

Effect of Maturity Stages on Potential Nutritive Value of *Rheum ribes* L.Olgunlaşma Döneminin *Rheum ribes* L.'nin Potansiyel Besleme Değerine EtkisiÖzer Kurt¹ 

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Abstract: The purpose of the current work was to designate the effect of maturity stages potential nutritive value, the chemical composition, condensed tannin (CT), gas production (GP), methane production, metabolizable energy (ME), and organic matter digestibility (OMD) of *Rheum ribes* L. Maturity stages significantly affected ($P<0.05$) the chemical composition, CT, GP, methane production, ME and OMD of *Rheum ribes* L. Dry matter (DM), crude ash (CA), crude protein (CP), ether extract (EE), CT, neutral detergent fiber (NDF) and acid detergent fiber (ADF) of *Rheum ribes* L. ranged from 92.73-98.64%, 6.11-14.15%, 8.81-19.12%, 1.94-3.04%, 10.47-14.72%, 36.99-53.98% and 24.88-37.63% respectively. Gas production and methane production of *Rheum ribes* L. at 24 ranged from 29.73-40.60 ml and 2.63-5.50 ml respectively. ME and OMD of *Rheum ribes* L. ranged from 6.97-9.87 MJ kg⁻¹ KM and 45.68-60.02% respectively. To sum up, maturity stages is a significant point on the nutritive value of *Rheum ribes* L. Nutritive value especially CP, ME and OMD of *Rheum ribes* L. decreased with advancing maturity. GP, ME and OMD were significant and negatively correlated with ADF and NDF contents, whereas positively correlated with CP. Moreover in vivo studies are needed to determine the effect of *Rheum ribes* L. on the feed intake and performance of ruminant animals.

Keywords: *Rheum ribes* L., nutritive value, condensed tannin, methane production

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Öz: Bu çalışmanın amacı *Rheum ribes* L. 'nin farklı olgunlaşma dönemlerinin kimyasal bileşimine, kondanse tanen (KT) içeriğine, gaz ve metan üretimine, metabolik enerji (ME) ve organik madde sindirim derecesine (OMSD) etkisinin belirlenmesidir. Olgunlaşma dönemi kimyasal bileşimi, KT içeriğini, gaz ve metan üretimini, ME ve OMSD önemli derecede etkilemiştir ($P<0.05$). *Rheum ribes* L.'nin kuru madde (KM), ham kül (HK), ham protein (HP), ham yağ (HY), KT, asit çözücülerde çözünmeyen lifli bileşikler (ADF), nötr çözücülerde çözünmeyen lifli bileşikler (NDF) sırasıyla 92.73-98.64%, 6.11-14.15%, 8.81-19.12%, 1.94-3.04%, 10.47-14.72%, 36.99-53.98% ve 24.88-37.63% aralıklarında belirlenmiştir. *Rheum ribes* L.'nin 24 saatlik gaz üretimi, metan üretimi 29.73-40.60 ml ve 2.63-5.50 ml aralığında belirlenmiştir. ME ve OMSD 6.97-9.87 MJ kg⁻¹ KM ve 45.68-60.02% aralığında belirlenmiştir. Özet olarak olgunlaşma dönemi *Rheum ribes* L.'nin besleme değerini önemli ölçüde etkilemiştir. *Rheum ribes* L. 'nin özellikle HP, ME, OMSD olgunlaşma dönemi ilerledikçe azalmıştır. *Rheum ribes* L.'nin gaz üretimi, ME ve OMSD, ADF ve NDF içeriği ile önemli ve negatif korelasyon göstermiş, ham protein içeriği ile pozitif korelasyon sergilemiştir. Ek olarak *Rheum ribes* L.'nin ruminant hayvanların performansı ve besleme değerinin belirlenebilmesi için in vivo çalışmalara da ihtiyaç duyulmaktadır.

Anahtar Kelimeler: *Rheum ribes* L., besleme değeri, kondanse tanen, metan üretimi

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INTRODUCTION

Forages have an important role in ruminant animal nutrition with the potein, mineral and energy they provide. At the same time, these forages are a source of fiber for animals with chewing and rumination. There are many factors that affect the nutritional value of forages. Although the effect of the maturation period, which is one of them, on the chemical composition, metabolic energy content and digestion degree of plants has been revealed by some researchers, there are many more plants waiting to be investigated in natural pastures (Atalay and Kamalak, 2019; Kaplan et al., 2016; Kurt and Kamalak, 2020) *Rheum ribes* L. has several different local Turkish names such as: ısgın, ugun, dag muzu, ribes, revas. *Rheum ribes* L. that is belonging to *Polygonaceae*, is a perennial wild plant that is of medical importance as flowers shoots and stalks can be consumed as vegetables. It has been reported that the only species grown in our country belonging to the genus *Rheum* is *Rheum ribes* L. (Cullen, 1996; Tuncer and Günsan, 2017). In the high plateaus, in the season when the snow starts to melt, it has a 40 cm tall inflorescence stem that rises from the large coarse leaves in the form of elephant ear, 2-5 long-stalked, kidney-shaped leaves with toothed edges, small flowers and a well-developed taproot (Baytop, 1984). It grows naturally in the Eastern Anatolia Region, where Muş is located, and is collected from nature in the spring and summer months and consumed (Muzuroğlu et al., 2000). In different regions, different plant parts are evaluated both nutritionally and medicinally (Chang et al., 2014; Çakılcıoğlu and Türkoğlu, 2007; Hu et al., 2014; Kaval et al., 2014; Meral, 2017). In our country, there are studies on the nutrient content and medical importance of the ray plant, and no study has been found in which the animal nutrition value is determined by using the in vitro gas production technique. Some screening assays have been conducted in recent years to try to identify plant species with potential antimethanogenic activity (García- González et al., 2008; Soliva et al., 2008).

In the study, it was aimed to determine the chemical composition and anti-methanogenic effect of the *Rheum ribes* L., which is widely found in the natural flora of Muş province, at different maturation periods (pre-flowering, flowering, seedling).

MATERIAL AND METHOD

Rheum ribes L. plants were harvested from plots established in the experiment unit of native pastures at 3 different maturation periods (pre-flowering, flowering and seedling stages) in Mus, Turkey, in April-May, 2021. The collected samples were dried in the shade after their dry matter was determined, ground to pass through a 1 mm sieve, and made ready for chemical analysis and in vitro gas production. 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 (AOAC, 1990). Crude protein was calculated as N X 6.25., EE content of *Rheum ribes* L. determined by AOAC (1990), ADF and NDF were determined according to the method reported by Van Soest et al. (1991). CT concentration was determined by described by Makkar et al. (1995). *In vitro* gas production technique was used to determine the TG production of *Rheum ribes* L. samples (Menke et al., 1979). Rumen fluid was immediately taken from sheep slaughtered in the Kahramanmaraş animal market and placed in a thermos, and brought to the laboratory quickly so that microorganism activity could continue. Approximately 0.200 gram air dried samples of *Rheum ribes* L. samples was weighed into calibrated glass syringes which were prewarmed at 39 ° C. Then 30 mL rumen fluid-buffer mixture was transferred into each syringe. The glass syringes containing samples and rumen fluid-buffer mixture were placed in a water bath at 39 ° C. Gas production was measured at 24 h after incubation and corrected for blank and hay standard. The gases obtained as a result of the incubation were determined by transferring them to the Infrared Methane Analyzer (Sensor Europe GmbH, Erkrath, Germany) with plastic syringes to determine the methane percentages (Goel et al. 2008). The methane gas production amounts of the samples were calculated using the formula given below.

$$\text{Methane production (ml)} = \text{Total gas production (ml)} \times \text{Percentage of Methane (\%)} \quad (1)$$

ME and OMD of *Rheum ribes* L. were determined according to the following equations (Menke and Steingass, 1988).

$$\text{ME (Mj kg}^{-1}\text{ DM)} = 1.06 + 0.1570\text{GP} + 0.084\text{CP} + 0.220\text{EE} - 0.081\text{CA} \quad (2)$$

$$\text{OMD (\%)} = 28.49 + 0.7967\text{GP} + 0.325\text{CP} \quad (3)$$

GP= Net gas production at 24 h incubation time

The data obtained in the study were evaluated statistically (Tukey 5%) using one-way analysis of variance (One-way ANOVA).

RESULTS AND DISCUSSION

Effects of maturity stage on the chemical composition and condensed tannin of *Rheum ribes* L. plants are summarized in Table 1. Changes ($P < 0.05$) were observed for chemical composition and condensed tannin in terms of maturity stages. The CP content of *Rheum ribes* L. ranged from 8.81-19.12% and decreased with increased maturity. CP content of *Rheum ribes* L. harvested at the preflowering stage was significantly higher than those of the flowering and seedling stages. This decrease in protein content is due to the decrease in protein concentration in stems and leaves as maturation progresses (Buxton, 1996). Such result is in agreement with findings of similar experiment (Atalay and Kamalak 2019; Aydın et al., 2007; Canbolat, 2012; Giray, 2019; Kamalak et al., 2011; Kaplan et al., 2016; Kurt and Kamalak, 2020). Özcan et al. (2007) determined the HP content of the *Rheum ribes* L. as 5.45-6.31%, Andiç et al. (2009), determined the HP content of the *Rheum ribes* L. as 1.07-1.56%, and Tunçtürk and Çelen (2017) determined the HP content of the *Rheum ribes* L. as 21.69%. All these variations might have resulted in ecological conditions, maturity stages, plant parts. It has been reported that for optimum rumen fermentation and feed consumption in ruminants, the HP content of the feeds should be at least 7-8% (Van Soest, 1994). In this case, the HP content of the *Rheum ribes* L. was found to be appropriate in three maturity stages.

The CA content of *Rheum ribes* L. varied between 6.11-14.15 %, and it was found to be significantly higher during the flowering period compared to the pre-flowering and seedling stages ($P < 0.05$). Özcan et al. (2007) reported CA content of *Rheum ribes* L. as between 7.74-9.69%, Tunçtürk ve Çelen (2017) as 7%. Such results support our current findings. The EE content of *Rheum ribes* L. ranged from 1.94-3.04%. The highest EE content of *Rheum ribes* L. was determined during the flowering period. Özcan et al. (2007) reported EE content of *Rheum ribes* L. as between 1.90-3.60%. Such results support our current findings.

The ADF and NDF content of *Rheum ribes* L. ranged from 24.88-37.63%, 36.99-53.98% respectively. It was determined that ADF and NDF content increased from pre-flowering to the seedling period. Similarly, it has been reported in various studies that ADF and NDF content with advancing maturity were significantly increased (Atalay and Kamalak, 2019; Aydın et al., 2007; Canbolat, 2012; Giray, 2019; Kamalak ve ark., 2005a, 2005b; Kamalak and Canbolat 2010; Kamalak et al., 2011; Kaplan et al., 2016; Kurt and Kamalak, 2020). The CT content of *Rheum ribes* L. ranged from 10.47-14.72% and decreased with increased maturity. It has been reported that the low level of condensed tannin in the feed (1-4% in dry matter) has a beneficial effect as it prevents the excessive breakdown of proteins in the rumen, while the high amount of grains (5% and above in dry matter) affects the performance of the animal negatively by limiting feed consumption (Boğa et al., 2021; Budağ, 2009; Kamalak, 2007; Ünver et al., 2014). However, the tannin found in *Rheum ribes* L. was found to be high in all three maturation periods. Therefore, more care should be taken when using it in all three periods.

Table 1. Chemical compositions and condansed tannin content of *Rheum ribes* L. harvested at three stages.
Çizelge 1. Farklı hasat dönemlerindeki *Rheum ribes* L.'nin kimyasal bileşimi ve kondense tanen içeriği.

Parameters	Maturity stages			SEM	Sig.
	Preflowering	Flowering	Seedling		
DM	92.73 ^c	96.40 ^b	98.64 ^a	0.311	**
CA	6.81 ^b	14.15 ^a	6.11 ^b	0.305	**
CP	19.12 ^a	14.43 ^b	8.81 ^c	0.157	**
EE	3.04 ^a	1.94 ^b	2.86 ^a	0.251	**
ADF	24.88 ^c	30.54 ^b	37.63 ^a	1.315	**
NDF	36.99 ^b	52.07 ^a	53.98 ^a	0.671	**
CT	14.72 ^a	11.52 ^b	10.47 ^c	0.270	**

Means within the same row with differing superscripts (a-c) (P>0.05); ** P<0.05, S.E.M.: standard error mean, Sig: significance level.

As can be seen from Table 2, GP of *Rheum ribes* L. decreased with increased maturity. Gas and methane after 24 h incubation ranged between 29.73-40.60 ml, 2.63-5.50 ml respectively. It is thought that the reason for the decrease in gas production as the maturation period is due to the increase in ADF and NDF against digestible substances. It is well known that ADF and NDF contents are the parts of the plant that cannot be digested anymore. The gas released as a result of fermentation depends on the amount of digestible nutrients in the rumen, and it has been stated that the higher the amount of digestible nutrients, the more gas is produced (Blümmel and Orskov, 1993). The decrease in GP with increasing maturity was also a reflection of the decreased quality and was consistent with the findings of Kamalak et al. (2005a; 2005b) reported that a decrease in GP as the forage growing period extended.

Table 2. Gas production, ME and OMD of *Rheum ribes* L. harvested at three stages.
Çizelge 2. Farklı hasat dönemlerindeki *Rheum ribes* L.'nin gaz üretimi, ME ve OMSD.

Parameters	Maturity stages			SEM	Sig.
	Preflowering	Flowering	Seedling		
Total gas (ml)	40.60 ^a	37.28 ^b	29.73 ^c	1.068	**
CH ₄ (%)	13.56 ^a	12.64 ^b	8.86 ^c	0.121	**
CH ₄ (ml)	5.50 ^a	4.71 ^b	2.63 ^c	0.243	**
ME (Mjkg ⁻¹ DM)	9.87 ^a	8.69 ^b	6.97 ^c	0.131	**
OMD (%)	60.02 ^a	55.44 ^b	45.68 ^c	0.888	**

Means within the same row with differing superscripts (a-c) (P>0.05); ** P<0.05; S.E.M.: standard error mean, Sig.: significance level.

ME and OMD ranged from 6.97-9.87 Mj kg⁻¹ KM, 45.68-60.02% respectively. The highest values of ME and OMD were recorded before flowering. OMD and ME of *Rheum ribes* L. also decreased with increasing maturity. As the amount of gas released as a result of fermentation decreased as the periods progressed, it decreased in ME and OMD. The decrease in CP concentration and gas production resulted in ME and OMD of *Rheum ribes* L. also decreased with increasing maturity. Such results support our present findings (Atalay ve Kamalak, 2019; Canbolat 2012; Giray, 2019; Kamalak ve ark., 2005a, 2005b; Kaplan ve ark., 2014; Kaplan ve ark., 2016; Kurt ve Kamalak, 2020). CH₄% of total gas were significantly decreased with advancing maturity (P<0.05). Similarly, it has been reported in various studies that CH₄% total gas was significantly

decreased with advancing maturity (Atalay ve Kamalak, 2019; Kaplan ve ark., 2016; Kurt ve Kamalak, 2020; Üke ve ark., 2017).

Gas production, ME and OMD were significant and negatively correlated with NDF ve ADF contents (Table 3). This result is consistent with the findings reported by (Aydın et al., 2007; Canbolat, 2012; Ceylan and Kamalak, 2019; Kamalak et al., 2011; Kamalak et al., 2005a, 2005b; Kamalak and Canbolat 2010; Kaplan et al., 2016). CP content was positively and significantly correlated with GP, which is in agreement with the earlier findings of Canbolat, (2013), Karabulut et al. (2007), Larbi et al. (1998).

According to the percentage of methane in the gas released as a result of fermentation, the antimethanogenic potential of the feeds is classified as low (>11% and ≤14%), medium (>6% and <11%), and high (>0% and <6%) (Lopez et al., 2010). CH₄% total gas of *Rheum ribes* L. ranged from 8.86-13.56%. According to the classification the seedling maturity of *Rheum ribes* L. can be said to have anti-methanogenic properties, even if at moderate potential and pre-flowering and flowering maturity stages of *Rheum ribes* L. even if at low potential.

Table 3. Correlation coefficient (r) of the relationship of chemical composition with gas production, ME (MJ kg⁻¹ DM) and OMD (%) of *Rheum ribes* L.

Çizelge 3. *Rheum ribes* L.'nin kimyasal bileşimi ile gaz üretimi, ME ve OMSD arasındaki korelasyonlar.

Parameters	DM	CA	CP	EE	NDF	ADF	CT
TG	-0.903**	0.270 ^{NS}	0.0953**	-0.019 ^{NS}	-0.795*	-0.979**	0.839**
CH ₄ (%)	-0.910**	0.320 ^{NS}	0.973**	-0.070 ^{NS}	-0.779*	-0.957**	0.846**
CH ₄ (ml)	-0.874**	0.406 ^{NS}	0.954**	-0.153 ^{NS}	-0.712*	-0.909**	0.799**
ME	-0.956**	0.178 ^{NS}	0.989**	0.064 ^{NS}	-0.863**	-0.985**	0.906**
OMD	-0.924**	0.266 ^{NS}	0.974**	-0.017 ^{NS}	-0.810**	-0.979**	0.861**

** P<0.05, NS: Non-significant (P>0.05).

CONCLUSION

This study provided useful information about the possible decrease in the nutritional value of *Rheum ribes* L. with increasing maturity. The chemical composition, in vitro total gas, ME, OMD of *Rheum ribes* L. were negatively affected by the maturity stage. It was concluded that *Rheum ribes* L. will provide more CP and ME energy for ruminants when harvested or grazed at the pre-flowering stage vegetative and flowering stages. *Rheum ribes* L. showed promising potential for ruminant animals. However, in this experiment the CT levels *Rheum ribes* L. at the three maturity stages were higher than those considered detrimental to ruminants. Therefore, care should be taken when using the animal feed.

CONFLICT OF INTEREST

The author must report under this title that there are no conflicts of interest.

DECLARATION OF AUTHOR CONTRIBUTION

Özer Kurt designed the study, participated in experiment, and drafted the manuscript.

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