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# THE EFFECTS OF VARIOUS DRYING METHODS ON THE NUTRIENT COMPOSITION OF ALFALFA VARIETIES

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## ABSTRACT

This study was carried out to reveal the effects of drying some alfalfa varieties using various drying methods on their nutrient composition. To this end, four drying methods (drying in the sun, shade, oven and microwave) were implemented on sixteen alfalfa varieties (Alsancak, Verdor, Gea, Gözlü 1, Özpınar, Bilensoy, Kayseri, Ömerbey, Magnum, Nimet, Sunter, Verko, Magma 601, Elçi, Savaş and Başbağ). The crude protein, crude ash, ADF (acid detergent fiber), NDF (neutral detergent fiber), DDM (digestible dry matter), DMI (dry matter intake), and RFV (relative feed value) levels of the dried alfalfa varieties were measured. According to the results, differences in the mean values in terms of alfalfa varieties, drying methods and the interaction between the variety and the drying method were found to be significant ($P<0.01$). The levels of crude protein, crude ash, ADF, DDM and RFV were significantly affected by the variety factor and the drying methods that were used ($P<0.01$).

**KEYWORDS:**
Alfalfa, drying method, crude protein, crude ash, ADF, NDF

## INTRODUCTION

Alfalfa is an important forage legume that can adapt to various climatic conditions [1]. It also ranks first in meeting the coarse forage needs of livestock. When it is mown during its early flowering stage, it contains energy in the same amount as and crude protein twice as much as other meadow-grass varieties [2]. Besides its high protein levels, the fact that it contains sufficient amounts of amino acids apart from cysteine makes it even more important [3]. Alfalfa may be used for animals' consumption in dried, fresh and ensiled forms. Dry alfalfa contains 12.11-20.26% crude protein, 1.47-2.33% crude fat, 24.71-30.62% crude cellulose, 8.74-10.57% crude ash, 33.52-39.64% ADF and 8.26-9.92% ADL (acid detergent lignin), though the values may vary according to quality and variety [4]. Like other legumes, alfalfa is categorized as a variety of forage that is difficult to ensile due to its high protein-mineral and low water-soluble carbohydrate contents [5].

Drying is one of the methods applied to alfalfas to meet the quality needs in coarse forage during periods when fresh grass cannot be found due to the difficulty of ensilaging. In Turkey, practices of drying and providing alfalfas for animals to consume are more common than other methods. However, significant nutrient loss occurs during the drying process [2]. The nutrient loss that occurs while drying green grass is directly proportionate to the duration of drying. As the duration is lengthened, the loss increases through oxidation of existing carbohydrates and beta-Carotenes, and the nutritional value of the dried grass decreases. Therefore, it is of utmost importance that green grass varieties are recovered with minimal nutrient loss [6].

Such a loss is much lower in artificial drying systems compared to natural ones since artificial systems involve a drying process that takes place rapidly and indoors [2]. With artificial drying systems, the nutrient compositions of plants are affected less, and their nutritive values are protected better [3].

The objective of this study is to investigate the effects of drying sixteen alfalfa varieties with four different methods (drying in the sun, shade, oven and microwave) on their nutrient compositions.

## MATERIALS AND METHODS

The alfalfa varieties that were used in the study were Alsancak, Verdor, Gea, Gözlü 1, Özpınar, Bilensoy, Kayseri, Ömerbey, Magnum, Nimet, Sunter, Verko, Magma 601, Elçi, Savaş and Başbağ, and they were harvested when they were 10% through their flowering stage. The harvested alfalfas were dried with the four aforementioned

drying methods.

The alfalfas were divided into four groups after being harvested and weighed. The plants in the first group were laid over a place where they could receive sunlight throughout the day, while the second group plants were laid over a place that did not receive any sunlight throughout the day, and all of them were dried until gaining a stable weight. The plants in the third group were dried within an oven at 70°C until they gained a stable weight, while the plants in the fourth group were dried in a microwave at 600 W for 3 minutes. After the drying process, the alfalfa samples were sifted through a 1-mm sieve, and their nutrient analyses were carried out. For crude ash analysis, the alfalfa samples were exposed to fire in a 550°C ash furnace, and their crude ash contents were calculated. The protein levels of the alfalfa samples were determined through the Kjeldahl method and calculated by multiplying their nitrogen content by AOAC (1990) [7]. Their NDF and ADF values were calculated by using an ANKOM 200 Fiber Analyzer (ANKOM Technology Corp. Fairport, NY, USA) [8]. Using the calculated NDF and ADF levels, digestible dry matter [DDM = 88.9 – (0.779 x % ADF)], dry matter intake (DMI = 120 / % NDF) and relative feed value [RFV = (DDM x DMI) / 1.29] levels were calculated [9].

The data obtained in the study were analyzed by using the SAS statistical software according to the randomized block and factorial experiment designs, while Duncan's test was used to determine the differences among the mean values.

## RESULTS AND DISCUSSION

Table 1 shows the crude protein contents of the alfalfa varieties dried by using different methods. Within the scope of the study, the factors of variety, drying method and interaction between variety and drying method significantly affected the crude protein levels of the samples ($P<0.01$).

Among the varieties, the highest crude protein content was found in Magnum as 21.9%, followed by Ömerbey, which was in the same group as the former, with a crude protein level of 21.6%. The lowest crude protein content was observed in the Alsancak variety as 17.7%. On the basis of the methods that were applied, , while the highest crude protein level was achieved with the sun-drying method as 21.0%, the lowest crude protein level was obtained by the microwave method as 18.6%. Ball et al. [10] reported that the protein level difference among varieties differs based on genetic structures, petioles, duration of maturation, temperature and fertilization procedures. The reason why the lowest crude protein level was obtained with the microwave drying method may be considered to be loss of ammonia and other non-protein nitrogen compounds due to temperature [11].

In terms of the interaction between he variety and the drying method, the highest protein content belonged to the sun-dried Ömerbey variety with 24.4%, followed by the same variety that was dried by using the oven drying method as 23.7% and the shade-dried Özpınar variety as 23.5%. The lowest crude protein content was obtained from the shade dried Alsancak variety as 14.8% (Table 1).

The results regarding the protein contents bore similarities to those in studies carried out by Canbolat and Karaman [12], Jančík et al. [13], Kamalak et al. [14] and Iantcheva et al. [15] (as 17.84%, 16.6-21.7%, 15.05-21.39% and 18.2%, respectively), while they were found to be lower than those reported by Çaçan et al. [16] and Yavuz [17] (as 25% and 22.1%, respectively).

**TABLE 1**
**Results regarding the crude protein contents (%) of the alfalfa varieties dried by using different methods**

| | Sun | Shade | Oven | Microwave | Average |
|---|---|---|---|---|---|
| Varieties | | | | | |
| Alsancak | 19.8 p-t | 14.8 h1 | 18.8 v-a1 | 17.2 c1d1 | 17.7 I |
| Verdor | 21.4 f-j | 15.7 f1g1 | 20.6 j-p | 17.6 b1c1 | 18.8 G |
| Gea | 22.7 b-d | 19.6 q-v | 20.1 n-s | 19.8 o-t | 20.6 DC |
| Gözlü 1 | 20.3 n-r | 18.9 u-a1 | 21.7 f-i | 15.5 f1-h1 | 19.1 GH |
| Özpınar | 18.5 x-b1 | 23.5 ab | 15.4 g1h1 | 21.0 h-n | 19.6 FG |
| Bilensoy | 22.3 c-f | 17.0 c1-e1 | 20.4 m-q | 20.9 i-n | 20.1 DEF |
| Kayseri | 19.3 s-x | 20.8 i-n | 19.8 o-t | 16.3 d1-f1 | 19.1 GH |
| Ömerbey | 24.4 a | 21.8 c-g | 23.7 a | 16.4 d1-f1 | 21.6 AB |
| Magnum | 21.9 d-g | 22.1 c-g | 22.6 c-e | 20.9 h-n | 21.9 A |
| Nimet | 21.2 g-m | 22.8 bc | 19.6 q-v | 18.4 y-b1 | 20.5 DC |
| Sunter | 19.3 s-y | 19.7 p-u | 18.6 x-a1 | 19.2 t-z | 19.2 GH |
| Verko | 21.8 e-h | 20.7 j-o | 22.7 b-d | 16.1 e1-g1 | 20.3 DE |
| Magma 601 | 22.3 c-f | 21.3 g-l | 19.3 s-x | 21.4 g-k | 21.1 BC |
| Elçi | 20.4 n-r | 18.9 u-a1 | 18.6 w-a1 | 18.3 a1b1 | 19.1 GH |
| Savaş | 20.5 k-p | 21.6 f-i | 19.5 r-w | 20.4 l-q | 20.5 DC |
| Başbağ | 20.2 n-r | 18.4 y-b1 | 22.3 c-f | 18.3 z-b1 | 19.8 EF |
| Average | 21.0 A | 19.9 C | 20.2 B | 18.6 D | |

In terms of crude ash ratios, the differences among the mean values of the alfalfa varieties, drying methods and interaction between variety and drying method were found to be statistically significant (P<0.01) (Table 2).

Among the alfalfa varieties in the study, the highest crude ash ratio belonged to Elçi as 8.9%, followed in the same group by the Ömerbey variety with the value of 8.7%. The lowest crude ash ratio was obtained from the Kayseri variety a 7.4%. On the basis of the methods that were applied, the highest crude ash ratio was achieved with the sun-drying method as 8.7%, while the lowest was obtained by the oven drying method as 7.8%. When evaluated in terms of the interaction between variety and drying method, the shade dried Nimet variety achieved the highest crude ash ratio (9.86%), followed in the same group by the sun-dried Alsancak and Elçi varieties (9.75% and 9.55% respectively). The lowest crude ash ratio was found in the oven-dried Magma 601 variety (6.86%).

The values that were obtained regarding the crude ash ratios differed from those found in studies carried out by Canbolat and Karaman [12], Iantcheva et al. [15], Jančík et al. [13] and Kamalak et al. [14] (as 5.75%, 9.3%, 11% and 10.33-11.65%, respectively).

Differences among the ADF ratio mean values of the alfalfa varieties, drying methods and interaction between variety and drying method were found to be statistically significant (P<0.01) (Table 3).

**TABLE 2**
**The results regarding the crude ash ratios (%) of the alfalfa varieties dried by using different methods**

| | Sun | Shade | Oven | Microwave | Average |
|---|---|---|---|---|---|
| Varieties | | | | | |
| Alsancak | 9.75 a | 8.95 d-f | 8.29 k-o | 7.36 w-z | 8.6 B |
| Verdor | 8.17 m-p | 8.85 d-g | 7.56 u-x | 7.18 y-a1 | 7.9 E |
| Gea | 8.77 e-h | 6.99 za1 | 7.77 q-v | 8.16 m-p | 7.9 E |
| Gözlü 1 | 8.37 j-n | 7.47 v-y | 8.15 m-p | 7.66 t-w | 7.9 E |
| Özpınar | 8.07 m-q | 8.74 e-i | 7.19 x-a1 | 7.85 p-u | 8.0 E |
| Bilensoy | 8.66 f-k | 7.18 y-a1 | 7.14 y-a1 | 7.46 v-y | 7.6 F |
| Kayseri | 7.35 w-z | 7.48 v-y | 7.26 x-z | 7.56 u-x | 7.4 F |
| Ömerbey | 9.18 cd | 8.66 f-j | 8.44 h-m | 8.57 g-l | 8.7 AB |
| Magnum | 8.98 d-f | 8.76 e-h | 8.17 m-p | 8.35 j-o | 8.6 B |
| Nimet | 8.26 l-o | 9.86 a | 8.16 m-p | 7.69 r-w | 8.5 BC |
| Sunter | 9.06 c-e | 8.14 m-q | 7.68 s-w | 7.65 t-w | 8.1 DE |
| Verko | 8.55 g-l | 8.08 m-q | 8.05 n-r | 8.37 i-n | 8.3 CD |
| Magma 601 | 8.57 g-l | 8.81 d-g | 6.86 a1 | 7.48 v-y | 7.9 E |
| Elçi | 9.55 ab | 9.17 cd | 8.36 j-n | 8.67 f-j | 8.9 A |
| Savaş | 8.68 f-j | 8.05 n-s | 7.06 za1 | 7.98 o-t | 7.9 E |
| Başbağ | 8.86 d-g | 8.17 m-p | 9.36 bc | 7.86 p-u | 8.6 B |
| Average | 8.7 A | 8.3 B | 7.8 C | 7.9 C | |

**TABLE 3**
**The results regarding the ADF ratios (%) of the alfalfa varieties dried by using different methods**

| | Sun | Shade | Oven | Microwave | Average |
|---|---|---|---|---|---|
| Varieties | | | | | |
| Alsancak | 34.43 j-o | 21.67e1 | 35.33h-m | 39.39 a-c | 32.7 E-G |
| Verdor | 32.69 s-x | 30.66 v-y | 33.40 n-s | 35.67 h-j | 32.9 E-G |
| Gea | 31.54 t-x | 34.38 j-o | 31.95 q-w | 31.45 u-x | 32.3 F-H |
| Gözlü 1 | 37.69 c-f | 31.78 r-x | 30.56 v-y | 33.53 n-r | 33.4 DE |
| Özpınar | 33.29 n-t | 27.33b1c1 | 39.45 ab | 37.49 d-g | 34.4 CD |
| Bilensoy | 32.57 p-u | 33.36 n-s | 34.61 i-n | 32.57 p-u | 33.3 D-F |
| Kayseri | 35.39 h-m | 33.55 n-q | 35.45 h-l | 38.54 b-e | 35.7 AB |
| Ömerbey | 30.38 w-z | 30.13x-a1 | 27.72b1c1 | 26.62 c1 | 28.7 J |
| Magnum | 32.72 o-u | 31.07 u-y | 31.33 u-y | 30.72 v-y | 31.4 H |
| Nimet | 30.55 v-y | 23.56 d1 | 33.89 k-p | 39.41 a-c | 31.8 GH |
| Sunter | 36.79 e-h | 28.57 a1b1 | 34.66 i-n | 35.63 h-k | 33.9 DE |
| Verko | 28.74 z-b1 | 32.30 p-v | 30.41 w-z | 29.68 y-a1 | 30.3 I |
| Magma 601 | 40.50 a | 31.76 s-x | 39.57 ab | 34.50 i-n | 36.6 A |
| Elçi | 38.59 b-d | 32.59 p-u | 36.22 f-i | 33.77 l-p | 35.3 BC |
| Savaş | 40.54 a | 33.35 n-s | 34.75 i-n | 35.83 g-j | 36.1 AB |
| Başbağ | 38.73 b-d | 33.69 m-q | 28.77 z-b1 | 35.47 h-l | 34.2 CD |
| Average | 34.6 A | 30.6 C | 33.6 B | 34.4 A | |

ADF is not desired to be on high levels since its digestion in the rumen is slow [17, 18]. Among the sampled alfalfa varieties, the Magma 601 variety had the highest ADF ratio as 36.6%, followed in the same group by the Savaş variety with the value of 36.1% and the Kayseri variety with the value of 35.7%. The lowest ADF ratio was observed in the Ömerbey variety as 28.7%. Güney et al. [19] reported that, as the ADF and NDF ratios increase, forage quality decreases. On the basis of the methods that were applied, the highest ADF ratios were obtained with the sun-drying method as 34.6% and the microwave drying method as 34.4% in the same group, while the lowest ADF ratio was achieved by the shade drying method as 30.6%. This result was in parallel with the report by Pelletier et al. [20] that the ADF ratios of forage samples dried at high temperatures may increase as a result of the Maillard reaction.

When the results are evaluated in terms of the interaction between variety and drying method, it is observed that the sun-dried Savaş variety had the highest ADF ratio (40.54%), followed by the sun-dried and oven-dried Magma variety (40.50% and 39.57% respectively), the oven-dried Özpınar variety (39.45%), the microwave-dried Nimet variety (39.61%) and the microwave-dried Alsancak variety (39.39%). The lowest ADF ratio was observed in the shade dried Alsancak variety (21.67%).

While the results regarding the ADF ratios of the alfalfa varieties dried by using different methods bore similarities to those reported by Jančík et al. [13] (27-39.7%), they were observed to be higher than those reported by Çaçan et al. [16] and Canbolat and Karaman [12] (20.4% and 28.87%, respectively), and lower than those put forward by Iantcheva et al. [15] and Yavuz [17] (41.8% and 37.3%, respectively).

The NDF ratios of the alfalfa varieties dried by using different methods are shown in Table 4. They were observed to be significantly affected (P<0.01) by variety factor, drying method and interaction between variety and drying method.

High NDF ratios in forage slow digestion down and affect forage consumption negatively since the NDF ratio is related to forage fermentation [17, 18].

In terms of NDF ratios, the Magma 601 variety had the highest level as 46.3%, while the lowest level was observed in the Ömerbey variety as 37.2%. On the basis of the methods that were applied, the highest NDF ratio was obtained by the oven drying method (45.6%), while the lowest level was achieved by the sun drying method (38.71%).

This result was in parallel with the result reported by Parissi et al. [21] that oven drying increases NDF and ADL ratios by causing water-insoluble tannin-protein polymers to appear in forage.

To evaluate the NDF ratios in terms of the interaction between variety and drying method, the sun-dried Nimet variety had the highest NDF ratio (54.48%), while the lowest NDF ratios were observed in the shade-dried Magnum (32.73%) and Nimet (33.74%) varieties, which were in the same group as the former.

The values regarding the NDF ratios of the alfalfa varieties dried through different methods bore similarities to those reported by Jančík et al. [13] (33.8-47.9%), while they were found to be higher than those reported by Çaçan et al. [16] (29.1%) and lower than those put forward by Yavuz [17] and Canbolat and Karaman [12] (46.7% and 42.51%, respectively).

The variety, drying method and interaction between variety and drying method were evaluated in terms of DDM ratios, as a result of which the differences between the groups were found to be statistically significant (P<0.01) (Table 5).

**TABLE 4**
**The results regarding the NDF ratios (%) of the alfalfa varieties dried by using different methods**

| | Sun | Shade | Oven | Microwave | Average |
|---|---|---|---|---|---|
| Varieties | | | | | |
| Alsancak | 41.44 j-n | 39.48 r-t | 49.33 cd | 48.47 d | 44.4 BC |
| Verdor | 41.22 j-n | 36.81 u-w | 44.58 gh | 42.50 i-k | 41.3 FG |
| Gea | 40.64 n-p | 42.36 i-l | 46.31 ef | 40.37 n-q | 42.4 FG |
| Gözlü 1 | 46.49 e | 40.58 n-p | 41.66 j-n | 40.73 m-p | 42.4 FG |
| Özpınar | 42.55 ij | 34.59 xy | 51.34 b | 44.48 gh | 43.2 D-F |
| Bilensoy | 41.35 j-n | 42.54 ij | 44.72 f-h | 40.75 m-p | 42.3 FG |
| Kayseri | 42.26 i-m | 40.92 k-o | 49.56 cd | 44.56 gh | 44.3 B-D |
| Ömerbey | 34.56 xy | 38.41 r-o | 40.45 n-p | 35.51 wx | 37.2 I |
| Magnum | 40.81 l-p | 32.73 z | 41.48 j-n | 35.55 v-x | 37.6 HI |
| Nimet | 53.48 a | 33.74 yz | 46.69 e | 45.69 e-g | 44.9 B |
| Sünter | 46.24 ef | 39.26 p-r | 45.47 e-g | 39.58 o-r | 42.6 EF |
| Verko | 37.45 s-u | 37.55 s-u | 42.60 ij | 37.14 t-v | 38.7 H |
| Magma 601 | 50.68 bc | 41.60 j-n | 49.18 cd | 43.59 hi | 46.3 A |
| Elçi | 46.61 e | 38.65 r-t | 48.69 d | 40.66 n-p | 44.6 C-E |
| Savaş | 49.39 cd | 40.44 n-p | 48.31 d | 42.30 i-m | 45.1 B |
| Başbağ | 46.36 e | 40.76 m-p | 38.82 q-s | 43.68 hi | 42.4 FG |
| Average | 38.71 D | 43.8 B | 45.6 A | 41.6 C | |

**TABLE 5**
**Results regarding the DDM ratios (%) of the alfalfa varieties dried by using different methods**

| | Sun | Shade | Oven | Microwave | Average |
|---|---|---|---|---|---|
| Varieties | | | | | |
| Alsancak | 62.08 q-v | 72.02 a | 61.37 s-x | 58.21 c1-e1 | 63.4 D-F |
| Verdor | 64.21 h-m | 65.01 g-j | 62.88 m-r | 61.11 v-x | 63.3 D-F |
| Gea | 64.33 h-l | 62.12 q-v | 64.01 i-o | 64.40 h-k | 63.7 C-E |
| Gözlü 1 | 59.54 z-c1 | 64.14 h-n | 65.09 g-j | 62.78 n-r | 62.9 E-G |
| Özpınar | 62.97 l-r | 67.61 cd | 58.17 d1e1 | 59.70 y-b1 | 62.1 GH |
| Bilensoy | 63.53 k-p | 62.91 m-r | 61.94 r-w | 63.53 k-p | 63.0 E-G |
| Kayseri | 61.33 s-x | 62.77 o-r | 61.29 t-x | 58.88 a1-d1 | 61.1 IJ |
| Ömerbey | 65.24 f-i | 65.43 e-h | 67.31 cd | 68.17 c | 66.5 A |
| Magnum | 63.41 k-q | 64.69 g-k | 64.50 g-k | 64.97 g-j | 64.4 C |
| Nimet | 65.10 g-j | 70.55 b | 62.50 p-u | 58.20 c1-e1 | 64.1 CD |
| Sunter | 60.24 x-a1 | 66.65 de | 61.90 r-w | 61.15 u-x | 62.5 FG |
| Verko | 66.51 d-f | 63.74 j-p | 65.21 f-i | 65.78 e-g | 65.3 B |
| Magma 601 | 57.35 e1 | 64.16 h-m | 58.07 d1e1 | 62.03 r-w | 60.4 J |
| Elçi | 58.84 b1-d1 | 63.51 k-p | 60.68 w-z | 62.59 p-t | 61.4 HI |
| Savaş | 57.32 e1 | 62.92 m-r | 61.83 r-w | 60.99 v-y | 60.8 IJ |
| Başbağ | 58.73 b1-d1 | 62.66 o-s | 66.49 d-f | 61.27 t-x | 62.3 GH |
| Average | 61.9 C | 65.0 A | 62.7 B | 62.1 C | |

**TABLE 6**
**Results regarding the DMI ratios (%) of the alfalfa varieties dried by using different methods**

| | Sun | Shade | Oven | Microwave | Average |
|---|---|---|---|---|---|
| Varieties | | | | | |
| Alsancak | 2.90 k-p | 3.12 e-h | 2.43 z-b1 | 2.48 x-a1 | 2.73 EF |
| Verdor | 2.91 k-p | 3.26 d | 2.69 r-u | 2.83 o-q | 2.92 C |
| Gea | 2.95 i-l | 2.83 n-q | 2.59 t-w | 2.97 i-k | 2.84 D |
| Gözlü 1 | 2.58 u-x | 2.96 i-k | 2.88 k-p | 2.95 i-m | 2.84 D |
| Özpınar | 2.82 o-q | 3.47 bc | 2.34 b1c1 | 2.70 r-t | 2.83 D |
| Bilensoy | 2.90 k-p | 2.82 o-q | 2.68 r-v | 2.95 i-n | 2.84 D |
| Kayseri | 2.84 l-q | 2.93 j-o | 2.42 z-b1 | 2.69 r-u | 2.72 EF |
| Ömerbey | 3.47 bc | 3.13 e-h | 2.97 i-k | 3.38 c | 3.24 A |
| Magnum | 2.94 j-n | 3.67 a | 2.89 k-p | 3.38 c | 3.22 A |
| Nimet | 2.24 c1 | 3.56 ab | 2.57 v-y | 2.63 t-v | 2.75 EF |
| Sunter | 2.60 t-w | 3.06 hi | 2.64 s-v | 3.03 h-j | 2.83 D |
| Verko | 3.21 d-f | 3.20 d-g | 2.81 pq | 3.23 de | 3.11 B |
| Magma 601 | 2.37 a1b1 | 2.89 k-p | 2.44 z-b1 | 2.75 qr | 2.61 G |
| Elçi | 2.58 v-y | 3.11 f-h | 2.47 y-a1 | 2.95 i-l | 2.77 DE |
| Savaş | 2.43 z-b1 | 2.97 i-k | 2.48 w-z | 2.84 m-q | 2.68 FG |
| Başbağ | 2.59 t-x | 2.95 i-m | 3.09 gh | 2.75 q-s | 2.84 D |
| Average | 2.77 C | 3.12 A | 2.65 D | 2.91 B | |

Regarding the alfalfa varieties, the highest DDM ratio was measured in the Ömerbey variety (66.5%), while the lowest ratios were determined to be in the Magma 601 (60.4%), Savaş (60.8%) and Kayseri (61.1%) varieties, which were in the same group as the former. On the basis of the methods that were applied, the highest DDM ratio was obtained with the shade drying method (65%), followed by the oven drying method (62.7%), microwave drying method (62.1%) and sun drying method (61.9%).

To evaluate the DDM ratios in terms of the interaction between variety and drying method, the highest DDM ratio was obtained in the shade-dried Alsancak variety (72.02%), while the lowest ratios were found in the sun-dried Savaş (57.32%) and Magma 601 (57.35%) varieties.

The results that were obtained bore similarities to those reported by Canbolat and Karaman [12] (59.5-66.8%), while they were lower than those put forward by Çaçan et al. [16] (73%) and higher than those stated by Yavuz [17] (59.7%).

The variety, drying method and interaction between variety and drying method significantly affected ($P<0.01$) the DMI ratios of the dried alfalfa varieties (Table 6).

To evaluate the dried alfalfas in terms of their varieties, the highest DMI ratios belonged to the Ömerbey (3.24%) and Magnum (3.22%) varieties, both of which were in the same group. The lowest DMI ratios were measured in the Magma 601 (2.61%) and Savaş (2.68%) varieties, likewise in the same group. On the basis of the methods that were applied, the varieties dried through the shade drying method had the highest DMI ratio as 3.12%,

**TABLE 7**
**Results regarding the RFV of the alfalfa varieties dried by using different methods**

| | Sun | Shade | Oven | Microwave | Average |
|---|---|---|---|---|---|
| Varieties | | | | | |
| Alsancak | 139.4 m-q | 174.2 de | 115.8 z-d1 | 111.7 c1-f1 | 135.3 DE |
| Verdor | 144.9 l-n | 164.4 f-h | 131.2 r-u | 133.8 q-t | 143.6 C |
| Gea | 147.3 kl | 136.4 p-r | 128.6 s-v | 148.5 j-l | 140.2 CD |
| Gözlü 1 | 119.2 x-b1 | 147.1 kl | 145.5 lm | 143.5 l-p | 138.8 CD |
| Özpınar | 137.7 n-r | 181.9 bc | 105.4 f1 | 124.9 u-x | 137.5 DE |
| Bilensoy | 143.0 l-p | 137.6 o-r | 128.9 s-v | 145.1 lm | 138.6 CD |
| Kayseri | 135.1 q-s | 142.8 l-p | 115.1 a1-e1 | 123.0 v-z | 129.0 FG |
| Ömerbey | 175.6 c-e | 158.5 g-i | 154.9 ij | 178.7 b-d | 166.9 A |
| Magnum | 144.6 l-o | 184.0 b | 144.7 l-o | 170.2 ef | 160.9 B |
| Nimet | 113.3 b1-e1 | 194.7 a | 124.6 u-y | 118.6 x-c1 | 137.8 D |
| Sünter | 121.2 w-a1 | 158.1 hi | 126.7 t-w | 143.8 l-o | 137.5 DE |
| Verko | 165.3 fg | 158.0 hi | 142.5 l-p | 164.8 f-h | 157.6 B |
| Magma 601 | 105.2 f1 | 143.6 l-p | 109.9 d1-f1 | 132.5 q-t | 122.8 H |
| Elçi | 117.5 y-c1 | 153.0 i-k | 116.0 z-d1 | 143.2 l-p | 132.4 EF |
| Savaş | 108.0 e1f1 | 144.8 lo | 119.1 x-b1 | 134.2 q-s | 126.5 HG |
| Başbağ | 117.9 x-c1 | 143.1 l-p | 159.4 g-i | 130.5 r-u | 137.7 D |
| Average | 133.4 C | 157.6 A | 129.3 D | 140.4 B | |

followed by the microwave drying method (2.91%), sun drying method (2.71%) and oven drying method (2.65%). In terms of the interaction between variety and drying method, the highest DMI ratios belonged to the shade-dried Magnum (3.67%) and Nimet (3.56%) varieties. The lowest DMI ratios were observed in the oven-dried Özpınar variety (2.34%) and the sun-dried Nimet variety (2.24%) within the same statistical group.

The results regarding the DMI ratios bore similarities to those presented by Canbolat and Karaman [12] (2.8%), while they were determined to be lower than those reported by Çaçan et al. [16] (4.23%) and higher than those reported by Yavuz [17] (2.56%).

The variety, drying method and interaction between variety and drying method were found to have statistically significant effects ($P<0.01$) on the RFV levels of the alfalfa varieties (Table 7).

Though it may be used for every plant, RFV was initially developed to measure the nutrient value of alfalfas [22]. The DMI and DDM ratios, which are determined through ADF and NDF analyses, are used to calculate RFV [23]. RFV is based on the value of 100 calculated through 41% ADF and 53% NDF contents contained by alfalfa hay on a perfect flower. The forage quality decreases when the RFV drops below 100 and increases when the RFV rises above 100 [24].

With regard to the alfalfa varieties, the highest RFV belonged to the Ömerbey variety as 160.9, while the lowest values were obtained from the Magma 601 and Savaş varieties from the same group as the former, as 122.8 and 126.5, respectively. On the basis of the methods that were applied, the shade drying method generated the highest RFV as 157.6, while the lowest value was obtained by the oven drying method as 129.3. In terms of the interaction between variety and drying method, the highest RFV was generated by the shade-dried Nimet variety (194.7), while the lowest values belonged to the sun-dried Magma 601 variety (105.2) and the oven-dried Özpınar variety (105.4).

The results regarding the relative feed values bore similarities to those reported by Canbolat and Karaman [12] (145.4), while they were lower than the values reported by Çaçan et al. [16] (240.1) and higher than those put forward by Yavuz [17] (118.8).

## CONCLUSION

Changes in the nutritional values of some alfalfa varieties dried by using different methods were observed within the scope of this study. Different drying methods affected the chemical and nutrient compositions of the alfalfa varieties. The crude protein, crude ash, ADF, DDM and RFV levels of the dried alfalfa varieties were determined to be significantly affected ($P<0.01$) by the variety and drying method factors.

The sun-dried and oven-dried Ömerbey variety and the shade-dried Özpınar variety had the highest crude protein content. The lowest ADF ratio was observed in the shade-dried Alsancak variety, while the lowest NDF ratios belonged to the similarly shade-dried Magnum and Nimet varieties. In the light of all these results, it is concluded that alfalfas must be shade-dried for the sake of preserving their nutritional values and digestibility.

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