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Comparison of Shrub Leaves in terms of Chemical Composition and Nutritive Value

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ABSTRACT

The goal of the present study was to compare the leaves of some shrubs in terms of chemical composition and nutritive value at the period of baby fruit. For this purpose, leaves of *Quercus coccifera* L (*QC*), *Quercus branti* Lindl (*QB*), *Quercus vulcanica* Boiss and Heldr. Ex Kotschy (*QV*), *Phillyrea latifolia* (L.) Salibs (*PL*), *Styrax officinalis* L (*SO*), *Arbutus andrachne* L (*AA*) and *Olea europaea* L (*OE*) plants were collected at the period of baby fruit. In this research, dry matter (DM), crude protein (CP), crude ash (CA), organic matter (OM), neutral detergent fiber (NDF), acid detergent fiber (ADF), acid detergent lignin (ADL), non-fiber carbohydrates (NFC), crude fat (CF) and condensed tannins (CT) was measured to determine the chemical compositions of leaves ($P<0.01$). In addition, dry matter intake (DMI), dry matter digestibility (DMD), relative feed value (RFV) and metabolic energy (ME_{ADF}) were calculated to evaluate the nutritive value of leaves. All investigated parameters were statistically different except for DM content of leaves. Results of current study showed that the SO had better nutritive value and chemical contents for livestock especially goats. It can be concluded that the CT content of *SO* can be examined at the flowering and/or earlier period in further studies.

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Bazı Maki Türlerinin Kimyasal Kompozisyonu ve Besin Değerlerinin Karşılaştırılması

ÖZET

Bu çalışmanın amacı meyve oluşturma döneminde toplanan maki türlerinin yapraklarının kimyasal kompozisyonunu ve besin değerlerini karşılaştırmaktır. Bu amaçla *Quercus coccifera* L. (*QC*), Quercus branti Lindl. (QB), Quercus vulcanica Boiss and Heldr. Ex Kotschy (QV), *Phillyrea latifolia* (L.) Salibs (*PL*), *Styrax officinalis* L. (*SO*), *Arbutus andrachne* L. (*AA*) ve *Olea europaea* L. (*OE*) bitkilerinin yaprakları meyve oluşturma döneminde toplanmıştır. Bu araştırmada, kuru madde (KM), ham protein (HP), ham kül (HK), organik madde (OM), nötral deterjan lif (NDF), asit deterjan lif (ADF), asit deterjan lignin (ADL), lif olmayan karbonhidratlar (NFC), ham yağ (HY) ve kondense tanen (KT) özellikleri yaprakların kimyasal kompozisyonunu belirlemek için ölçülmüştür. Ek olarak, kuru madde tüketimi (KMT), kuru madde sindirimi (KMS), nispi yem değeri (NYD) ve metabolik enerji (ME_{ADF}) gibi özellikler ise yaprakların besleme değerini değerlendirmek için hesaplanmıştır. Yaprakların KM içeriği dışında incelenen tüm parametreler istatistiki açıdan önemli bulunmuştur. Mevcut çalışmanın sonuçları *SO*'nun çiftlik hayvanları özelliklede keçiler için daha iyi bir besin değeri ve kimyasal içeriğe sahip olduğunu göstermiştir. Sonuç olarak, *SO*'nun ileriki çalışmalarda çiçeklenme ve/veya daha erken bir periyotta incelenebileceği söylenebilir.

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Anahtar Kelimeler
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INTRODUCTION

The number of ruminants is 63.3 million live animals including 46.1 million small ruminants (goats and sheep) in 2018 in Turkey (TUIK, 2018). However, these animals can't be fed as much as their yield potential. The main reason of inadequate nutrients for animal in Turkey, cheap and quality roughage is not enough (Özen *et al.* 2005). To meet feed requirements of goats and sheep, as well as conventional feed sources (concentrated feeds, forage crops, silages etc.), there are also important nutrient resources such as trees and shrubs in natural and semi-natural vegetation of the Mediterranean climate (Temel and Tan, 2011).

Shrubs which are one of the major vegetation types of the earth especially Mediterranean ecological conditions are short and have a strong root-system. Moreover, these plants are highly resistant to drought. The share of goat and sheep farming in agricultural activities is around 60-80% (Rogosic *et al.* 2006). It is reported that shrubs have an important nutrient in ruminant animal feeding in many regions of the world and many nutrition (more than 60%) consumed by goats and sheep is provided from woodlands and shrublands in Mediterranean ecological conditions (Kamalak *et al.* 2004; Temel and Tan, 2011). It is well-known that shrubs have been used feeding ruminant livestock to meet their requirements like protein, energy and mineral matter around the Mediterranean conditions (Kamalak *et al.* 2010; Kaya and Kamalak, 2012; Kilic *et al.* 2010;). Although the knowledge about feed quality of some shrubs is attained from many scientific sources, some shrubs is not evaluated in terms of chemical composition and nutritive value up to now. Furthermore, the chemical compositions and nutritive value of growing plants in natural areas are affected by the factors like the region's topography (Kamalak *et al.* 2004; Oberhuber and Kofler, 2000), soil (Adams and Rieske, 2003) and ecological condition (Burke *et al.* 1997). Shrub and tree species having deep and strong root systems maintain their green form at the period when it is not available enough feed source for animals (Papanastasis *et al.* 2008). In addition, it is reported that these plant species can meet to energy requirements of ruminants especially goats in Turkey (Dökülgen, 2015; Temel and Tan, 2011).

The aim of this study was to compare chemical composition and nutritive value of shrub leaves.

MATERIAL and METHODS

Shrub Species

The present study was conducted on Bucak district of Burdur province (37° 26' N, 30° 46' E, 402 m above the sea level and 80 km away from Mediterranean Sea). Location of the study area was given in Figure 1. Leaves of seven different shrub species (*Quercus coccifera* L. *Quercus branti* Lindl., *Quercus vulcanica* Boiss and Heldr. Ex Kotschy, *Phillyrea latifolia* (L.) Salibs, *Styrax officinalis* L., *Arbutus andrachne* L. and *Olea europaea* L.) were collected to determine the feeding value and chemical composition with the triplicate samples in the 2017 year. All the shrub leaves were hand-harvested at the period of baby fruits. Leaves picked from these shrub species were dried in 60 °C for 48 hours and these materials were then milled to pass a 1-mm sieve for chemical analysis.

Figure 1. Location of Burdur Province on Turkey's Map

Chemical Analyses

Dry matter (DM) contents of shrub leaves were determined by oven drying at 105 °C for 24 hours (Keppler *et al.* 2006). Crude ash (CA) contents of leaves were investigated by burning in the muffle furnace at 525 °C for 8 hours (AOAC 1990). Nitrogen (N) contents

of leaves were measured by the Kjeldahl method (AOAC 1990). Crude protein (CP) contents were calculated as Nx6.25. Crude fat (CF) contents of leaves were examined according to the AOAC (1990). Neutral detergent fiber (NDF) and acid detergent fiber (ADF) were analyzed according to the sequential method of Van Soest et al. (1991) by using the ANKOM filter bag system with A220 fiber analyzer (ANKOM Technology, Fairport, NY). Non-fiber carbohydrate (NFC) content of leaves was estimated by using the equation NFC = 100 – (NDF +CP + CF + CA) (NRC, 2001). Condensed tannin (CT)contents of leaves were evaluated by the method of Makkar *et al.* (1995).

The relative feed value (RFV) of leaves was calculated by the following formulas developed by Van Dyke and Anderson (2002). Before calculating the RFV, digestible dry matter (DDM) and dry matter intake (DMI) were numbered by taking advantage of NDF and ADF values. Metabolizable energy (ME_{ADF}) based on ADF contents of leaves was calculated according to the formula below (Güngör *et al.* 2008).

$$DDM\ \% = 88.9 - 0.779\ Xx\ ADF\ \% \quad (1)$$

$$DMI\ \% = 120 / NDF\ \% \quad (2)$$

Where, DDM was digestible dry matter as % of dry matter, and DMI was dry matter intake as a % of animal body weight (BW).

DDM and DMI values were used to calculate the RFV.

$$RFV = DDM\ \% \times DMI\ \% \times 0.775 \quad (3)$$

$$ME_{ADF}\ (MJ\ kg^{-1}\ DM) = 14.70 - 0.150 \times ADF \quad (4)$$

Statistical Analyses

One-way analysis of variance (ANOVA) was conducted to comparison the chemical composition and nutritive value of some shrub leaves. Significance among the means was evaluated by using the Tukey pairwise test ($P \leq 0.05$).

RESULTS and DISCUSSION

The chemical compositions of leaves of shrub species were presented in Table 1. Expect DM contents, species had a significant effect on the chemical compositions of leaves of shrub species. The CP contents of species was ranged from 4.82% to 10.36%. CP of leaves from *Quercus vulcanica* Boiss and Heldr. Ex Kotschy was markedly higher than other species. CP content of *Quercus vulcanica* Boiss and Heldr. Ex Kotschy was lower than reported by Kökten *et al.* (2017). On the other hand, CP contents of leaves from *Quercus coccifera* L. were convenient with that reported by Kökten *et al.* (2012) and Kökten *et al.* (2017). CP content of *Quercus branti* Lindl. was higher than reported by Kamalak *et al.* (2004). CP content of *Arbutus andrachne* L. was consistent with that reported by Kamalak *et al.* (2010). CP content of *Olea europaea* L. was lower than reported by Delgado-Pertíñez *et al.* (2000). CP content of *Phillyrea latifolia* (L.) Salibs was relation with reported by Temel and Tan (2011). There is not any scientific source about chemical composition of *Styrax officinalis* L.. As can be seen from Table 1, it seems to be conceivable that CP contents of *Quercus vulcanica* Boiss and Heldr. Ex Kotschy will meet the CP requirements of small ruminants especially goats.

CA and OM contents of shrubs leaves ranged from 3.81% to 6.02% and 93.98% to 96.19%, respectively. CA and OM contents of *Quercus coccifera* L. and *Quercus vulcanica* Boiss and Heldr. Ex Kotschy were lower than reported by Kökten *et al.* (2017), while CA and/or OM contents of *Quercus branti* Lindl. were appropriate with reported by Kamalak *et al.* (2004). CA and OM contents of *Arbutus andrachne* L. and *Phillyrea latifolia* (L.) Salibs were higher than reported by Yolcu *et al.* (2014). CA and OM contents of *Olea europaea* L. were lower than reported by Delgado-Pertíñez *et al.* (2000). Kökten *et al.* 2012 reported that CA and OM contents increase depending on advancement in maturity. Therefore, these differences can be explained by the fact that plants are in different stages of development.

NDF, ADF and ADL contents of shrub leaves ranged from 26.96% to 52.97%, 16.51% to 31.78% and 4.49%-15.60%, respectively. NDF and ADF contents of *Quercus coccifera* L. and *Quercus vulcanica* Boiss&Heldr. Ex Kotschy were higher than reported by Kökten *et al.* (2017). Moreover, NDF and ADF contents of *Quercus coccifera* L. and *Phillyrea latifolia* (L.) Salibs were consistent with that reported Kökten *et al.* (2012). NDF and ADF contents of *Arbutus andrachne* L. were lower than reported by Temel and Tan (2011). NDF and ADF contents of *Olea europaea* L. were convenient with reported by Delgado-Pertíñez *et al.* (2000). On the other hand, ADL contents of *Olea europaea* L. were lower than reported by Delgado-Pertíñez *et al.* (2000).

NFC values of shrub species ranged from 32.77% to 58.81%. The lowest NFC value was obtained from *Quercus branti* Lindl. while the highest NFC value was obtained from *Styrax officinalis* L..

Significant differences were detected among shrub species on CF. The highest CF content was obtained from *Olea europaea* L. (7.93%), while the lowest was obtained from *Quercus branti* Lindl. (1.94%).CF contents of *Quercus coccifera* L. were consistent with reported Kamalak *et al.* (2004) while the CF contents of *Quercus branti* Lindl. were lower than reported Kamalak *et al.* (2004). CF contents of *Arbutus andrachne* L., *Phillyrea latifolia* (L.) Salibs and *Quercus coccifera* L. were convenient with reported by Yolcu *et al.* (2014). These differences can be explained by different stages of development and changes in ecological conditions.

Table 1. Chemical compositions of leaves of some shrubs

Species	Nutrients (% of DM)									
	DM	CP	CA	OM	NDF	ADF	ADL	NFC	CF	CT
Quercus coccifera L.	90.85	6.66^{bc}	4.47^{cd}	95.53^{ab}	49.47^{ab}	30.84^{a}	11.54^{bc}	35.04^{cd}	4.36^{d}	9.72^{b}
Quercus branti Lindl.	92.43	7.37^{b}	4.95^{bc}	95.05^{bc}	52.97^{a}	31.78^{a}	13.17^{b}	32.77^{d}	1.94^{e}	16.72^{a}
Quercus vulcanica Boiss and Heldr. Ex Kotschy	92.76	10.36^{a}	3.81^{d}	96.19^{a}	45.51^{b}	27.22^{b}	12.18^{bc}	34.83^{cd}	5.49^{bc}	7.74^{bc}
Phillyrea latifolia (L.) Salibs	94.89	6.70^{bc}	5.89^{a}	94.11^{d}	42.92^{bc}	27.56^{b}	15.60^{a}	40.53^{bc}	3.97^{d}	1.46^{d}
Styrax officinalis L.	94.39	5.67^{cd}	3.94^{d}	96.06^{a}	26.96^{d}	16.51^{d}	4.49^{d}	58.81^{a}	4.63^{cd}	6.81^{c}
Arbutus andrachne L.	93.25	4.82^{d}	6.02^{a}	93.98^{d}	38.13^{c}	23.09^{c}	10.60^{c}	45.50^{b}	5.54^{b}	8.02^{bc}
Olea europaea L.	94.83	4.84^{d}	5.49^{ab}	94.51^{cd}	42.70^{bc}	27.34^{b}	15.55^{a}	39.05^{bcd}	7.93^{a}	2.28^{d}
SEM	0.470	0.122	0.054	0.054	0.545	0.243	0.184	0.556	0.071	1.990
Significance	NS	***	***	***	***	***	***	***	***	***

SEM, standard error mean; ^{abcd}Row means with common superscripts do not differ (P>0.05). ***P<0.001; NS, Not significant.

CT contents of investigated shrub species ranged from 1.46% to 16.72%. The lowest CT content was obtained from *Phillyrea latifolia* (L.) Salibs whereas the highest CT content was obtained from *Quercus branti* Lindl. Higher contents of condensed tannins have adverse effects on animal performance. If the tannin content rises above 5%, the forage intake and digestibility of the Mediterranean shrubs are depressed (Rogosic *et al.* 2006). Condensed tannin (commonly known as proanthocyanidins) accumulated by many plants can have both positive and negative effects of digestibility of feed matters and performance of livestock the depending on its concentration and biological activity (Schofield *et al.* 2001). Moreover, high levels condensed tannin (>%5 of DM) results in decreased in efficiency of utilization of crude protein in feeds due to excessive formation of tannin-protein complexes (Kumar and Singh 1984). The results of the study showed that only two of the bush species examined (*Phillyrea latifolia* (L.) Salibs and *Olea europaea* L.) had tannin content below 5%. Previous researchers reported that the tannin content of the shrub species increase depending on during advancing growth stage (Kamalak, 2006; Kökten *et al,* 2012; Yolcu *et al.* 2014). Therefore, it would be useful to manage grazing by examining the chemical compositions of the shrub species at different periods.

The dry matter intake (DMI), dry matter digestibility (DMD), relative feed value (RFV) and metabolic energy (ME_{ADF}) levels of the bushes used in the study were determined and given in Table 2.

Table 2. Nutritive values of leaves of some shrubs

Species	DMI (% of BW)	DDM (% of DM)	RFV	ME_{ADF} (MJ kg^{-1} DM)
Quercus coccifera L.	2.43^{cd}	64.87^{d}	122.46^{cd}	10.07^{d}
Quercus branti Lindl.	2.27^{d}	64.14^{d}	112.66^{d}	9.93^{d}
Quercus vulcanica Boiss&Heldr. Ex Kotschy	2.65^{cd}	67.70^{c}	138.87^{cd}	10.62^{c}
Phillyrea latifolia (L.) Salibs	2.80^{bc}	67.43^{c}	146.17^{bc}	10.57^{c}
Styrax officinalis L.	4.45^{a}	76.04^{a}	262.51^{a}	12.22^{a}
Arbutus andrachne L.	3.15^{b}	70.91^{b}	173.23^{b}	11.24^{b}
Olea europaea L.	2.83^{bc}	67.60^{c}	148.24^{bc}	10.60^{c}
SEM	0.035	0.190	2.190	0.037
Significance	***	***	***	***

SEM, standard error mean; ^{abcd}Row means with common superscripts do not differ (P>0.05). ***P<0.001.

All calculated quality parameters (DMI, DDM, RFV and ME_{ADF}) had significant differences depending on the shrub species. The DMI values ranged from 2.27% to 4.45 % of BW among shrub species. The highest DMI was obtained from *Styrax officinalis* L. while the lowest DMI was found out *Quercus branti* Lindl. The DDM of shrubs ranged from 64.14% to 76.04%. The highest RFV and ME_{ADF} were obtained from *Styrax officinalis* L. leaves while the lowest values were found out *Quercus branti* Lindl.. The differences among shrub species in terms of these properties have been reported by Kökten *et al.* (2012) and Kökten *et al.* (2017). The results of the study showed that *Styrax officinalis* L. had statistically superior characteristics from all other species examined in terms of all quality parameters. NDF and ADF contents of *Styrax officinalis* L. were found very low in current study. Therefore, RFV of this plant was calculated quite high based on NDF and ADF values.

CONCLUSIONS

Even though CT content of *Styrax officinalis* L. plant was slightly found high, the nutritive value and some chemical contents of this plant was higher than other shrubs. This study indicated that the *Styrax officinalis* L. had better nutritive value and chemical contents for livestock especially goats (Figure 2). Although the highest CP content was obtained from *Quercus vulcanica* Boiss and Heldr. Ex Kotschy, this shrub had the high-level condensed tannin contents. It can be said that Oak species is not more appropriate than other species for feeding animals in this current study and the *Styrax officinalis* L. plant is more convenient for small ruminants. However, nutritive value and chemical contents of this plant can be investigated due to high condensed tannins at different vegetation periods. Since the high condensed tannin content can decrease protein benefit for livestock. In addition, the use of bush leaves in animal feeding requires more (in vivo and in vitro) studies.

Figure 2 *Styrax officinalis* L. shrub grazed by goats

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