**Determination of the Nutritive Value and Methane Production Potential of Storax Tree Leaves**

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# Abstract

This study has been conducted to identify the impact of nutritive values of “storax tree” (*Styrax officinalis L*.) on *in vitro* gas production, metabolic energy value and organic matter digestibility. Plant samples have been collected for analysis in May, July and September. According to the findings of our study, Dry Matter, crude ash, crude fat, NDF and ADF values have increased in September in comparison to the May and July values. In comparison to the values from the May samples, DM has increased by 64%, CA by 23%, CF by 30.5%, NDF by 9.8% and ADF by 9.8%. There have been increases in dry matter parallel to maturation in the vegetation period. Crude protein amount was 19, 17 and 15 % and crude fat 3.2, 4.4 and 4.3% in May, July and September, respectively. Crude ash, NDF, ADF content in storax tree varies from 8.58, 9.86 and 10.56; 37.5%, 39.0%, 41.5%; 27%, 28.5%, and 30% in May, July and September, respectively. Metabolic energy has varied between 8.86 and 10.06 (MJ/kg DM) as per periods. The analysis of organic matter digestion levels has shown the peak value in July (58.71%). Gas production has been identified via 0, 3, 6, 12, 24, 48, 72 and 96 hours incubations, and gas measurement values have started generally from the highest and actualized respectively in September, July and May. This study has identified nutrition matter content of the storax tree plant, which is an indispensable nutrition resource of Mediterranean type forages, especially during the drought terms of, and their nutrition value and quality for animal feeding.

**KEY WORDS:** *In Vitro* gas production; *Styrax officinalis L.*; metabolic energy; nutrient value

**Introduction**

Coarse and dense fodder are used in animal feeding, especially for ruminants. In daily feeding of the animals, dense fodders are required while coarse fodders are necessary for animals to be productive and healthy (Kılıç, 2003). Coarse fodders are of plant origin; fresh, dried or silaged, containing high amount of crude cellulose but low protein and energy levels (Hanoğlu, 2014). Coarse fodder resources in Turkey are insufficient to meet the requirements. Although the share of graze-pastures within the total land size in Turkey is relatively good, productivity is very low due to poor ecological conditions and misuses (Okuyucu and Okuyucu, 2006). The ligneous group of graze vegetation are formed of “shrubs” and “shrubbized trees” while the herbaceous group is formed of graze plants (Uluocak, 1980). Forage plants include plants in many different features and structure. In pastures, one can see forage plants of good quality, which is useful for soil preservation and fodder quality.

Storax (*Styrax officinalis*), a member of the ligneous group of forage plants, is usually grown in Central America, Mexico and the Mediterranean region (Davis, 1972). It grows in mountainous areas and has a height of 1,5 to 3 meter. In Turkey, it is generally seen in altitudes of 10-1000 meters and is common in Western Anatolia and the Mediterranean regions. Even though the border of its expansion is not certainly known, it is seen in most of the provinces in both regions, usually in valleys, open habitats and northern slopes (Vardar and Oflas, 1973). *Styrax officinalis* is a nice plant, with falling leaves and is a small tree or a big bush. The color of the leaves is light green and the leaves are round shaped. The upper part of the leave is smooth while the bottom part is pileous. The height of the plant varies between 2 to 7 meters. The 2-4 cm big white flowers form bunches by combining 3-6 flowers. Petals of the flower unite below to form a small tube. Its fruit has the size of cherry and is covered with a white cover. Although *Styrax officinalis* is known as “tesbih çalısı” (storax tree) in Turkey, it is called “havz” in Antakya, “tesbih” in Adana and Muğla, “mangıkı” in Tire, “deli tesbih” in Ödemiş and “domuz” in Bayındır (Zeybek, 1963).

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# Materials and Methods

**Preparation of Fodder Material and Conducting the Chemical Analysis**

In this study, samplings have been taken from naturally growing storax trees in 3 periods; in May, July and September. Leaves collected from 10 trees in 3 periods in 3 turns were taken to the laboratory, first weighed wet, then dried, and their dry weights were calculated. The dried samples were grinded to go through 1 mm sieve, and packed to measure dry matter (DM), crude ash (CA), crude protein (CP), crude fat (CF), crude cellulose (CC), ADF, NDF and in vitro gas values.

Crude feed matter (DM, CP, CF, CA and organic matter (OM)) values of the storax tree leaves used in the test have been identified according to AOAC (1990). ADF (acid detergent fiber) and NDF (neutral detergent fiber) analysis of the fodder plant have been conducted according to the method described by Van Soest et al. (1991). Although the most ideal method in identifying the real digestion level of the storax tree is the *in-vivo* method, due to facts such as high labor force and cost, *in-vitro* method was employed. Metabolic Energy (ME) contents of the storax tree leaves used in the trial, and the *in vitro* organic matter digestion levels were identified according to the method described by Menke et al. (1979) by using gas production technique.

**Statistical Analysis**

Statistical assessment of the data to identify differences between the averages was carried out using one way variance analysis of the SPSS (9.0) package program. The significance of the differences between groups was evaluated according to Duncan’s t test.

# Findings and Discussion

Raw material food contents of the fodder plant used in the research are given in Table 1. The influence of the period differences of the storax tree on DM, CA, CP, CF, NDF and ADF are found statistically important (P*<0.01)*. DM, CA, NDF and ADF contents were at the lowest level in May while they were at the highest level in September. When compared with May, increases in September have been 64% in DM, 23% in CA, 30.5% in CF, 9.8% in NDF and 9.8% in ADF. CP amounts of the storax leaves were in the same statistical group in May and July, and the lowest CP amount was obtained in September. CP amount in September is 17.5%, lower than the amount in May.

Table 1. Food matter contents in storax tree leaves for different periods (%)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Periods | DM | CA | CP | CF | NDF | ADF |
| May | 29.72±0.91a | 8.58±0.18a | 18.81±0.62a | 3.21±0.08a | 37.78±0.36a | 27.28±0.26a |
| July | 42.07±1.36b | 9.86±0.17b | 17.43±0.29a | 4.30±0.16b | 39.09±0.37b | 28.21±0.26b |
| September | 48.74±0.57c | 10.56±0.20c | 15.52±0.13b | 4.19±0.11b | 41.50±0.34c | 29.95±0.24c |
| *P* | \*\* | \*\* | \*\* | \*\* | \*\* | \*\* |

*abc: Differences between groups in the same column are statistically important. \*\*P<0.01*

The table shows that the dry material amount is the highest (50%) in September compared to the 30% in May and 40% in July. During the vegetation period, there are increases in dry material content parallel to ripening. Analysis conducted after mowing the storax in various periods showed that CA amount is 9% in May, 10% in July and the highest again, 11%, in September. As dry material amount increases with time, Crude ash amount increases accordingly. Crude protein amount in storax tree is around 19% in May, around 17% in July and around 15 % in September. As storax matures, CP disrupts and its proportion decreases. Crude fat content in storax varies per mowing period, and has the highest value of 4.4% in July, and is 4.3% in September. Crude fat content is at its lowest level in May. According to the analysis of the storax, NDF content was 37.5% in May, 39% in July and 41.% in September, which is the highest value. In the vegetation period, there are increases in NDF content parallel to ripening. As a result of the analysis, it is found that there are increases in ADF content, and the values are 27% in May, 28.5% in July and 30% in September. As mowing period is longer, ADF content increases accordingly.

Metabolic energy (MJ/kg DM) and organic material digestibility (%) values in the storax tree leaves used in the research at various periods are given in Table 2.

Table 2. ME (MJ/kg DM) and OMD (%) levels for various periods in storax tree leaves

|  |  |  |
| --- | --- | --- |
| Periods | ME  (MJ/kg KM) | OMD  (%) |
| May | 8.86a | 54.62a |
| July | 10.06b | 58.71b |
| September | 9.12a | 54.55a |
| *St. Error* | 0.25 | 1.22 |
| *P* | \*\* | \* |

*ab: Differences between groups in the same column are statistically important. \*P<0.05 \*\*P<0.01*

Metabolic energy rates in storax tree leaves as per periods have been found significant in the statistical analysis results (*P<0.05).* May and September periods are in the same group in term of metabolic energy, and are lower than the July period. Metabolic energy has shown differences per periods between 8.86 and 10.06 (MJ/kg KM). It is found that organic digestion levels are significant as a result of the statistical analysis (*P<0.01)*. The highest organic matter digestion level is found in July as 58.71%.

Table 3. Gas production amounts of storax tree leaves in various periods (ml/200 mg KM)

| Incubation time  (hours) | May | July | September |
| --- | --- | --- | --- |
| 3 | 8.60±1.42 | 13.20±0.75 | 14.54±1.28 |
| 6 | 14.29±2.79 | 22.26±1.88 | 23.80±1.88 |
| 9 | 16.18±3.45 | 25.23±1.41 | 25.97±2.27 |
| 12 | 24.50±3.47 | 32.80±4.52 | 34.49±4.5 |
| 24 | 34.56±3.30 | 39.76±2.37 | 35.99±2.66 |
| 48 | 43.63±5.28 | 43.38±1.53 | 45.23±2.32 |
| 72 | 51.88±2.04 | 51.04±3.50 | 50.98±3.26 |
| 96 | 52.67±4.68 | 56.73±2.44 | 58.66±3.87 |

Gas production amounts of storax tree leaves in various periods, as incubation time increases, gas amounts increase accordingly. Although there are differences in gas production amounts in different periods, it is generally the highest in September and the lowest in May (Figure 1).

0,00

10,00

20,00

30,00

40,00

50,00

60,00

70,00

3

6

9

12

24

48

72

96

Incubation time hours (hours)

Gas production amount (ml/200g KM)

MAYIS

TEMMUZ

EYLÜL

Figure 1. Gas production amounts of storax tree leaves in various periods (ml/200 mg DM)

Gas measurement as a result of the incubation is found in 3-6-12-24-48-72 and 96 hours, and is in the lowest level after 3 hours, and highest after 96 hours. Gas measurement values generally started from the highest and were conducted in September, July and May consecutively (Figure 2).

0,00

10,00

20,00

30,00

40,00

50,00

60,00

70,00

0

10

20

30

40

50

60

70

80

90

100

Incubation time (hours)

Gas production amount (ml/200g DM)

MAY

JULY

SEPTEMBER

Figure 2. Gas production of storax tree leaves in various periods (ml/200 mg KM).

The increase in ADF levels found in structures of the storax tree leaves lower the digestion rate of the fodder, while increase of the NDF rate lowers taking the fodder and gives the animal the feeling of satiety, and limits fodder consumption of the animal and the convenience of the fodder. Due to negative impact of the NDF and ADF on digestion of the fodder and fodder consumption, in using the rations, fodders with ideal levels are preferred (Canbolat and Karaman, 2009; Van Soest, 1994; Bozkurt Kiraz, 2011). Populations are mostly of first quality while a small quantity has the second quality according to ADF and NDF contents (Van Soest, 1994).

As the back and leave rates of the plants differ, and as a result of this raw protein, ADF and NDF rates differ, there is accordingly difference in the gas amounts produced by the populations. Aslan (2015), has identified that there is a negative relation between the ADF and NDF levels in coarse fodder contents and digestibility of the fodder. Organic matter digestibility level (OMDL) is found low in wheat straw, which is a coarse fodder. It is determined that there is a negative relation between CA contents of the fodder and the total gas produced. The highest gas production after the fermentation of the fodders is found in corn (67.36%) while the lowest is found in sunflower seed pulp (26.72%). It is found that there are major differences (p<0.001) in terms of metabolic energy, organic matter digestibility level and methane production of the fodders subject to the research. Ülger and Kaplan (2016), have found major differences (P≤0.01) statistically important for the chemical composition of the trefoil population. They have identified that raw protein level is between 12.73% and 15.90%; raw ash level between 5.95% and 7.63%; dry matter level between 19.41% and 22.39%; condensed tannen rate 2.07% and 4.70%; ADF rate 32.01% and 41.79%; NDF rate between 42.57% and 53.89%; and crude fat rates between 0.69% and 2.02%.24 hours in vitro gas and methane productions are found to be between 39.49and 52.40 ml, and 7.70 and 10.30; metabolic energy contents between 8.31 and 10.19 MJ/kg KM; and the organic matter digestion levels between 60.05% and 72.59%.

# Results

In this study, the aim was to identify the impact of the storax tree (*styrax officinalis l*.), which is found in many regions in Turkey as a major fodder resource for ruminants, on in-vitro gas production, food matter contents, metabolic energy contents and organic matter digestibility. Nutritional composition of feeds primarily determined by chemical analysis. However, this does not provide sufficient information to determine the true nutritional value of the feed. For this reason, it is thought that these studies carried out in laboratory conditions will be carried out on animals as well. This research has also identified the availability and quality of the fodder material requirements of the animals grazing on storax tree plants, which are indispensable fodder sources especially in draught periods of summer in pastures of the Mediterranean climate areas. The feed consumption of the leaves of the storax tree plants, its effect on performance and methane production In vivo trials are needed to determine.

**Appendices**

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**References**

Aslan, F., 2015. Ruminant Beslemede Kullanılan Bazı Kaba ve Kesif Yemlerin İn Vitro Gaz Üretimi, Metabolik Enerji Ve Organik Madde Sindirim Değerlerinin Belirlenmesi. Kahramanmaraş Sütçü İmam Üniversitesi, Fen Bilimleri Enstitüsü, Yüksek Lisans Tezi, Kahramanmaraş, 33s.

Bozkurt Kiraz, A., 2011. [Determination of relative feed value of some legume hays harvested at flowering stage.](https://scholar.google.com.tr/scholar?oi=bibs&cluster=6428355473250940841&btnI=1&hl=tr) Asian Journal of Animal and Veterinary Advances.6(5): 525-530.

A.O.A.C., 1990. Official Method of Anallysis. Association of Official Analytical Chemists. 15th. edition Washington, DC.USA., 66-88.

Canbolat, Ö. and Karaman, Ş. 2009. Bazı Baklagil Kaba Yemlerinin in Vitro Gaz Üretimi, Organik Madde Sindirimi, Nispi Yem Değeri ve Metabolik Enerji İçeriklerinin Karşılaştırılması. Tarım Bilimleri Dergisi, 15(2): 188-195.

Davis, P.H., 1972. Flora of Turkey and the East Aegean Islands, Vol. 4. University of Edinburgh Pres, Edinburgh.

Hanoğlu, H., 2014. Türkiye'de Meralar ve Kaliteli Kaba Yem Üretimi, Tarım ve Mühendislik Dergisi,107:14-16.

Kılıç, A., 2003. Kaba Yem Üretimi ve Sorunları, [www.zmo.org.tr](http://www.zmo.org.tr/).

Menke, K.H.,Raab, L., Salewski, A., Steingass, H., Fritz, D., Schneider, W. 1979. The Estimation of Digestibility and Metabolizable Energy Content of Ruminant Feeding Stuffs from the Gas Production when they are incubated with Rumen Liqueur İn Vitro. Journal of Agricultural Science, 93: 217-222.

Okuyucu, B. and Okuyucu, F., 2006.Çayır-Meralarda Organik Tarım Uygulamaları ve Yararları, 7(1):54-61.

SPSS (9.0). 1999: SPSS for Windows. Chicago, Illinois.

Uluocak, N., 1980. Toprak Koruyucu Doğal Bitki Örtüsü ve İndikatör Olaylar. İstanbul Üniversitesi Orman Fakültesi Dergisi, 30(1):66-67.

Ülger, İ., and Kaplan, M., 2016. Yerel Korunga (Onobrychissativa) Popülasyonlarında Potansiyel Besleme Değeri, Gaz ve Metan Üretimi Yönünden Farklılıklar. Alınteri Zirai Bilimler Dergisi, 31 (B):1307-3311.

Van Soest., P. J., 1994. Nutritional Ecology of the Ruminant (2nd Ed.). Ithaca, N.Y. Cornell University Press.

Van, Soest., P.J., Robertson, J.D., Lewis, B.A., 1991. Methods for Dietary Fibre, Neutral Detergent Fibre and Non-starch Polysaccharides in Relation to Animal Nutrition. Journal of Dairy Science, 74:3583–3597.

Vardar, Y. and Oflas, S., 1973. Qual. Plant Mater. Veg. XXII, 2: 145-148.

Zeybek, N., 1963. Ein Berichtüber den echten Storaxbaum (Styrax officinalis L.). Seien. Rep. of the Fac. Of Seien. Ege Universitesi.13.