken to the shaded place lost less moisture as well as showed lower water absorption since it was protected. This contributed to the approximation of drying methods.

The last collection during the drying process was carried out at 8:30 a.m. Hay was baled at 9:30, so, the collection at time 46 showed higher moisture content (Figure 1).

The interaction was significant between the drying methods and collection time concerning DM content after the cut. At times 0, 3, 6 and 9, drying rates were close, even in the method that received only one turning.

Twenty-four hours after cutting, the drying methods began to differ from each other. The method without turning showed the lowest DM content when compared to the one

turning method, maybe because this last one was more uniformly exposed to the sun, so it got dried faster while the first one remained in the pile with less surface exposed to solar radiation.

Twenty-seven hours after cutting, the drying in the field up to 50% DM and dried under the shade began to reduce the DM value because the material did not have any solar radiation, which, according to Harris & Tullberg (1980), has been identified as the main environmental factor that influences the drying of grass and leguminous.

Concerning the moisture losses, it was found that, except for drying in shed, the final values were very close, however, for leguminous, the drying rate for leaves was much faster than for stems. Thus, the drying method choice should consider the loss of leaves according to the turnings.

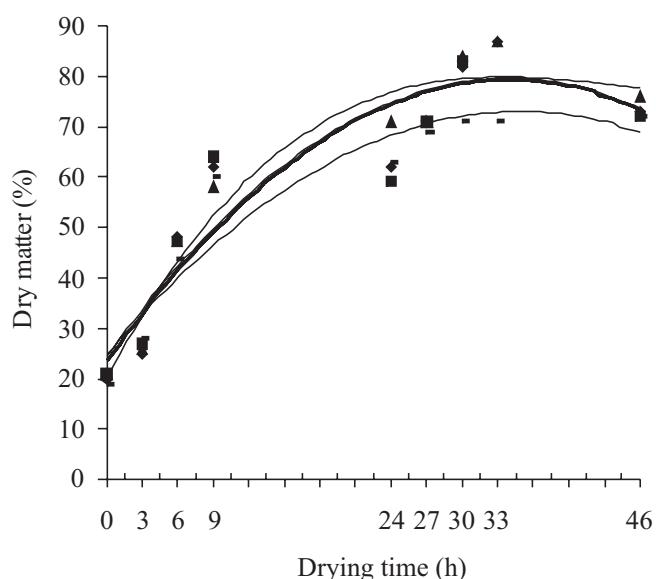


Figure 1 - Total dry matter contents in alfalfa, dried in a shed (—) without turning (■), a single turning (▲) and two turnings (◆) according to drying time.

Table 2 - Evaluations of dry matter contents of the whole plant, leaves and stems of alfalfa under different drying methods according to the collection time

Total dry matter (%)	Equation	r <sup>2</sup>	CV %
Shed	$-0.040138x^2 + 2.79212x + 24.700829$	91.13	
No turning	$-0.049740x^2 + 3.329296x + 24.252201$	84.45	
1 turning	$-0.049846x^2 + 3.427983x + 22.882202$	93.67	
2 turnings	$-0.048858x^2 + 3.315285x + 23.774736$	87.55	8.19
Dry matter of leaf (%)	$-0.047383x^2 + 3.212730x + 21.636970$	87.62	14.77
Dry matter of stem (%)			
Shed	$-0.033977x^2 + 2.516098x + 19.533388$	91.48	
No turning	$-0.044258x^2 + 2.995882x + 20.343459$	89.93	
1 turning	$-0.033446x^2 + 2.660425x + 18.481447$	94.82	
2 turnings	$-0.026868x^2 + 2.356312x + 18.293549$	90.84	16.60
Leaf/stem ratio	Ns		
Number of leaves/stem	Ns		

Ns: nonsignificant; CV: coefficient of variation.

The DM percentages of alfalfa leaves did not undergo interaction of drying methods over time, while the averages were adjusted to the quadratic regression model (Table 2). The moisture loss in the leaves was faster than in the stems, according to all studied times. The moisture increase was also observed in the early hours of the day (Figure 2).

The DM contents were also adjusted to the quadratic regression model, when the moisture loss in stems was taken into account and, in the early morning, there was always an increase in moisture content depending on dew. There was a significant interaction among drying methods and times (Figure 3). Factors such as stem diameter and thickness of the cuticle obstruct water loss of stems when compared to leaves.

The leaf/stem (L/S) ratio is strongly influenced by the drying methods, and a low ratio will reflect negatively on the forage nutritional value (Costa et al. 2006). It can be observed that L/S ratio (Table 3) was constant until the implementation of the first turnings.

After the turnings (6 and 9 times), the drying methods began to interfere in the L/S ratio. This can be observed by comparing the means over time when the drying method in field was until 50% DM and a subsequent drying at shade; and the method without turnings showed some variations ( $p > 0.05$ ) in times as, for example, 0 (1.086) and 33 (0.938). However, the dryings with one or two turnings showed some effective decreases.

The records for one turning ranged from 0.948 at time 0 to 0.074 at time 45. However, with two turnings and an

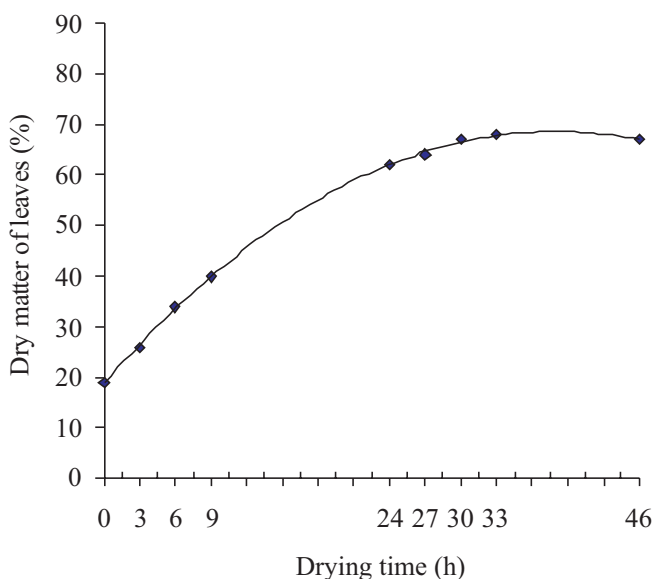


Figura 2 - Effect of drying time on dry matter contents of alfalfa leaves according to methods of dehydration.

L/S ratio, this answer increased from 0.914 at time 0 to 0.738 at time 45.

The obtained values of L/S ratio in this experiment were lower than those ones obtained by Costa et al. (2006), due to the season and also because crioula alfalfa has shown some decrease of L/S ratio as days get hotter, which explains the lower L/S ratio.

Viana et al. (2004) evaluated the L/S ratios of 28 alfalfa cultivars and the crioula cultivar was always part of the group with a lower ratio between L/S (nearly 1.05) in all periods when this relationship was studied.

Nascimento et al. (2000), before the cut, obtained, with Florida cultivar, a 1.12 L/S ratio higher than our studied answer, however, with 80% of sun drying, this ratio was 0.46, suggesting that there was a great loss of leaves.

There was an effect ( $p > 0.05$ ) for drying methods only for times 3, 33 and 45, based on the number of leaves per stem (Table 4). But, up to time 33, the superiority of drying without turning became evident when compared to the drying with two turnings, which can be explained by the less intensive management, applied to this method, as the material without turning suffered no turning during the drying process.

Table 3 - Leaf/Stem ratio of alfalfa under four drying methods

Time	Shed	No turning	One turning	Two turnings
0	1.086a*	0.970a	0.948a	0.914a
3	1.006a	0.870ab	0.796b	0.854ab
6	1.200a	0.892ab	0.886ab	0.658b
9	1.026ab	1.052a	0.690c	0.648b
24	0.992ab	1.078a	0.748bc	0.860ab
27	0.996ab	1.068a	0.766bc	0.902ab
30	0.978ab	0.826b	0.758bc	0.652b
33	0.938b	0.884ab	0.880ab	0.654b
45	0.976ab	0.986a	0.774ab	0.738ab
CV	24.64%			

\* Values followed by the same letter in column do not differ among themselves by Tukey test at 5%.

Table 4 - Number of leaves per stem of alfalfa under four drying methods

Times	Shed	No turning	One turning	Two turnings
0	39.628a*	39.734a	38.264a	41.314a
3	36.360ab	34.696b	40.640ab	42.320a
6	39.972a	41.986a	41.100a	43.160a
9	38.120a	36.614a	34.840a	36.130a
24	37.954a	41.522a	36.588a	36.630a
27	39.042a	40.334a	38.126a	36.646a
30	35.300a	33.910a	34.800a	31.840a
33	35.380ab	36.560a	29.420bc	27.460c
45	34.360ab	35.744a	32.982ab	28.518b
Means	37.352	37.900	36.306	36.002
CV%	11.28			

\* Values followed by the same letter in row do not differ among themselves by Tukey test at 5%.

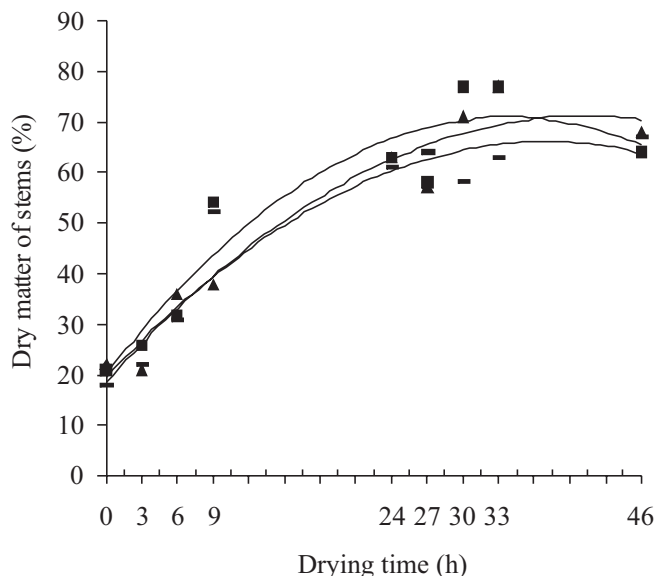


Figure 3 - Dry matter contents of stems in dried alfalfa hay in a shed (-) without turning (■), a single turning point (▲) and two turns (◆) according to time.

Likewise, the inferiority of drying with two turnings can be explained due to a more intensive management, because the material has undergone two turnings during the drying process. Despite of the differences for the values of number of leaves per stem, in drying times, there was no effect of drying methods on the means ( $p > 0.05$ ).

The nutritonal value of forage is traditionally estimated by the concentrations of crude protein and wall cell (NDF, ADF and lignin) according to in vitro or in vivo digestibility (Paterson et al., 1994).

Plants that were exposed to the sun for longer and received a larger number of turnings showed hay of lower quality in terms of crude protein, neutral detergent fiber, acid detergent fiber, acid detergent insoluble nitrogen, neutral detergent insoluble nitrogen and lignin (Table 5).

According to Nascimento et al. (2000), this fact can be explained by the significant reduction of L/S ratio with wilting due to the sun and turnings, observed in this essay, as well as in the dryings with complete exposure to the sun.

Based on NDIN contents, when the steps of haymaking process were compared, their values increased at the time of storage in dryings without turning, with one turning and two turnings ( $P < 0.05$ ), which, according to Van Soest (1994), occurs when there is high humidity, and temperature reaches values above 55°C. Non-enzymatic reactions also occur between soluble carbohydrates and amine groups of amino acids, resulting in reduction of protein digestibility.

The values were constant during the drying period in the shed, so there was less warming. When the different methods of drying were compared, the NDIN values did not differ in cut and at the baling time, on the other hand, for the dryings with 1 and 2 turnings, values were higher after 60 days of storage.

For ADIN, the steps of process were influenced by one or two turnings on the obtained values, however, when the comparison was made in each method of drying, there was no difference among values ( $p > 0.05$ ). The reported increases might have been caused because of a higher moisture content during hay storage.

The values of ether extract ranged among the drying methods mainly at storage. In the NRC (2000), ether extract value for alfalfa was 2.39%, but only the stored hay, which was not completely dried in field, reached a higher value (2.45%). For the other drying methods, the means ranged around 1.60%.

Fiber content has been used as a negative index of diet quality, as it represents the least digestible fraction of food. But, fiber is required for normal metabolism and functioning of the rumen, so it is an important factor in ruminants diet, mainly for lactiferous cows (Matos, 1989).

Table 5 - Bromatologic composition of alfalfa under different methods of drying before the cut, at baling time and after 60 days of storage

Treatment	CP %			NDF%			ADF%			EE%			
	Cut	baling	storage	Cut	baling	storage	Cut	baling	storage	Cut	baling	storage	
Shed	22.17a	24.86a	23.31a	38.66a	36.40a	32.72c	30.61a	30.38b	32.37b	1.69aB	1.44aB	2.45aA	
No turning	23.89a	23.89a	23.76a	42.00a	38.47a	43.54b	33.73a	30.50b	33.10b	2.33aA	1.53aB	1.57bcB	
1 turning	21.56a	21.37a	20.34ab	44.73aB	40.16aB	62.26aA	32.19aB	37.24abAB	40.57aA	2.28aA	1.43aB	1.51cB	
2 turnings	20.39aB	23.99aA	19.62bB	46.25aB	45.71aB	61.21aA	33.29a	38.26a	35.71ab	1.85aAB	1.55aB	2.30abA	
VC%	9.85			13.72			12.73			24.77			
		ADIN %			NDIN%			Cellulose%			Lignin%		
Shed	0.26ab	0.25a	0.30a	0.32a	0.41a	0.28b	20.10a	17.16b	20.89b	7.90a	7.70a	5.61ab	
No turning	0.33a	0.25a	0.24a	0.49aB	0.50aB	0.93bA	23.82a	19.26ab	19.77b	7.19aAB	7.68aA	4.99bB	
1 turning	0.25aB	0.25aAB	0.30aA	0.53aB	0.45aB	1.27aA	22.60aAB	23.84aB	29.55aA	5.77a	7.29a	8.12a	
2 turnings	0.27aB	0.29aB	0.34aA	0.49aB	0.44aB	1.52aA	23.36aB	23.72aB	27.58aA	6.77a	8.85a	7.77a	
CV%	24.53			31.18			16.02			21.91			

\* Values followed by the same capital letter in row and minuscule in the column do not differ among themselves by Tukey test at 5%. CP = crude protein; NDF = neutral detergent fiber; ADF = acid detergent fiber; EE = ether extract; ADIN = acid detergent insoluble nitrogen; NDIN = neutral detergent insoluble nitrogen.

The NDF values were higher in storage with one and two turnings, although they did not differ in the other stages ( $p>0.05$ ). Monteiro et al (1998) have compared 17 cultivars of alfalfa and obtained lower values of NDF for the native cultivar with 43.64% at summertime. The superiority for ADF was observed only during the drying with one turning step.

When ADF contents were compared among drying methods, the answers were higher for 1 and 2 turnings. Although there was an increase in values of ADF and NDF with storage and turnings, their ranges are still available for ruminants.

Costa et al. (2006) obtained values (44.10% NDF and 34.73% ADF) similar to the ones from this experiment and those reported by NRC (2000), when a native cultivar was cropped in the summer.

Cellulose is one of the most important constituents of the cell wall and its contents can range from 20 to 40% (Matos, 1989). So, in this trial, cellulose contents ranged from 17.16% to 29.55%, as well as they increased significantly during the storage with one and two turnings. Such increase was due to the loss of leaves during the turnings of hay, dried under the sun, consequently, there was a higher proportion of stem (Table 3). The same answer was observed for lignin, a constituent of the cell wall that has an adverse impact on degradability of stem tissues of alfalfa (Jung & Engels, 2002).

It is also known that digestibility is one of the characteristics associated with one of the most important nutritional value of forage plants (Poppi et al., 1987), since it has an important influence on forage consumption.

Studies which have taken into account several forage species have consistently shown increases on consumption, as well as on digestibility with values from 40 to 80% (Lyons et al., 1999).

There were no differences ( $p < 0.05$ ) among the drying methods on digestibility at the baling time (Table 6), which were around 69.79% and 41.39% for DM and cell wall, respectively. Ferragine et al. (2004) obtained 75.79% of IVDDM for native alfalfa during the summertime.

Table 6 - In vitro dry matter digestibility and in vitro cell wall of alfalfa hay after baling

Drying methods	IVDDM %	IVDCW %
Shed	70.60	41.36
No turning	70.21	40.85
One turning	69.24	41.80
Two turnings	69.11	41.55
CV (%)	5.26	3.68

IVDDM =nitrogen and in vitro digestible dry matter; IVDCW = in vitro digestibility of cell wall.

Values of IVDCW were higher than those ones found by Fukushima & Savioli (2001) with the whole plants (early flowering) of stylosanthes, siratro and perennial soybean, which were 33, 32.5 and 30.9%, respectively.

## Conclusions

It is registered that alfalfa hay, when kept under the sun and with some turnings, shows poorer quality due to their leaf fall. The most efficient method for preserving the nutritional quality of hay suggests an initial drying under the sun plus a succeeding drying in an airy shed.

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