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RESEARCH ARTICLE

Quality classification of alfalfa hays according to protein and fiber contents

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Yonca kuru otlarının protein ve lif içeriklerine göre kalite sınıflarının oluşturulması

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Öz

Amaç: Bu çalışma Türkiye'de üretilen ve analizi yapılmış olan kuru otlarının protein ve lif düzeylerine göre kalitelerinin belirlenmesi ve yem tablolarında kullanılması amacıyla yapılmıştır.

Gereç ve Yöntem: Çalışmada 210 adet yonca kuru otuna ait analiz değerleri kullanılmıştır.

Bulgular: Kuru maddedeki ham protein (HP) düzeyleri %8,79 ile 22,96 arasında, ortalama %16,83, ortalama nötral deterjan lif (NDF) düzeyi %47,25 (%28,39-69,30), asit deterjan lif (ADF) düzeyi %37,01 (%22,76-52,57) olarak bulunmuştur. Bu sonuçlara göre 6 kalite sınıfı oluşturulmuş, %21'in üzerinde HP içeren yonca kuru otu 1. kalite olarak kabul edilmiştir. 2. kalitede %19-21, 3. kalitede %17-19, 4. kalitede %15-17, 5. kalitede %13-15, 6. kalitede <%13 HP içeren yoncalar gruplandırılmıştır. Örneklerin yaklaşık %23'ünün 3. kalitede, % 26'sının 4. kalitede, % 19'unun 5. kalitede, sadece %9,5'unun 1. kalitede olduğu görülmüştür. HP ile NDF ve ADF düzeyleri arasındaki ilişkiler incelendiğinde, kalite sınıflandırmasında ADF (r=-0,67)'nin kullanılmasının daha uygun olacağı belirlenmiştir. Kalite gruplandırmasında 1'den 6'ya sınıflarda ADF için <%28, %28-32, %32-37, %37-41, %41-46 ve >%46 olması uygun bulunmuştur. Tüm örneklerin ortalama protein, enerji, lif düzeylerine bakıldığında, yoncaların 4. kalitede olduğu belirlenmiştir.

Öneri: Ülkemizde daha bol yapraklı yoncaların üretilmesi, kurutma yönteminin tekrar gözden geçirilmesi ve yaprak kaybının azaltılması üzerinde durulmalıdır.

Anahtar kelimeler: Yonca kuru otu, ham protein, kalite, lif

Abstract

Aim: This study was made to determine the quality classification of alfaalfa hays produced in Turkey according to their protein and fiber levels and use in national feed tables. .

Materials and Methods: The nutrient analysis results of 210 alfalfa hays were used.

Results: The crude protein (CP) levels in the dry matter (DM) ranged from 8,79 to 22,96%, with an average of 16,83%. The mean of neutral detergent fiber (NDF) level was 47,25% (28,39-69,30%) and the acid detergent fiber (ADF) level was 37,01% (22,76-52,57%). According to the CP, 6 quality classes were created. Alfalfa hays containing more than 21% CP were considered as 1st quality, 19-21% as 2nd, 17-19% as 3rd, 15-17% as 4th, 13-15% as 5th, and less than 13% CP as 6th quality. It was seen that about 23% of the samples were in 3rd quality range, 26% in 4th, 19% in 5th and only 9,5% of samples were in 1st quality range. It was determined that ADF (r = -0,67) could be used for quality classification when the correlations between CP and NDF or ADF were examined. In the quality classification of 1st to 6th, it was found that for ADF, the classification from 1st to 6th would be <28%, 28-32%, 32-37%, 37-41%, 41-46% and >46%, respectively. When alfalfa hays evaluated according to the average protein, energy and fiber levels, all samples were found in 4th quality.

Conclusion: Cultivation of extra leafy alfalfa in country, revision of drying methods and reduction of leaf loss should be emphasized.

Keywords: Alfalfa hay, crude protein, fiber, quality

Introduction

When preparing rations, estimating nutrient content of roughage by looking at it or using table values can sometimes cause misconceptions. The nutritional value of forage can vary from field to field, from farm to farm, from year to year because many factors such as plant species, maturity, complexity of different plants, climate, fertilization, harvesting and storage affect it. Therefore, performing nutrient level analysis is the best way to know the quality of roughage. For ruminants, roughage and roughage quality are priorities. The quality of the feed is decided after a visual assessment according to the nutrient composition of the feed.

Alfalfa is a valuable roughage used in feeding almost all animals. It is consumed in different forms such as fresh, hay, pellets and silage. Dried alfalfa is mostly used in ruminant feeding in our country. It has many advantages in terms of yield and nutritional value. It is rich in energy and contributes to milk yield (Robinson 1998, Ward 2011). Besides being nutritious, it is also a delicious feed for ruminants.

Alfalfa hay is also an important source of structural fiber. The fiber in the roughage helps a suitable digestion and fermentation in the rumen. Fiber ensures the production of volatile fatty acids (VFA) and supports the optimum rumen pH by providing rumination. It also reduces feed costs and provides effective neutral detergent fiber (eNDF) that improves chewing and salivation. In addition to the contribution of digestibility of organic matter, animals are also need to be protected against ruminal acidosis and displacement of abomasum. It is difficult to balance the ration with roughage with very low NDF. Conversely, forages with high NDF lead to reduced dry matter consumption and milk yield in highly productive animals (Kocabatmaz et al 1987, Robinson 1998).

In the determination of the quality of alfalfa hay, relative feed value (RFV) is calculated according to ADF and NDF content (Ward 2011). Alfalfa hays are classified and priced according to NDF, ADF, RFV, total digestible nutrients (TDN) and CP levels in Western America, California feed markets (Table 1).

The price difference between exceptional and medium quality varies by years, but is around 50% (Putnam et al 2008, Marsalis et al 2014). In our country, there is no such classification to determine the selling prices that are suitable for it.

There are too many factors affecting the results of alfalfa hays analysis such as type of the plant, the soil, climate, country, harvesting, and drying methods, taking the sample and so on. The nutritional values found in the ration programs of foreign origin are mostly incompatible with those in our country. There are even differences between the values of the middle west and other regions of America (Marsalis et al 2014). In a study conducted in Turkey (Yolcu et al 2008) NDF levels in 12 different artificial dried alfalfa varieties showed a wide range from 33,41% to 50,39% in dry matter. There was also a significant difference between CP levels (24,17-32,00%).

The aim of this study is to evaluate the alfalfa hay samples coming from different regions of our country according to nutrients, classifying them according to CP, NDF and ADF contents and to lead pricing policy according to possible quality in the future. At the same time, by contributing the usage of alfalfa hay values of our country in formulating rations for ruminants, prepare more realistic ration.

Material and Methods

Materials of this study consisted of 210 alfalfa hay samples which analysed in Feed Analysis Laboratory in Faculty of Veterinary Medicine throughout 2010-2018. The alfalfa samples were milled through a 1 mm sieve in the Retsch SM 100. The DM, CP, ash, ether extract (EE) analysis were performed with the methods reported in Akkılıç and Sürmen (1979). ADF, NDF, and acid detergent lignin (ADL) levels were determined using the ANKOM 200 fiber analyzer device according to Methods 5, 6 and 8 reported for Ankom 200 in Ankom (2017) technology. After the analysis of ADF and NDF, crude protein determination was performed in filter bags which were obtained from the device and acid detergent insolub-

Table 1. The quality guidelines for alfalfa hay in California feed markets

Qulity grade	NDF,%	ADF,%	RFV	TDN,%	CP,%
Supreme	<34	<27	>185	>62	>22
Premium	34-36	27-29	170-185	61-62	20-22
Good	36-40	29-32	150-170	58-60	18-20
Fair	40-44	32-35	130-150	56-58	16-18
Low	>44	>35	<100	<56	<16

le nitrogen (ADIN) and neutral detergent insoluble nitrogen (NDIN) ratios were found. TDN, metabolizable energy (ME) and net energy lactation (NEL) were calculated using the formulas given in NRC (2001).

In order to determine the relationship between CP and NDF, ADF, ME and NEL, correlation analysis was performed in SPSS program. Alfalfa hays were classified from low to high as to 6 grades according to CP levels. NDF and ADF are divided into 6 quality classes. Chi-Square, Cochran's and Mantel-Haenszel analysis of these categorical groups determined in SPSS (V.22) program were used to determine the percentage of overlap of the groups.

Results

An average of 47,25% NDF in DM, ranging from 28,39% to 69,30% was determined in 210 alfalfa hays used in this study. 37,01% (22,76-52,57%) ADF was determined on dry matter basis. The average CP level was 16,83% in dry matter of the analysed alfalfa hay samples. The lowest value was 8,79% and the highest value was 22,96% (Table 2).

The average TDN in dry matter was 54,59%. There was a distribution between 39,18% and 69,58%. In the alfalfa hay, 1,92 (1,24-2,48) Mcal ME/kg DM and 1,15 (0,68-1,55) Mcal NEL/kg DM were determined (Table 2).

The significant correlations were found between CP and NDF (r=-0,62) and between CP and ADF (r=-0,67) (p<0,01).

Six different quality classes have been created in 2% increments based on CP levels in alfalfa hays. NDF and ADF levels were divided into 6 quality classes. Table 3 shows the CP, NDF and ADF limits for each class.
The association rates formed according to CP-ADF and CP-NDF levels of 6 quality classes are given in tables 4 and 5, respectively.

Discussion

Although the average NDF level of analysed alfalfa hays appears to be higher than the reported NDF values for alfalfa hay (41,73%) or alfalfa cubes (45,46%) in NRC (2016), it is consistent with CP content.

Table 2. Nutrient analysis and energy contents of alfalfa hays

Nutrient	Mean	SEM	Minimum	Maximum
Ash, % DM	8,72	0,12	4,06	14,12
EE, % DM	2,53	0,07	0,36	5,36
CP, % DM	16,83	0,20	8,79	22,96
NDF, % DM	47,25	0,55	28,39	69,30
ADF, % DM	37,01	0,45	22,76	52,57
ADL, % DM	10,12	0,16	4,67	15,73
TDN, %/DM	54,59	0,37	39,18	69,58
ME, Mcal/kg DM	1,92	0,02	1,24	2,48
NEL, Mcal/kg DM	1,15	0,01	0,68	1,55

Table 3. Quality classification according to protein and fiber contents in alfalfa hays

Quality class	CP	NDF*	ADF**
1	>21	<36	<28
2	19-21	36-41	28-32
3	17-19	41-46	32-37
4	15-17	46-51	37-41
5	13-15	51-56	41-46
6	<13	>56	>46

*: Correlation coefficient between CP and NDF is -0,62 (p<0,01).
**: Correlation coefficient between CP and ADF is -0,67 (p<0,01).

Table 4. The overlap rates of CP and ADF quality classes in alfalfa hay, %

		ADF						
	Quality class (no)	1	2	3	4	5	6	p
CP	1 (20)	95,0 (19)	5,0 (1)	0	0	0	0	0,001*
	2 (28)	0	100,0 (28)	0	0	0	0	
	3 (49)	0	4,1 (2)	95,9 (47)	0	0	0	
	4 (55)	0	0	10,9 (6)	83,6 (46)	5,5 (3)	0	
	5 (40)	0	0	0	0	100,0 (40)	0	
	6 (18)	0	0	0	0	5,6 (1)	94,4 (17)	

*:Cochran's and Mantel-Haenszel test

Table 5. The overlap rates of CP and NDF quality classes in alfalfa hay, %

		NDF						
	Quality class (no)	1	2	3	4	5	6	P
CP	1 (20)	95,0 (19)	5,0 (1)	0	0	0	0	0,001*
	2 (28)	0	96,4 (27)	3,6 (1)	0	0	0	
	3 (49)	0	0	93,9 (46)	6,1 (3)	0	0	
	4 (55)	0	0	0	95,0 (52)	5,0 (3)	0	
	5 (40)	0	0	0	0	95,0 (38)	5,0 (2)	
	6 (18)	0	0	0	0	0	100,0 (18)	

*:Cochran's and Mantel-Haenszel test

Because the CP levels of 19,81% in hays and 18,08% in cubes are higher than the average of 16,83% CP in this study. Therefore, if we look at the 2nd and 3rd quality alfalfa (Table 4) in which these protein levels were found in this study, it can be seen that NDF is approximately the same as in the NRC (2016) feed tables. While, a 40-44% NDF ratio was found in alfalfa hay which is medium quality according to CP content in the California quality classification (Table 1), it is 47,25% in this study. A high NDF value may be due to reasons that the plant was harvested late or that sampling was not made properly. The rate of NDF increases due to the loss of leaves during sampling and taking so much branched parts of alfalfa while sampling. Rain damage during drying of the plants increases NDF, ADF and lignin levels. In alfalfa varieties, changes can be seen according to the soil and the region where it grows (Robinson 1999). Indeed, Yolcu et al (2008) reported NDF levels ranged from 33,41% to 50,39% in 12 different alfalfa varieties. NDF values of alfalfa hay determined by different researchers (Balde et al 1993, Yari et al 2012, Yu et al 2003) are very similar to those in this study.

The ADF ratio was 37,01% (22,76-52,57%) in dried alfalfa samples and 33,25% in alfalfa hay in NRC (2016) feed table. It is important to note that the CP level of alfalfa hay in the NRC table is 19,81%, which is equivalent to the 2nd grade alfalfa hay determined in this study. Therefore, it is natural to be lower. The ADF may be higher than normal levels in samples analysed due to vegetation period, loss of leaves during drying or sampling. ADF level may also be increased in alfalfa which mixed with grass. Cash and Bowman (1993) reported that ADF, which was below 30% during budding, was over 40% during full flowering. The average ADF level determined in this study is very close to the ADF level in alfalfa hay obtained during the full flowering period of Balde et al (1993). Again, it is within the limits of low quality alfalfa hay of Güngör et al (2008). On the contrary, it is higher than the values found in some studies (Yu et al 2003, Dale et al 2012). Crude protein content varies according to plant maturity, leaf presence, weed content, rain and heat damage. CP levels are reported to be 21,8-35,0% in leaves and 9,6-20,0% in branches (Collins 1988, Putnam 2000). CP values reported for alfalfa hay in the literature (Balde et al 1993, Yu et al 2003, Abaş et al 2005, Yari et al 2012) are similar to the lower and upper limits in this study and have a distribution between 13,84-23,20%.

A higher correlation was found between CP and ADF than in NDF (-0,67 vs -0,62). Although this situation indicates that grouping feeds in the feed tables according to ADF levels would be more appropriate, the use of acidic chemicals in ADF analysis creates problems for laboratories health and environment. Therefore, it is thought that ADF analysis will be

abandoned after a while. In addition, NDF analysis becomes more important as it is necessary to determine the response of dairy cows to total mixed ration (TMR) and also to predict structural fiber (Robinson 1999). Reeves (1997) found that the correlation between CP and ADF in 15 alfalfa hays is very close to that found in this study.

According to the CP content of alfalfa hay, 6 quality classes, which are formed as 2% slices below 13% and 21% above, are overlapped with ADF and NDF levels. Examining Tables 4 and 5, it is seen that NDF classes can be grouped regularly in 5% tranches and the association rates with CP are better. When problems related to ADF analysis are considered, it seems more appropriate to use NDF in tables or quality classification. In fact, considering the relationship between NDF and the association of quality classes, it may be sufficient to use only CP.

Conclusion

The results of the analysis of alfalfa hay are very influenced by the type of plant, the maturity at the time of harvest, the type of harvest and sampling.

When the average CP and fiber levels of alfalfa hay are examined which are produced in our country, it is seen that alfalfa hay is sold in American markets.

In our country, it is compulsory to produce better quality dry alfalfa in response to the continuously increasing medium and large capacity cattle enterprises and increasing milk yield. For this purpose, suitable species for the region, leaf yields, species with low lignin levels should be used. In addition, irrigation, fertilization, form time, drying conditions, storage methods and conditions should be given maximum attention.

Especially because of the wide fluctuations in CP and energy levels, it is recommended that enterprises should analyse their alfalfa and regulate their rations according to their analysis values since they will be used throughout the year.
In the ration formulation for cattle, using local datas of alfalfa hay values instead of datas in foreign feed tables would be more accurate.

In our country, alfalfa quality classification, and pricing according to quality should be improved. It should be remembered that the quality classification and pricing accordingly will encourage the production of high-quality alfalfa.

Conflict of Interest

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References

Abaş İ, Özpınar H, Kutay HC, Kahraman R, 2005. Determination of the metabolizable energy (ME) and net energy lactation (NEL) contents of some feeds in the Marmara region by in vitro gas technique. Turk J Vet Anim Sci, 29, 751-757.

Akkılıç M, Sürmen S, 1979. Yem maddeleri ve hayvan besleme laboratuvar kitabı. Ankara Universitesi Basımevi, Ankara.

Ankom Technology. Analytical Methods Fiber Analyzer A200 (Method 5, Method 6, Method 8). 5/19/17. https://www.ankom.com/analytical-methods-support/fiber-analyzer-a200

Balde AT, Vandersall JH, Erdman RA, Reeves III JB, et al., 1993. Effect of stage of maturity of alfalfa and orchardgrass on in situ dry matter and crude protein degradability and amino acid composition. Anim Feed Sci Technol, 44, 29-43.

Cash D, Bowman HF, 1993. Alfalfa hay quality testing. MT-9302, Field Crops C-9 (Forages), February.

Collins M, 1988. Composition and fibre digestion in morphological components of an alfalfa-timothy sward. Anim Feed Sci Tech, 19, 135-143.

Dale LM, Rotar I, Thewis A, Vidican R, et al., 2012. Determination of alfalfa crude fiber, NDF, ADF and lignin content by NIR spectrometry. Lucrări Ştiinţifice, Seria Agronomie, 55, 245-249.

Güngör T, Başalan M, Aydoğan İ, 2008. Kırıkkale yöresinde üretilen bazı kaba yemlerde besin madde miktarları ve metabolize olabilir enerji düzeylerinin belirlenmesi. Ankara Üniv Vet Fak Derg, 55, 111-115.

Kocabatmaz M, Durgun Z, Eksen M, 1987. Kuru yoncanın rumendeki silialı protozoonlar üzerindeki etkisi. Selçuk Üniversitesi Vet Fak Dergisi, 3(1), 259-270.

Marsalis MA, Hagevoort GR, Lauriault LM, 2014. Hay quality, sampling, and testing. NM State Univercity, Circular 641, 1-6.

National Research Council, 2001. Nutrient Requirements of Dairy Cattle. Seventh Revised Edition. Natl. Acad. Press, Washington DC.

National Research Council, 2016. Nutrient Requirements of Beef Cattle. Eighth Revised Edition. Natl. Acad. Press, Washington DC.

Putnam DH, 2000. Producing high quality alfalfa: Factors that influence alfalfa forage quality. Proc. CA Plant and Soil Conference, Jan. 19-20. Stockton, CA.

Putnam DH, Robinson PH, DePeters E, 2008. Forage quality and testing. ANR Publications 8302.

Reeves III JB, 1997. Relationships between crude protein and determination of nondispersible lignin. J Dairy Sci, 80, 692-699.

Robinson PH, 1998. What are dairy nutritionists looking for in alfalfa hay? Proceedings, 28th California Alfalfa Symposium, 3-4 December, CA.

Robinson PH, 1999. Neutral Detergent Fiber (NDF) and its Role in Alfalfa Analysis. Proceedings, 29th California Alfalfa Symposium, 8-9 December, 1999, Fresno, CA.

SPSS. SPSS for Windows, Version 22. SPSS Inc. Chicago.

Ward RT, 2011. Analyzing silage crops for quality: what is most important? In: Proceedings, 2011 Western Alfalfa and Forage Conference, 11-13 December, Las Vegas, NV.

Yari M, Valizadeh R, Naserian AA, Jonker A, et al., 2012. Modeling nutrient availability of alfalfa hay cut at three stages ofmaturity and afternoon and morning. Anim Feed Sci Technol, 178, 12-19.

Yolcu H, Dascı M, Tan M, Comaklı B, 2008. Nutrient value of some lucerne cultivars based on chemical composition for livestock. Asian J Chem, 20(5), 4110-4116.

Yu P, Christensen DA, Mckinnon JJ, Markert JD, 2003. Effect of variety and maturity stage on chemical composition, carbohydrate and protein subfractions, in vitro rumen degradability and energy values of timothy and alfalfa, Can J Anim Sci, 83(2), 279-290.

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Ethical Approval

The data and information presented in this article were obtained within the framework of academic and ethical rules. Ethical declaration that the evaluation results were in accordance with scientific and ethic rules, was received from the authors.

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