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RESEARCH ARTICLE

# Potential Nutritive Value of Field Binweed (*Convolvulus arvensis* L) Hay Harvested at Three Different Maturity Stages

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## Summary

The aim of this study was to determine the potential nutritive value of *Convolvulus arvensis* L. using chemical composition and *in vitro* gas production technique. Gas productions of *Convolvulus arvensis* hay were determined at 0, 3, 6, 12, 24, 48, 72 and 96 h incubation times and their gas production kinetics were described using the equation $y = A (1\text{-}exp^{-ct})$. As a result of this study, maturity had a significant effect on the chemical composition, *in vitro* gas production, metabolisable energy (ME) and organic matter digestibility (OMD) of *Convolvulus arvensis* ($P<0.05$). Dry matter (DM), cell wall contents neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) of *Convolvulus arvensis* hay increased whereas crude protein (CP), ether extract (EE) and ash content decreased with maturity. The CP contents of *Convolvulus arvensis* hay ranged from 16.63 to 23.83%. The NDF, ADF and ADL contents of *Convolvulus arvensis* hay ranged from 34.00 to 54.04, 28.76 to 40.34 and 5.26 to 12.18% respectively. The potential gas production and estimated parameters decreased with increasing maturity of *Convolvulus arvensis* hay ($P<0.05$). The potential gas production (A) ranged from 61.59 to 71.77 ml. The ME and OMD ranged from 9.31 and 11.71 MJ/kg DM and 63.19 to 79.17% respectively. In conclusion, although the nutritive value of *Convolvulus arvensis* plant hugely decreased with increasing maturity it appears that *Convolvulus arvensis* plant could be grazed or harvested at these more advanced stages and still provides forage with an adequate quality for ruminant animals to meet their nutrient requirements.

***Keywords:*** *Chemical composition, Convolvulus arvensis hay, Digestibility, In vitro gas production, Nutritive value*

# Üç Farklı Dönemde Hasat Edilen Tarla Sarmaşığı (*Convolvulus arvensis* L) Otunun Potansiyel Besleme Değeri

## Özet

Bu çalışmanın amacı, farklı zamanda hasat edilen tarla sarmaşığının potansiyel besleme değerinin *in vitro* gaz üretim tekniği ile saptanmaktır. Tarla sarmaşığının *in vitro* gaz ölçümleri fermentasyonun başlamasından itibaren 3, 6, 12, 24, 48, 72 ve 96 saat aralıklarla yapılmış ve gaz üretimine ait parametreler ise $y = A (1\text{-}exp^{-ct})$ fonksiyonu kullanılarak saptanmıştır. Hasat zamanı tarla sarmaşığının kimyasal bileşimi, *in vitro* gaz üretimi, metabolik enerji (ME) ve organik madde sindirimine (OMSD) önemli düzeyde etki etmiştir ($P<0.05$). Tarla sarmaşığı bitkisi olgunlaştıkça kuru madde (KM), hücre duvarı bileşenlerinden nötral deterjan lif (NDF), asit deterjan lif (ADF) ve asit deterjan lignin (ADL) içerikleri yükselmiş, diğer taraftan ham protein (HP), ham yağ (HY) ve kül içeriği ise azalmıştır. Tarla sarmaşığı otunun ham protein içeriği %16.63 ile 23.83 arasında değişmiş, NDF, ADF ve ADL içerikleri sırasıyla %34.00 ile 54.04, 28.76 ile 40.34 ve 5.26 ile 12.18 arasında bulunmuştur. Potansiyel gaz üretimi ve tahmin edilen parametreler de tarla sarmaşığının olgunlaşmasıyla birlikte azalmıştır ($P<0.05$). Potansiyel gaz üretimi 61.59 ile 71.77 ml arasında, ME düzeyi 9.31 ile 11.71 MJ/kg KM arasında, OMSD ise %63.19 ile 79.17 arasında değişmiştir. Sonuç olarak, tarla sarmaşığı otunun besleme değeri bitkinin olgunlaşmasına bağlı olarak önemli miktarda azalmasına rağmen, tarla sarmaşığı otu hasat dönemi ilerlemiş dönemlerde bile, ruminant hayvanların ihtiyaçlarını karşılayabilecek miktarda yeterli kalitede ot sağlayabileceği söylenebilir.

***Anahtar sözcükler:*** *Besleme değeri, İn vitro gaz üretimi, Kimyasal kompozisyon, Sindirim derecesi, Tarla sarmaşığı otu*

## INTRODUCTION

It is well established that forages play an important role for ruminant animals since forages provide energy, protein and minerals. Forages also provide fiber to ruminants for chewing and rumination. Field bindweed

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*(Convolvulus arvensis* L*)* is one of the most problematic weeds in agricultural fields in the most parts of world. Field bindweed causes important economic losses through reduction of germination and yield of wheat as 14 and 80% [1]. On the other hand field bindweed was hand pulled by some farmers and given to their ruminant animals as forage to meet nutrient requirements. Therefore it is possible that this practice would be encouraged if field bindweed could be promoted as forage for ruminant animals. However the potential nutritive value of some forages obtained at different harvest maturity is well determined [2-5] there is limited information about the nutritive value of field bindweed hay obtained at different maturity stages. Kazemi et al.[6] reported that field bindweed contained 17.41% crude protein, 27.50% NDF, 27.33% ADF and 17.50% ash. Therefore more information on variation in concentration of nutrients, presence of tannin and digestibility of field bindweed is required for an accurate evaluation of potential use of field bindweed as forage in ruminant ration. Recently some researches suggested that chemical composition and *in vitro* gas production technique can be used to determine the potential nutritive value of previously uninvestigated plants [2-5,7]. Therefore the aim of this study was to determine the potential nutritive value of field bindweed (*Convolvulus arvensis* L) harvested at three maturity stages using chemical composition and *in vitro* gas production technique.

## MATERIAL and METHODS

Field bindweed (*Convolvulus arvensis* L) plants were harvested at three maturity stages [pre-flowering (15.07.2011), flowering (26.07.2011) and seeding stages (08.08.2011)]. Field bindweed plants were hand harvested from three replicate plots of 5x2 m established in the experimental field in July-August, 2011 in Kahramanmaras, Turkey. The experimental field was not irrigated and cultivated. The soil at the experimental plots is a clay loam. The pH of soil was 7.25. The area is located at 630 m above sea level. The mean annual rainfall and temperature were 713 mm and 11.95°C.

Samples were shade dried and representative dry samples from each plot was taken to laboratory and milled in a hammer mill through a 1 mm sieve for subsequent analysis.

Dry matter (DM) was determined by drying the samples at 105°C overnight and ash by igniting the samples in muffle furnace at 525°C for 8 h. Nitrogen (N) content was measured by the Kjeldahl method [8]. Crude protein was calculated as N x 6.25.

Neutral detergent fiber (NDF), ADF and ADL contents were determined by the method Van Soest et al.[9] Condensed tannin was determined by butanol-HCl method as described by Makkar et al.[10].

Field bindweed hay samples (0.200 g DM) milled through a 1 mm sieve were incubated *in vitro* with diluted rumen fluid (10 ml rumen fluid + 20 ml culture medium) in triplicate calibrated glass syringes of 100 ml following the procedures of Menke et al.[11]. Rumen fluid was obtained from cows fed a daily ration containing maize silage and concentrates. The cows (4 years old and 600 kg live weight) had free access to water throughout the experiment. Rumen fluid was obtained using stomach tube from two lactating and pregnant cows fed a daily ration containing 20 kg maize silage and 8 kg concentrates (18% CP and 2750 Kcal ME kg-1). Rumen samples was collected before the morning meal in the thermos flaks and taken immediately to the laboratory where it was strained through 4 layers of cheesecloth and kept at 39°C. The rumen fluid was flushed with $CO_2$. The rumen fluid was added to buffered mineral solution in the ratio of 1:2 respectively. The syringes were prewarmed at 39°C before the injection of 30 mL rumen fluid-buffer mixture into each syringe followed by incubation in a water bath at 39°C. Gas production was recorded at 3, 6, 12, 24, 48, 72 and 96 h after incubation and corrected for blank incubation. Cumulative gas production data were fitted to non-linear exponential model as:

$$Y = A\ (1 - \exp^{-ct})$$

Where *Y* is gas production at time't', *A* is the potential gas production (ml/200 mg DM), c is the gas production rate constant ($h^{-1}$) and *t* is the incubation time (h).

Time (h) to produce 50 and 95% of potential gas production using the equation suggested by Şahin et al.[12].

$$t_{50}=0.693/c$$

$$t_{95}=2.996/c$$

ME (MJ/kg DM) content of field bindweed was calculated using equation of Menke et al.[11] as follows:

$$ME\ (MJ/kg\ DM) = 2.20 + 0.136\ GP + 0.057\ CP$$

where GP = 24 h net gas production (ml/200 mg DM); CP = Crude protein.

Organic matter digestibility (%) of field bindweed was calculated using equation of Menke et al.[11] as follows:

$$OMD\ (\%) = 14.88 + 0.889GP + 0.45CP + 0.0651\ XA$$

where XA: ash content (%).

One-way analysis of variance (ANOVA) was used to determine the effect of maturity stage on the chemical composition, gas production kinetics, and some estimated parameters such as ME and OMD of field bind-weed hay using SPSS [13]. Significance between individual means was identified using the Tukey's multiple range tests. Mean differences were considered significant at ($P<0.05$) [14].

## RESULTS

The effect of maturity stage on the chemical composition of field bindweed hay is presented in *Table 1*. The maturity stage has significant effect on the chemical composition of field bindweed hay. Dry matter (DM), NDF, ADF and ADL of field bindweed hay increased whereas CP, ash and EE content decreased with maturity. Dry matter (DM), CP, ash, EE, NDF, ADF, ADL, CT of field bindweed hay ranged from 21.34 to 30.40, 16.63 to 23.83, 3.47 to 7.97, 2.41 to 4.92, 34.00 to 54.04, 28.76 to 40.34, 5.26 to 12.18 and 0.57 to 0.84% respectively.

The effect of maturity stages on gas production at different time intervals is presented in *Fig. 1*. At all incubation times, gas production at pre-flowering stage was significantly higher than those of flowering and seeding stages.

The effect of maturity stage on gas production kinetics, ME, OMD of field bindweed hay is represented in *Table 2*.

The maturity had a significant effect on the gas production kinetics (c, A, $t_{50}$ and $t_{95}$) and estimated parameters such as ME and OMD. The gas production kinetics and estimated parameters such as ME and OMD of

***Table 1.*** *The effect of maturity stage on the chemical composition of field bindweed hay (n=3)*
***Tablo 1.*** *Hasat zamanının tarla sarmaşığı otunun kompozisyonuna etkisi (n=3)*

| Nutrients (%) | Maturity Stages | | | SEM | Sig. |
|---|---|---|---|---|---|
| | Pre-flowering | Flowering | Seeding | | |
| DM | 21.34[c] | 23.39[b] | 30.40[a] | 0.579 | *** |
| CP | 23.83[a] | 20.71[b] | 16.63[c] | 0.330 | *** |
| Ash | 7.97[a] | 5.13[b] | 3.47[c] | 0.113 | *** |
| EE | 4.92[a] | 3.70[b] | 2.41[c] | 0.110 | *** |
| NDF | 34.00[c] | 40.35[b] | 54.04[a] | 0.723 | *** |
| ADF | 28.76[c] | 34.23[b] | 40.34[a] | 0.535 | *** |
| ADL | 5.26[c] | 7.39[b] | 12.18[a] | 0.266 | *** |
| CT | 0.84 | 0.72 | 0.57 | 0.113 | NS |

*[a b c] Row means with common superscripts do not differ (P>0.05);* ***s.e.m.:*** *standard error mean;* ***Sig.:*** *significance level;* ***DM:*** *Dry matter %,* ***CP:*** *Crude protein,* ***EE:*** *Ether extract,* ***NDF:*** *Neutral detergent fiber,* ***ADF:*** *Acid detergent fiber,* ***ADL:*** *Acid detergent lignin,* ***CT:*** *Condensed tannin,* ***NS:*** *Non-significant; *** (P<0.001)*

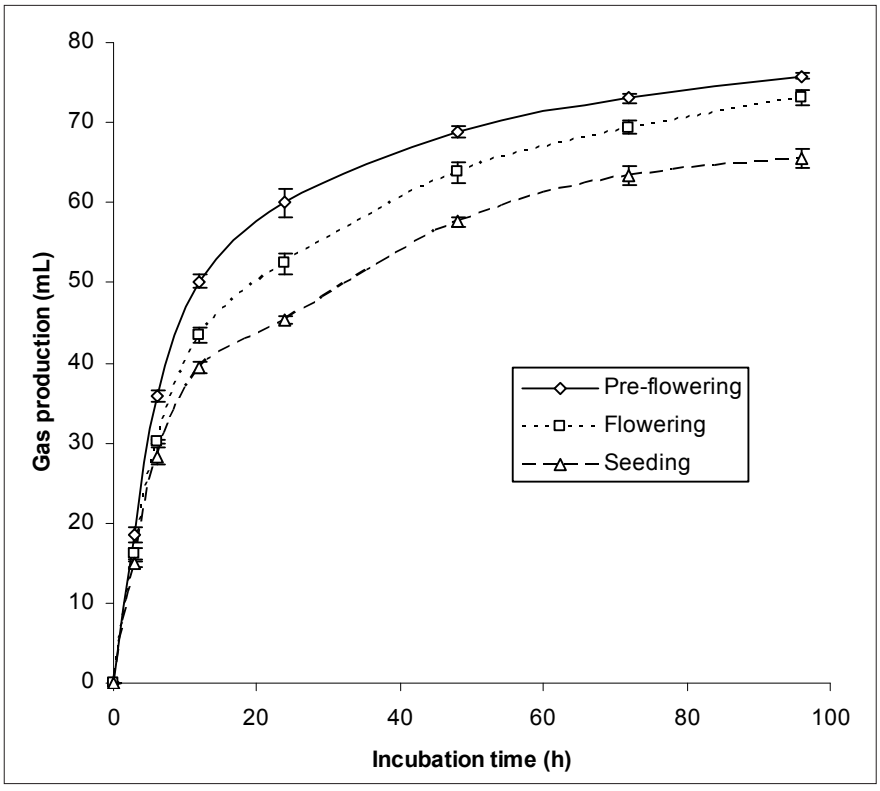


**Fig 1.** The effect of maturity stage on gas production of field bindweed hay

**Şekil 1.** Hasat zamanının tarla sarmaşığı otunun gaz üretimine etkisi

***Table 2.*** *The effect of maturity stage on the gas production kinetics, metabolisable energy and organic matter digestibility of field bindweed hay*

***Tablo 2.*** *Hasat zamanın tarla sarmaşığı otunun gaz üretim parametrelerine, metabolik enerji ve organik madde sindirim derecesine etkisi*

| Estimated Parameters | Maturity Stages | | | SEM | Sig. |
|---|---|---|---|---|---|
| | Pre-flowering | Flowering | Seeding | | |
| c | 0.099[a] | 0.079[b] | 0.080[b] | 0.0035 | ** |
| *A* | 71.77[a] | 68.51[b] | 61.59[c] | 0.877 | *** |
| $t_{50}$ | 6.96[b] | 8.67[a] | 8.68[a] | 0.365 | ** |
| $t_{95}$ | 30.13[b] | 37.51[a] | 37.54[a] | 1.581 | ** |
| ME | 11.71[a] | 10.50[b] | 9.31[c] | 0.147 | *** |
| OMD | 79.17[a] | 71.11[b] | 63.19[c] | 0.976 | *** |

*[a b c] Row means with common superscripts do not differ (P>0.05); s.e.m.: standard error mean; Sig.: significance level; NS: Non-significant, c: gas production rate (%); A:: potential gas production (mL); ME: Metabolisable energy (MJ /Kg DM); OMD: Organic matter digestibility %; ** P < 0.01; *** P<0.001*

field bindweed hay decreased with increasing maturity.

The gas production rate (c), potential gas production (A), time to produce 50 and 95% of potential gas production ranged from 0.08 to 0.099, 61.59 to 71.77 ml, 6.96 to 8.68 h and 30.13 to 37.54 h. On the other hand, ME and OMD of field bindweed hay ranged from 9.31 to 11.71 MJ /kg DM and 63.19 to 79.17% respectively.

## DISCUSSION

There was marked changes in the chemical composition of field bindweed with increasing maturity. The crude protein content of field bindweed hay is in excess of that proposed as the minimum requirements for lactation (12% of DM) and growth (11.3% of DM) in ruminants [15]. High crude protein levels suggests field bindweed hay with potential as N supplements to ruminants fed low quality forages during dry season. The concentration of field bindweed hay harvested at seeding stage was comparable with that reported by Kazemi et al.[6] who found that field bindweed contained 17.41% crude protein. It was well established that CP content of plants decreases with increasing maturity. This decrease in CP contents results from decrease in CP in leaves, while stems, which had a lower protein concentration, represented a larger proportion of the available herbage in more mature forages [16]. Several researchers estimated the daily reduction in CP contents of plant using the difference between CP of hay obtained at pre-flowering and seeding stages, divided by the time (days) required to reach from flowering to seeding stage [5,7,17]. In the current study, the reduction in CP content of field bindweed hay was 3.01 g/kg/day. This reduction was considerably higher than those reported by Minson [17], Kamalak and Canbolat[5] and Kamalak et al. [7] who reported that the average decline in crude protein concentration with advancing maturity averaged 1, 0.82 and 2.34 g/kg/day respectively. It is well known that high level of CT in forages may adversely affect of the microbial and enzyme ctivities [18-21]. However, in this experiment, the condensed tannin levels of field bindweed hay harvested at three maturity stages were lower than those considered detrimental to ruminant animals.

There was also marked changes in the gas production and estimated parameters of field bindweed with increasing maturity. The decline in gas production and estimated parameters is possibly associated with increase in cell wall contents (NDF, ADF and ADL) of field bindweed with maturity. It is well known that cell wall contents are more indigestible fractions of plant. Blummel and Orskov [22] suggested that gas production is associated with volatile fatty acid (VFA) production following fermentation of substrate so the more fermentation of a substrate the greater the gas production, although the fermentation end products do influence more closely with gas production. As a result, there was reduced gas production from the indigestible fractions with increasing maturity. The reduction in CP concentration and gas production resulted in OMD and ME concentration of field bindweed also decreased with increasing maturity. These results obtained in the current study are consistent with findings of Kamalak [4], Kamalak and Canbolat [5] and Kamalak et al.[7]. Even if there is a reduction in ME content of field bindweed with maturity, the ME content of field bindweed obtained at pre-flowering was similar to that of maize silage which is commonly regarded as a very high energy forage with a typical ME concentration of 11.7 MJ kg-1 DM [23]. Thus it is suggested that field bindweed could be used not only as a basic forage in the ruminant ration, but also as a high energy feed.

In conclusion, although there was a marked decline in nutritive value of the forage of field bindweed hay with advancing maturity, even at the seeding stage, the forage had high CP content and was quite digestible. Field bindweed hay showed promising potential for

ruminant animals. However, further studies especially on animal responses, is required to confirm the nutritional characteristics indicated in the current study.

## REFERENCES

**1. Bogatek R, Gniazdowka A, Stepien J, Kupidlowska E:** *Convolvulus* arvensis L. allelochemicals mode of action in germinating wheat seeds. Proceedings of the 4th World Congress on Allelopathy, 11-14 August, Wagga Wagga, Australia, pp. 263-266, 2005.

**2. Kamalak A, Canbolat O, Gurbuz Y, Erol A, Ozay O:** Effect of maturity stage on chemical composition, *in vitro* and *in situ* dry matter degradation of tumbleweed hay (*Gundelia tournetortii* L.), *Small Rum Res*, 58 (2): 149-156, 2005.

**3. Kamalak A, Canbolat O, Gurbuz Y, Ozkan CO, Kizilsimsek M:** Determination of nutritive value of wild mustard, *Sinapsis arvensis* harvested at different maturity stages using *in situ* and *in vitro* measurements. *Asian-Aust J Anim Sci*, 18 (9): 1249-1254, 2005.

**4. Kamalak A:** Determination of potential nutritive value of *Polygonum aviculare* hay harvested at three maturity stages. *J Appl Anim Sci*, 38, 69-71, 2010.

**5. Kamalak A, Canbolat O:** Determination of nutritive value of wild narrow-leaved clover *(Trifolium angustifolium)* hay harvested at three maturity stages using chemical composition and *in vitro* gas production. *Trop Grassland*, 44, 128-133, 2010.

**6. Kazemi M, Tahmasbi AM, Valizadeh R, Naserian AA, Moheghi MM:** Assessment of nutritive value of dominant weed species in range of Khorasan district of Iran by *in vitro* and in situ technique. *J Anim Vet Adv,* 8 (11): 2286-2290, 2009.

**7. Kamalak A, Atalay Aİ, Özkan CÖ, Kaya E, Tatlıyer A:** Determination of potential nutritive value of *trigonella kotschi* fenzl hay harvested at three different maturity stages. *Kafkas Univ Vet Fak Derg,* 17 (4): 635-640, 2011.

**8. AOAC:** Official Method of Analysis. 15th ed., pp. 69-88, Association of Official Analytical Chemist, Washington, DC, USA, 1990.

**9. Van Soest PJ, Robertson JD, Lewis BA:** Methods for dietary fibre, neutral detergent fibre and non-starch polysaccharides in relation to animal nutrition. *J Dairy Sci*, 74 (10): 3583-3597, 1991.

**10. Makkar HPS, Blummel M, Becker K:** Formation of complexes between polyvinyl pyrrolidones or polyethylene glycols and their implication in gas production and true digestibility *in vitro* techniques. *Brit J Nutr*, 73 (6): 897-913, 1995.

**11. Menke KH, Raab L, Salewski A, Steingass H, Fritz D, Schneider W:** The estimation of the digestibility and metabolizable energy content of ruminant feedingstuffs from the gas production when they are incubated with rumen liquor *in vitro*. *J Agric Sci Camb*, 93 (1): 217-222, 1979.

**12. Şahin M, Üçkardeş F, Canbolat, O, Kamalak A, Atalay A:** Estimation of partial gas production times of some feedstuffs used in ruminant nutrition. *Kafkas Univ Vet Fak Derg,* 17 (5): 731-734, 2011.

**13. SPSS for Window:** Statistical package for the social sciences, Release: 16, SPSS INC, Chicago, USA. 2008.

**14. Mendeş M, Akkartal E:** Comparison of ANOVA F and WELCH Tests with their respective permutation versions in terms of type I error rates and test power. *Kafkas Univ Vet Fak Derg,* 16 (5): 711-716, 2010.

**15. ARC:** The nutrient requirements of ruminant livestock. Technical review by an agricultural research council working party. Commonwealth Agricultural Research Burea, Farnham Royal, UK. 1984.

**16. Buxton DR:** Quality related characteristics of forages as influenced by plant environment and agronomic factors. *Anim Feed Sci Tech,* 59, 37-49, 1996.

**17. Minson DJ:** Forage in ruminant nutrition. 1-483, Academic Press, New York, 1990.

**18. Singleton VL:** Naturally occurring food toxicants: Phenolic substances of plant origin common in foods. *Adv Food Res*, 27, 149-242, 1981.

**19. Lohan OP, Lall D, Vaid J, Negi SS:** Utilization of oak tree fodder in cattle ration and fate of oak leaf tannins in the ruminant system. *Indian J Anim Sci,* 53, 1057-1063, 1983.

**20. Barry TN, Duncan SJ:** The role of condensed tannins in the nutritional value of *Lotus pedunculatus* for sheep. I. Voluntary intake. *Brit J Nutr*, 51 (3): 485-491, 1984.

**21. Makkar HPS, Singh B, Negi SS:** Relationship of rumen degradability with microbial colonization, cell wall constituents and tannin levels in some tree leaves. *Anim Prod*, 49, 299-303, 1989.

**22. Blummel M, Orskov ER:** Comparison of an *in vitro* gas production and nylon bag degradability of roughages in predicting feed intake in cattle. *Anim Feed Sci Tech*, 40 (2-3): 109-119, 1993.

**23. Moss AR, Givens DI, Phipps RH:** Digestibility and energy value of combinations of forage mixture. *Anim Feed Sci Technol,* 39 (1-2): 151-172, 1992.