Journal of Anatolian Environmental and Animal Sciences
(*Anadolu Çevre ve Hayvancılık Bilimleri Dergisi*)
DOI: https://doi.org/10.35229/jaes.638742

JAES
Year: 5, No: 1, 2020 (19-24)
AÇEH
Yıl: 5, Sayı: 1, 2020 (19-24)

ARAŞTIRMA MAKALESİ RESEARCH PAPER

The Effects of Ecological Factors on Some Characteristic of Fruits in *Vaccinium arctostaphylos* L. Populations in The Fırtına Valley[*],[**]

Filiz YÜKSEK*
Directorate of Eastern Black Sea Forestry Research Institute, General Directorate of Forestry, 61040, Trabzon/Turkey.

Geliş/Received: *27.10.2019* ***Kabul/Accepted:*** *22.01.2020*

How to cite: **Yüksek F. (2020).** The Effects of Ecological Factors on Some Characteristic of Fruits in *Vaccinium arctostaphylos* L. Populations in The Fırtına Valley. *J. Anatolian Env. and Anim. Sciences,* ***5***(1), 19-24.
Atıf yapmak için: **Yüksek F. (2020).** Fırtına Vadisi'ndeki *Vaccinium arctostaphylos* L. Populasyonlarında Ekolojik Faktörlerin Meyvelerin Bazı Özelliklerine Etkisi. *Anadolu Çev. ve Hay. Dergisi*, ***5***(1), 19-24.

*: https://orcid.org/0000-0003-3275-642X

***Corresponding author's:**
Filiz YÜKSEK
Directorate of Eastern Black Sea Forestry Research Institute, General Directorate of Forestry, 61040, Trabzon/Turkey
✉: filiz6153@gmail.com

Abstract: In this study, it was aimed to determine the effect of environmental factors such as altitude, geological formation and canopy cover on certain properties of fruit in the whortleberry populations in the Fırtına Valley. For this purpose, total 30 sampling plots with three replicates were taken in three different level of altitude (1000-1200 m, 1300-1500 m, 1800-1900 m. a.s.l.), in two different geological formations (Kaçkar Granitoyidi and Çatak) and in two different canopy covers (0% and 40-60%). Three sampling parcels were chosen for sampling in each of sampling plots. Fruit characteristics such as width, height, weight, dry matter amount of fruit were measured in fruit samples collected from sampling plots. As well as the time to start the ripening of the fruit was determined. Obtained results showed that fruit width varied between 4.04 and 12.91 mm, fruit length ranged from 4.94 to 13.92 mm, the 100 berry weight varied between 24.61 and 87.05 g, and the total dry matter amount varied between 10.14% and 17.35%. It was determined that ecological factors, especially altitude, significantly changed fruit characteristics. Fruit width, fruit height and 100 berry weight showed irregular change with increasing altitude. It was observed that the canopy cover negatively affected the properties of the fruit. Pomologically, the best fruit characteristics in the populations were found on the Çatak geological formation in the second elevation level (1300-1500 m a.s.l.). The wild Caucasian whorthleberry populations in the second elevation level should be selected as one of the genetic resource conservation areas in the valley. Furthermore this population may have promising genotypes that contribute to plant breeding programs.

Keywords: Altitude, canopy, Fırtına valley, fruit traits, geological formation, *Vaccinium arctostaphylos*.

Fırtına Vadisi'ndeki *Vaccinium arctostaphylos* L. Populasyonlarında Ekolojik Faktörlerin Meyvelerin Bazı Özelliklerine Etkisi

***Sorumlu yazar:**
Filiz YÜKSEK
Directorate of Eastern Black Sea Forestry Research Institute, General Directorate of Forestry, 61040, Trabzon/Turkey
✉: filiz6153@gmail.com

Öz: Bu çalışmada; Fırtına vadisi'ndeki ayı üzümü populasyonlarında rakım, jeolojik formasyon ve kapalılık gibi çevresel faktörlerin meyvenin bazı özellikleri üzerindeki etkisinin belirlenmesi amaçlanmıştır. Bu nedenle, üç farklı yükselti kademesinde (1000-1200 m, 1300-1500 m, 1800-1900 m), iki farklı jeolojik formasyonda (Kaçkar Granitoyidi ve Çatak) ve iki farklı meşçere kapalılığında (% 0 ve % 40-60) üçer tekrarlı olmak üzere toplam otuz adet deneme alanı alınmıştır. Her bir deneme alanında örnekleme için üç alt parsel seçilmiştir. Deneme alanlarından toplanan meyve örnekleri üzerinde; meyvenin genişliği, boyu, ağırlığı, kuru madde miktarı gibi meyve özellikleri ölçülmüştür. Ayrıca meyvelerin olgunlaşmaya başlama zamanı da belirlenmiştir. Araştırma sonucunda; meyve genişliğinin 4.04 ila 12.91 mm, meyve uzunluğunun 4.94 ila 13.92 mm arasında, 100 meyve ağırlığının 24.61 ile 87.05 g arasında ve toplam kuru madde miktarının % 10.14 ile % 17.35 arasında değiştiği tespit edilmiştir. Ekolojik faktörlerin, özellikle de yükseltinin, meyve özelliklerini istatistiksel olarak anlamlı bir şekilde değiştirdiği tespit edilmiştir. Yükselti arttıkça, meyve genişliği, meyve boyu ve 100 meyve ağırlığı değerlerindeki değişimin düzensiz olduğu görülmüştür. Ayrıca, meşçere kapalılığının meyvenin özelliklerini olumsuz yönde etkilediği tespit edilmiştir. Pomolojik olarak, populasyonlardaki en iyi meyve özellikleri, Çatak jeolojik formasyonunun ikinci yükselti kademesinde (1300-1500 m) bulunmuştur. İkinci rakımdaki bu doğal ayı üzümü populasyonları, vadideki genetik kaynak koruma alanlarından biri olarak seçilebilir. Ayrıca, bu populasyon bitki yetiştirme programlarına katkıda bulunabilecek umut verici genotiplere sahip olabilir.

Anahtar kelimeler: Fırtına vadisi, jeolojik formasyon, kapalılık, meyve özellikleri, *Vaccinium arctostaphylos*, yükselti.

[*] ,[*]*This study was prepared by adapting a part of the PhD Thesis titled "The Investigations on Effect of Some Ecological Factors on Plant and Fruit Properties in Whortleberry (Vaccinium arctostaphylos L.)" Populations Naturally Growing in Fırtına River Basin.*

[**]*Abstract of this paper was published in Abstract Book of International Forestry & Environment Symposium (IFES) 2017.*

INTRODUCTION

Non-timber forest products (NTFP) have been harvested by human populations for subsistence use and trade over thousands of years. The harvest of wild non-timber forest products (NTFP) represents an important source of income to millions of people worldwide (Ticktin, 2004). While until 1990, the wood raw material was considered the most important forest product in Turkey, in recent years, awareness and demand towards non-wood forest products are increasing (Fidan et al., 2013) and especially the use and trade of natural products is increasing (Yaldız et al., 2010a). Also, these products contribute significantly to the increase of local peoples income (Yaldizet al., 2010b). So it is suggested to increase the studies on medicinal aromatic species in sustainable rural development and alleviating poverty (Yüksek et al., 2017). Thus, researches on new species that would provide non-wood raw materials from forest have been increased. *Vaccinium arctostaphylos* L. which is the member of Ericaceae family is a deciduous shrub that has been newly discovered as medical and aromatic plant. It grows under forest canopy and in gaps, spreads from the seaside up to 1830 meters above sea level in fir, spruce, and beech stands in the Black Sea Region (Davis, 1978; Kayacık 1981; Anşin & Özkan, 2006). Many studies have been reported about its medical and aromatic value (Ayaz et al., 2001; Hasanloo et al., 2011; Ayaz et al., 2005; Koca & Karadeniz, 2009; Navar & Amin, 2004; Sedaghatoor et al., 2006). However, investigation on adaptation, propagation, and harvesting techniques in *Vaccinium arctostaphylos* are insufficient. In order to be successful in the researches conducted in this regard, the information about the performance of the plant in its natural habitat should be taken into consideration. Because, the quantity and quality of the plant are not only related with the genetic characteristics but also related with the environmental factors (Close & McArthur, 2002; Jakola et al., 2004; Latti et al., 2008; Zhu et al., 2010; Körner, 2007). Therefore, it is very important to know the changing characteristics of the plant against the different ecological factors in determining the direction and severity of the interventions for various purposes. Effective harvesting and production techniques can be developed by using this information. Despite the importance of phenotypic plasticity in fruit traits such as fruit mass being widely recognized, remarkably little is known about the environmental factors that affect fruit characteristics in the case of wild fruits (Pato & Obes, 2012).

Main goal of the the study is to determine the effect of environmental factors such as altitude, geological formation and canopy cover on some fruit characteristics of the whorthleberry populations in the Fırtına valley.

MATERIAL AND METHOD

The study area is located in Çamlıhemşin Province (40°58'11"N -40 59'40"E and 41° 00' 42"N-40°57'05"E) in easthern Blacksea region in Turkey (Figure 1). Climate of study area is sub-oceanic. The mean annual temperature is 6ºC and the total mean annual precipitation is 2745 mm (Yüksek, 2013). The study area is usually covered with snow from December through May or June. Geologically, experimental sites are defined as Çatak and Kaçkar Granitoyidi geologic formations (Güner, 1983; Gedik et al., 1992; Okay & Şahintürk, 1997; Yalçınlar, 1952). The vegetation in the study area is dominated by pure *Picea orientalis* L. stands and mixed *Picea orientalis* L. *Fagus orientalist* Lipsky stands. The canopy layer was dominated by *Picea orientalis* L. in sampling plots.

The most common understory species were *Vaccinium artostaphylos* L., *Rhododendron ponticum* L., *Rhododendron luteum* Sweet, *Sorbus aucuparia* L., *Ilex aquifolium* L., *Laurocerasus officinalis* Roemer, *Campanula* sp, *Epigaea* sp., *Carex* sp., *Hypericum* sp (Yüksek, 2013).

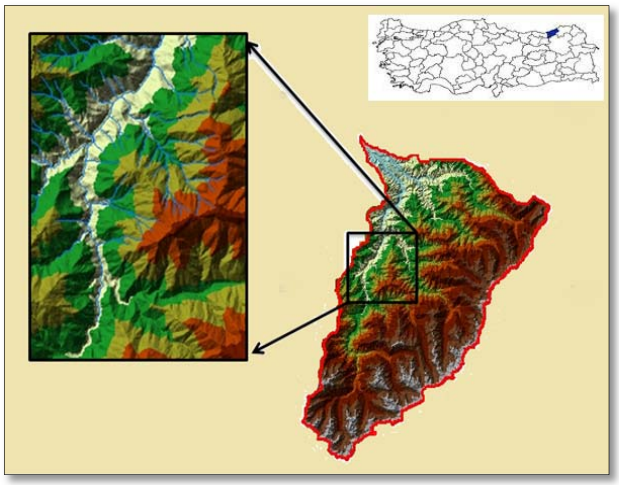

Figure 1. Study area (Yüksek, 2013).

In order to determine possible differences in berry traits, 30 sampling plots in total with three replicates were taken in three different altitude levels (1000-1200 m, 1300-1500 m, 1800-1900 m. a.s.l.), in two different geological formations (Kaçkar Granitoyidi and Çatak) and in two different canopy covers (0% and 40-60%). All sampling plots were similar as topographic factors (e.g. slope, hillside and aspect). Three sub-sampling parcels were randomly chosen in each sampling plots for obtaining data. After ripening the fruits, mature berries were harvested from sampling plots. Width, length, weight, and dry matter amount of berry were determined in laboratory. Fruit weight was measured by using a digital balance with a sensivity of 0.001 g. The length and width of berries were measured by using a digital calliper with a sensivity of 0.01 mm. The

amount of dry matter of the fruits was determined as % by weight loss (Yamankaradeniz, 1982; Günay, 2009). Statistical analysis of the data was carried out using SPSS for Windows version 15.0. Three-way (factorial) ANOVA test was used to determine the effect of altitudes, geological formations and canopy cover on berry characteristics. Duncan tests were used to separate the averages of the dependent variables (berry characteristics) which were significantly affected by factors.

RESULTS

The mean widths of berries harvested from sample plots were given in Table 1.

Table 1. Some properties of berries harvested from sample plots.

Mean width of berry (mm)		**N**	**Mean**	**Min.**	**Max.**	**Stan. Dev.**
Canopy Cover (%)	0	2250	9.18 [a]	4.45	12.91	±1.233
	40-60	1350	7.01 [b]	4.04	10.63	±1.324
Geological Formation	Kaçkar Granitoyidi	1440	7.79 [b]	4.04	12.91	±1.707
	Çatak	2160	8.76 [a]	5.04	12.50	±1.485
Altitude Group (m)	I. (1000-1200)	1440	8.03 [c]	4.04	12.30	±1.870
	II. (1300-1500)	1440	8.64 [a]	4.06	12.91	±1.495
	III. (1800-1900)	720	8.50 [b]	5.97	12.50	±1.306
Mean length of berry (mm)		**N**	**Mean**	**Min.**	**Max.**	**Stan. Dev.**
Canopy Cover (%)	0	2250	9.90 [a]	6.50	13.92	±1.31
	40-60	1350	7.46 [b]	4.94	12.94	±1.22
Geological Formation	Kaçkar Granitoyidi	1440	8.93 [b]	5.24	13.92	±1.82
	Çatak	2160	9.02 [a]	4.94	13.45	±1.69
Altitude Group (m)	I. (1000-1200)	1440	8.76 [b]	4.94	13.50	±1.87
	II. (1300-1500)	1440	9.15 [a]	5.24	13.92	±1.64
	III. (1800-1900)	720	8.91 [a]	5.83	13.45	±1.57
Mean weight 100 berry (g)		**N**	**Mean**	**Min.**	**Max.**	**Stan. Dev.**
Canopy Cover (%)	0	450	56.43 [a]	31.70	87.05	±10.054
	40-60	225	43.29 [b]	24.61	69.23	±8.068
Geological Formation	Kaçkar Granitoyidi	270	51.42 [a]	24.61	87.05	±11.425
	Çatak	405	53.81 [a]	26.63	80.36	±11.201
Altitude Group (m)	I. (1000-1200)	270	50.67 [b]	28.68	87.05	±10.696
	II. (1300-1500)	270	53.43 [a]	24.61	77.36	±11.708
	III. (1800-1900)	135	52.07 [a]	26.63	76.25	±11.327
Total dry matter (%)		**N**	**Mean**	**Min.**	**Max.**	**Stan. Dev.**
CanopyCover (%)	0	450	13.32 [a]	10.14	17.35	±1.73
	40-60	225	13.09 [a]	10.21	17.13	±1.66
Geological Formation	Kaçkar Granitoyidi	270	13.43 [a]	10.23	17.18	±1.70
	Çatak	405	13.13 [a]	10.14	17.35	±1.70
Altitude Group (m)	I. (1000-1200)	270	13.42 [a]	10.15	17.35	±1.84
	II. (1300-1500)	270	13.54 [a]	10.22	17.13	±1.58
	III. (1800-1900)	135	12.30 [b]	10.14	15.79	±1.32

*Different letters indicate significant differences between factors ($P < 0.05$).

Fruit width ranged between 4.04 mm and 12.91 mm. The lowest value of fruit width was obtained at 1000-1200 meters above sea level in Kaçkar Granitoyidi geological formation under 40-60 % canopy cover. The highest fruit width was obtained at 1300-1500 meters above sea level in Kaçkar Granitoyidi geological formation under 0 % canopy cover. The highest mean of berry width was obtained at 1300-1500 meters above sea level under 0 % canopy cover in Çatak geological formation. Berry width was significantly affected by canopy cover, geological formations and altitude. Also the effect of altitude was not linearly (Table 1).

The mean length of berries harvested from sample plots was given in Table 1. Fruit length ranged between 4.94 mm and 13.92 mm. The lowest fruit length is in the first group altitude, in Çatak geological formation and in

40-60 % canopy cover. The highest fruit length is in the second group altitude in Kaçkar Granitoyidi geological formation and in 0% canopy cover. The highest mean of berry length is 0% canopy cover, in Çatak geological formation and in the second altitude group (Table 1). Berry length was significantly affected by canopy cover, geological formations and altitude. Also the effect of altitude was not linearly (Table 1).

The mean 100 berry weight was given in Table 1. 100 berry weight ranged between 24.61 gr and 87.05 g. The lowest 100 berry weight is in the second group altitude in Kaçkar Granitoyidi geological formation and in 40-60 % canopy cover. The highest 100 berry weight is in the first group altitude in Kaçkar Granitoyidi geological formation and in 0% canopy cover. The highest mean of 100 berry weights is 0 % canopy in Çatak geological formation and in the second altitude group. According to altitude group, mean 100 berry weight first significantly increased, then decreased (Table 1).

The total dry matter amount of berries harvested from sample plots is given in Table 1. The total dry matter amount of fruit ranged between 10.14 % and 17.35 %. The only altitude has a significant influence on the total dry matter amount of berry (Table 1). First ripen time of berry is given in Figure 2. Altitude and canopy cover has an influence at the mature time of berry.

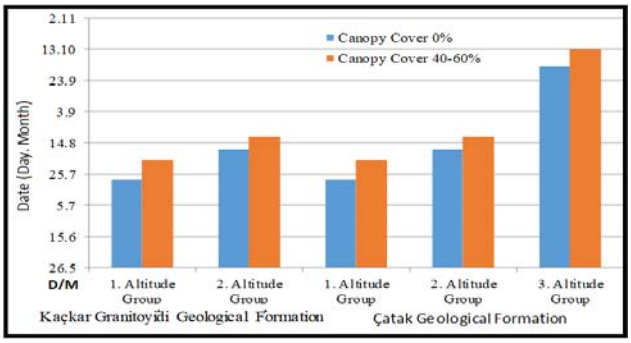

Figure 2. First ripen time of berry in research area.

DISCUSSION AND CONCLUSION

In this study, it was found that fruit width varied between 4.04 and 12.91 mm, fruit length ranged from 4.94 to 13.92 mm, the 100 berry weight varied between 24.61 and 87.05 g, and the total dry matter amount varied between 10.14% and 17.35%. While İslam et al. (2009) found that 100 berry weight ranged between 32.08 g and 100.5 g, Patan (2017) also found similar results to our research. As the altitude increased, fruit width, fruit height and 100 berry weight showed irregular change. Fruit mass is a plastic trait influenced by environmental factors like nutrient availability (Pato & Obeso, 2012). So it was determined that ecological factors, especially altitude, change statistically fruit characteristics. Gülsoy et al. (2013) reported that environmental factors affect the physical properties of the fruit. Likewise Torland and Birks (1996) found that mean seed weight are more strongly influenced by altitude which largely reflects the climatic severity at the site. In this research, it was observed that the canopy negatively affects the properties of the fruit. An increase in fruit yield was reported by Moola and Mallik (1998) in wild velvetleaf blueberry (*Vaccinium myrtilloides* Michx.) following canopy disturbance. Berry production by *V. myrtilloides* does improve significantly following artificial canopy disturbance; especially with partial cutting. This positive effect may be in response to increased light availability in canopy openings as indicated by the relationship between berry production and the number of reproductive shoots (Moola & Mallik, 1998). Similarly, shade significantly affected the growth of the 'bluecrop' blueberry and photosynthetic capacity was significantly depressed by shade (Kim et al., 2011). Altitude, especially high elevation, significantly affected the total dry matter amount of berries. This result may be related to environmental conditions in the high elevation. Because total dry matter amount influence fruit weight. So fruit mass may be influenced by the number of seeds per fruit. The number of seed is related to pollination and low temperatures limited their seed production (Torland, 2001).

As a result, pomologically, the best fruit characteristics in the populations were found on the Çatak geological formation at the second elevation (1300-1500 m a.s.l.). The wild Caucasian whortleberry populations in the second altitude group can be selected as one of the genetic resource conservation areas in the valley. Furthermore this population may have promising genotypes that contribute to plant breeding programs.

REFERENCES R

Anşin, R. & Özkan, Z.C. (2006). *Tohumlu bitkiler (spermatophyta) odunsu taksonlar*. KTÜ Basımevi, Orman Fakültesi Yayını, No:19, Trabzon, 262s.

Ayaz, A.F., Kadıoğlu, A., Bertoft, E., Acar, C. & Turna, İ. (2001). Effect of fruit maturation on sugar and organic acid composition in two blueberries (*Vaccinium arctostaphylos* and *V. myrtillus*) native to Turkey. *New Zealand Journal of Crop and Horticultural Science*, ***29***, 137-141.

Ayaz, A.F., Hayırlıoğlu-Ayaz, S., Gruz, J., Novak, O. & Strnad, M. (2005). Separation, characterization, and quantitation of phenolic acids in a little-known blueberry(*Vaccinium arctostaphylo*s L.)

fruit by HPLC-MS. *J. Agric. Food Chem.*, ***53***, 8116-8122.

Close, D.C. & McArthur, C. (2002). Rethinking the role of many plant phenolics-protection from photodamage not herbivores. *Oikos*, ***99***,166-172.

Davis, P.H. (1978). *Flora of Turkey and The East Aegean Islands*. Ed. P.H. Davis, 6, at the University press, Edinburg.

Fidan, M.S., Öz, A., Adanur, H. & Turan, B. (2013). Gümüşhane yöresinde yetişen bazı önemli odun dışı orman ürünleri ve kullanım miktarları. *GÜFBED/GUSTIJ*, ***3***(2), 40-48.

Gedik, A, Ercan, T, Korkmaz, S. & Karataş, S. (1992). Rize-Fındıklı-Çamlıhemşin arasında (Doğu Karadeniz) yeralan mağmatik kayaçların petrolojisi ve doğu ponditlerdeki bölgesel yayılımlar. *Türkiye Jeoloji Bülteni*, ***C-35***, 15-38.

Gülsoy, S., Özkan, G., Özkan, K. & Genç, M. (2013). Menengiç (*Pistacia terebinthus* L. subsp. *palaestina* (Boiss.) Engler) meyvelerinin bazı fiziksel ve fizikokimyasal özellikleri üzerine ekolojik faktörlerin etkisi. *SDU Faculty of Forestry Journal*, ***14***, 15-23.

Günay, K. 2009. *Variation in important fruit quality characteristics in 'Hayward'* (*A. deliciosa* Plach L.) *kiwifruit of different elevations and directions in Ordu (Turkey) province.* M.Sc. Thesis, Ordu University, Institute of Science, Ordu, Turkey, 65pp.

Güner, S. (1983). Rize-Çayeli-Fındıklı yöresinin jeolojisi, M.T.A. Yayınları, Proje Yılı 1982-82-13b, Yayın No. 82-13b, Trabzon.

Hasanloo, T., Sepehrifar, R. & Hajımehdıpoor, H. (2011). Levels of phenolic compounds and their effects on antioxidant capacity of wild *Vaccinium arctostaphylos* L. (Qare-Qat) collected from different regions of Iran. *Turk J. Biol.*, ***35***, 371-377.

İslam, A., Çelik, H. & Serdar, U. (2009). Evaluation of *Vaccinium arctostaphylos* selections from The Artvin and Trabzon provinces of Turkey. *ISHS Acta Hort.*, ***810***, 129-132.

Jaakola, L., Riihinen, K., M., Karenlampi, S. & Hohtola, A. (2004). Activation of flavonoid biosynthesis by solar radiation in bilberry (*Vaccinium myrtillus* L.) leaves. *Planta, **218***, 721-728.

Kayacık, H. (1981). Orman ve park ağaçlarının özel sistematiği, 2. Cilt Angiospermae (Kapalı Tohumlular), Bozak Matbaası, Orman Fakültesi Yayını, No: 287 İstanbul, 231pp.

Kim, S.J., Yu, D.J., Kim, T.C. & Lee, H.C. (2011). Growth and photosynthetic characteristics of blueberry (*Vaccinium corymbosum* cv. *Bluecrop*) under various shade levels. *Scientia Horticulturae, **129***, 486-492.

Koca, İ. & Karadeniz, B. (2009). Antioxidant properties of blackberry and blueberry fruits grown in The Black Sea Region of Turkey. *Scientia Horticulturae, **121***, 447-450.

Körner, C. (2007). The use of 'altitude' in ecological research. *TRENDS in Ecology and Evolution, **22***(11), 569-574.

Latti, A.K., Rıhınen, K.R. & Kaınulaınen, P. S. (2008). Analysis of anthocyanin variation in wild populations of bilberry (*Vaccinium myrtillus* L.) in Finland. *J. Agric. Food Chem.*, ***56***, 190-196.

Moola, F.M. & Mallik, A.U. (1998). Morphological plasticity and regeneration strategies of velvet leaf blueberry (*Vaccinium myrtilloides* Michx.) following canopy disturbance in boreal mixedwood forests, *Forest Ecology and Management*, ***111***, 35-50.

Navar, N. & Amin, G. (2004). Anthocyanins from V*accinium arctostaphylos* berries. *Pharmaceutical Biology*, ***42***(4-5), 289-291.

Okay, A.I. & Şahintürk, Ö. (1997). Geology of the eastern pontides, in a.g. robinson, ed., regional and petroleum geology of The Black Sea and Surrounding Region. *AAPG, Memoir*, 68, 291-311.

Patan, Z. (2017). *Determination on pomological and morphological characteristics of Vaccinium spp grown in Doğankent, Giresun province.* M.Sc. Thesis, Ordu University, Institute of Science, Ordu, Turkey, 69pp.

Pato, J. & Obeso, J.R. (2012). Fruit mass variability in *Vaccinium myrtillus* as a response to altitude, simulated herbivory and nutrient availability. *Basic and Applied Ecology, **13***, 338-346.

Sedaghathoor, S., Kashi, A.K., Talaeı, A.R. & Khalıghı, A. (2006). Essential oils of qare-qat (V*accinium arctostaphylos)* shoots and chemical composition of berries. *Internatıonal Journal of Agrıculture & Biology*, ***8***(1), 45-46.

Ticktin, T. (2004). The ecological implications of harvesting non-timber forest products. *Journal of Applied Ecology, **41***(1), 11-21.

Totland, Ø. & Birks, H.J.B. (1996). Factors influencing inter-population variation in *Ranunculus acris* seed production in an alpine area of southwestern Norway. *Ecography*, ***19***(3), 269-278.

Totland, Ø. (2001). Environment-dependent pollen limitation and selection on floral traits in an Alpine species. *Ecology*, ***82***, 2233-2244.

Yalçınlar, İ. (1952). İspir-Pazar-Arhavi ve Yusufeli Bölgesinin Jeolojisi. M.T.A. Rapor No: 2022, Ankara.

Yamankaradeniz, R. (1982). *Researches on composition and use possibilities of naturally grown rosehip in Erzurum region*. Ph.D. Thesis, Atatürk Üniv., Institute of Science, Erzurum, Turkey,120pp.

Yaldız, G., Yüksek, T. & Şekeroğlu, N., (2010a). Importance of medicinal and aromatic plants in development of forest and costal villiages of Rize province. III. National Black Sea Forestry Congress, 20-22 May 2010, Volume: III 1176-1186pp.

Yaldız, G., Yüksek, T. & Şekeroğlu, N. (2010b). Medicinal and aromatic plants in flora of Rize province and their usage areas, III. National Black Sea Forestry Congress, 20-22 May 2010, Volume: III, 1100-1114pp.

Yüksek, F. (2013). *The investigations on effect of some ecological factors on plant and fruit properties in whortleberry* (*Vaccinium arctostaphylos* L.) *populations naturally growing in Fırtına river basin*. Ph.D. Thesis, Karadeniz Technical University, Institute of Science, Trabzon, Turkey, 181pp.

Yüksek T., Yüksek, F. & Kurdoğlu, O. (2017). Natural resource problems and suggestions for resolving these problems in Fırtına watershed. *Journal of Anatolian Environmental & Animal Sciences,* ***2***(1), 1-6.

Zhu, J., T., Yi Li, X., Ming Zhang, X., Jiang Zeng, F., Sha Lin, L., Gong Yang, S., Wei Gui, D. & Wang, H. (2010). Ecophysiological adaptation of *Calligonum roborovskii* to decreasing soil water content along an altitudinal gradient in the Kunlun Mountains, Central Russian. *Journal of Plant Physiology*, ***57***(6), 826-832.