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Wild Edible Fruits: A Rich Source of Biodiversity

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ABSTRACT: *Wild edible fruits are highly valued fruit crops for their unique flavors, textures, and colors. In recent years, wild edible fruits have been shown to provide significant health benefits because of their high antioxidant content, vitamins and minerals, fiber, folic acid, etc. In addition to fresh consumption, wild edible fruits are widely used in beverages, ice cream, yogurt, jams, jellies and many other food products. A number of wild edible fruits are used by rural and tribal populations and significantly contribute to their livelihood. The use of non-cultivated foods, of which wild fruits form a part, as a diet supplement, or as a coping mechanism in times of food shortage, provides an important safety net for the rural poor especially in underdeveloped countries. There is now a greater awareness that products from the wild may support household subsistence and also that income may be created from their sale, either in raw or processed forms. This awareness has prompted a research on the diversity of species that are used and their relation to the socio-economic status of those who use them. Wild edible fruits are important constituents of biodiversity. The aim of this study is to compare the morphological, biochemical and molecular diversity among wild edible fruits and cultivated ones.*

Keywords*: Wild fruits, content, biodiversity, rural life.*

Yabani Yenilebilir Meyveler: Zengin Biyolojik Çeşitlilik Kaynağı

ÖZ*: Yabani yenilebilir meyveler, benzersiz lezzetleri, dokuları ve renkleri ile son derece değerli meyve grubunu oluştururlar. Son yıllarda yapılan çalışmalarla, yabani yenilebilir meyvelerin, yüksek antioksidan içeriği, vitaminler, mineraller, lif, folik asit, vb. zengin olması nedeniyle sağlık bakımından önemli yararlar sağladığı ortaya konulmuştur. Yabani yenilebilir meyveler, taze tüketime ek olarak, içecek, dondurma, yoğurt, reçel, jöle ve diğer pek çok gıda ürünlerinde yaygın olarak kullanılmaktadır. Bir takım yabani yenilebilir meyveler kırsal ve yerli nüfusları tarafından kullanılmakta ve onların geçim kaynaklarına önemli ölçüde katkıda bulunmaktadırlar. Yabani meyveleri içine alan kültüre alınmamış bitkilerin, diyet takviyesi olarak veya gıda yetersizliğinde kullanılması, özellikle az gelişmiş ülkelerde kırsalda yaşayanlar için önemli bir gıda güvenlik ağı sağlar. Günümüzde, doğadan gelen ürünlerin hane halkının geçimini destekleyebileceği ve ayrıca ham ya da işlenmiş halde satışlarından elde edilecek gelirin daha fazla farkındalık oluşturacağına inanılmaktadır. Bu farkındalık, kullanılan türlerin çeşitliliği ve bunları kullananların sosyo-ekonomik durumu ile olan ilişkileri üzerine araştırma yapmayı teşvik etmektedir. Yabani yenilebilir meyveler biyolojik çeşitliliğinde önemli bir bileşenini oluşturmaktadır. Bu çalışmanın amacı yabani yenilebilir meyveler ile kültür meyveleri arasındaki morfolojik, biyokimyasal ve moleküler çeşitliliği karşılaştırmaktır.*

Anahtar Sözcükler*: Yabani meyveler, içerik, biyolojik çeşitlilik, kırsal yaşam.*

INTRODUCTION

The earth is filled with an overwhelming plant biodiversity and a number of efforts have been made to categorize them based on their size, forms, habitat, structure, anatomy, and biochemical and molecular features with the aim of interpreting the relationships among the plants. (Mishra *et al*., 2015; Tsou *et al*. 2016).

Horticultural plants including cultivated and wild edible forms play a highly important role on human diet as vitamins, minerals and dietary fiber sources and they have also become a significant part of human life due to their medicinal and environmental uses as well as aesthetics and economic values. The stem, leaf, flowers, roots and the fruits of fruit crops have the highest potential of export (Kaczmarska *et al*., 2015; Ipek *et al*., 2016).

More recently, food and nutritional security have been regarded as one of the key concerns around the world. In addition, low food intake and poor access to food in underdeveloped countries remain unresolved issues (Andersen *et al*., 2003; Adebooye and Phillips, 2006). Around one billion people rely on wild harvested products for nutrition and income and the "invisible" trade in wild resources is estimated to reach $90 billion/annum (Pimentel *et al*., 1997). In India alone the livelihoods of around 6 million people are maintained by the harvest of forest products (Tuxill, 1999) and a great number of studies highlight just how important wild harvested plants, particularly obtained from forests, are to the economy of the rural poverty in the world (Pimentel *et al*., 1997). In many rural locations, particularly the areas that lack basic infrastructure and market access, the collection of wild resources provides a considerable support for subsistence in local livelihoods (Delang, 2006). In addition, the harvest and sale of wild products often provide one of the only means of access to cash economy (Redzic, 2007).

Wild edible fruits have played a significantly vital part in supplementing the diet of people since ancient times. Many people in tribal areas still use them as a supplement of their basic needs of food even the dependence on these fruits has gradually decline as more exotic fruits have been introduced. These fruits from forests are rich in terms of protein and energy and highly useful in treating protein energy deficiencies. The production and consumption of these fruits in arid zones provide dietary supplement in addition to commercial opportunity. Growing trees for fruit production promotes the prevention of more or less permanent stands in barren land. Such trees often represent features of desert landscapes and form the basis of traditional agro forestry land use system. They are immune to many diseases and often used in different formulation of 'Ayurveda' in Indian Folk-medicine. They provide fibers which prevent constipation (Kumbhojkar and Vartak, 1988; Natrajan and Paulsen, 2000).

A number of recent studies have indicated that the dietary use of wild fruits appears in numerous records especially in underdeveloped countries and some botanical studies and publications have emphasized on the diversity and food value of wild edible fruit plants (Reddy *et al*., 2006, Mishra *et al*., 2007; Deshmukh and Shinde, 2010).

Efforts have been made to assess crop genetic diversity using morphological, biochemical and molecular marker technologies over the last three decades. These assessments have created considerable amount of knowledge about the extent and nature of genetic diversity present in conserved and/or actively utilized germplasm of various crops (Rauf *et al*., 2010). These assessments not only facilitate our efforts in germplasm conservation, but also provide guidance for better germplasm utilization for genetic improvement (Kacar *et al*., 2014). Morphological and biochemical characters are likely to be influenced by environmental conditions whereas genetic characters are not influenced. Using all of them for germplasm characterization can offer more information about germplasm. Molecular markers provide discriminatory information, and they are commonly used for germplasm characterization for fruit species in addition to pomological traits (Ercisli, 2004).

There is a concensus that modern plant breeding reduces crop genetic diversity and intensive selection in modern plant breeding programs within a narrow range of plant germplasm with limited allele introgressions over time would have reduced genetic diversity. It is also evident that newly released crop varieties are phenotypically more uniform than before, implying a genetic diversity reduction (Duvick, 1984; Bowman *et al*., 2003).

Comparison of wild and cultivated plants in terms of plant culture, plant breeding and propagation, fruit quality and characteristics, harvesting, processing and transport, obtain by consumers and plant viability and sustainability are shown in Table 1, 2, 3, 4, 5 and 6. It is clear that there were huge differences on these characteristics between wild and cultivated plants. Because they grow in less than ideal conditions, wild edible fruits are often smaller than cultivated ones. They also produce less fruit in general, and the fruits are not as plump, making them seedier. Cultivated fruits are often juicier and sweeter. Wild edible fruits are very important in the diet and in the social life of the village people and they are always collected when in season, and brought by the villagers into the urban markets. The people themselves had a host of uses for many wild edible fruit species throughout world. Wild fruit bushes are hardier than cultivated bushes and do not transplant well.

Table 1. Comparison of wild and cultivated plants in terms of plant culture.
Çizelge 1. Yabani ve kültür formlarının bitki kültürü açısından karşılaştırılması.

Wild (Yabani)	Cultivated (Kültür formu)
No monoculture	Monoculture (establish nursery)
Irrigation with seasonal rainfall	Regularly Irrigated
Natural adaptation	Greenhouse cultivation/adaptation in special climate chambers
Full size growth	Production of dwarf types
Pollination by natural means (insects, wind)	Artificial pollination
Flowering and fruit set due to natural conditions/periodicity	Flowering and fruit set reduced and reproduced/enforcement for periodicity
No chemical fertilizers	The use of chemical fertilizers
No toxic applications (Pesticide, fungucide and so on)	There are toxic applications (Pesticide, fungucide and so on)

Table 2. Comparison of wild and cultivated plants in terms of plant breeding and propagation.
Çizelge 2. Yabani ve kültür formlarının bitki ıslahı ve çoğaltma açısından karşılaştırılması.

Wild (Yabani)	Cultivated (Kültür formu)
Natural selection	Selection by people
Irrigation with seasonal rainfall	Regularly Irrigated
No crossing (but, favorable circumstances)	Artificial hybridization common (Genetic engineering)
Seed propagation / vegetative propagation with the natural way	Vegetative propagation (mostly grafting)
Growth on their roots	Proper grafting of rootstocks

Table 3. Comparison of wild and cultivated plants in terms of fruit quality and characteristics.
Çizelge 3. Yabani ve kültür formlarının meyve kalitesi ve özellikleri açısından karşılaştırılması.

Wild (Yabani)	Cultivated (Kültür formu)
Small, fibrous, sour, bitter, sweet rarely (low sugar level)	Large, low-fiber, usually very sweet (high sugar level)
Small fruit, large seed	Large fruit, small seed

Table 4. Comparison of wild and cultivated plants in terms of harvesting, processing and transport.
Çizelge 4. Yabani ve kültür formlarının hasat, işleme ve taşıma açısından karşılaştırılması.

Wild (Yabani)	Cultivated (Kültür formu)
Multi-maturing fruits fall to the ground or is collected by hand	Generally, unmaturation harvest/pre-harvest chemical use in case of mechanical
No fumigation	Fumigation (hot water or cold applications)
No cooling/No transport	Cooling (for months)/transport (distances
No use of protective	There are protective film, wax, packaging operations

Table 5. Comparison of wild and cultivated plants in terms of obtain by consumers.
Çizelge 5. Yabani ve kültür formlarının tüketicilerin eldesi açısından karşılaştırılması.

Wild (Yabani)	Cultivated (Kültür formu)
Plant searched/harvested/existing of thornly, poisonous fruit, harmful animal attack etc. circumstances	Presented for easy and ready case in supermarkets

Table 6. Comparison of wild and cultivated plants in terms of plant viability and sustainability.
Çizelge 6. Yabani ve kültür formlarının bitki canlılığı ve sürdürülebilirliği açısından karşılaştırılması.

Wild (Yabani)	Cultivated (Kültür formu)
Remains viable and grows in nature	Protected by people, living in natüre can not continue

Diversity of wild fruit collection

In India, fifty-six fruiting plant species belonging to 40 genera and 26 families have been harvested from natural stands and their habit, local names, parts used and mode of consumption are determined (Mahapatra and Panda, 2012).

More generally, local climatic and edaphic conditions contributed to variation in inter-site fruiting season in a number of species. Consequently, it was considerable overlap in ripening among different species, both within and among localities, resulting in year-round availability of wild fruits in India (Figure 1).

Diversity on biochemical characteristics among wild and cultivated fruits

Yildiz *et al.* (2010) reported diversity among wild and cultivated blackberries on total phenolic content, total anthocyanin content and antioxidant activity determined by different methods. The result showed that (Table 7), lower values for most biochemical parameters were observed in cultivar Chester than all wild genotypes. They also reported high antioxidant activity in wild blackberries. Reyes-Carmona *et al.* (2005) also reported high bioactive content in wild blackberries compared to cultivated ones. This phenomenon could be due to an induction in the synthesis of antioxidant enzymes and an increase in polyphenolic concentration brought about due to the greater exposure of the unsheltered wild plants to extreme temperatures, and insult by pests and pathogenic organisms, because phenolic compound biosynthesis is typically a stress-defense mechanism (Antonnen and Karjalainen, 2005).

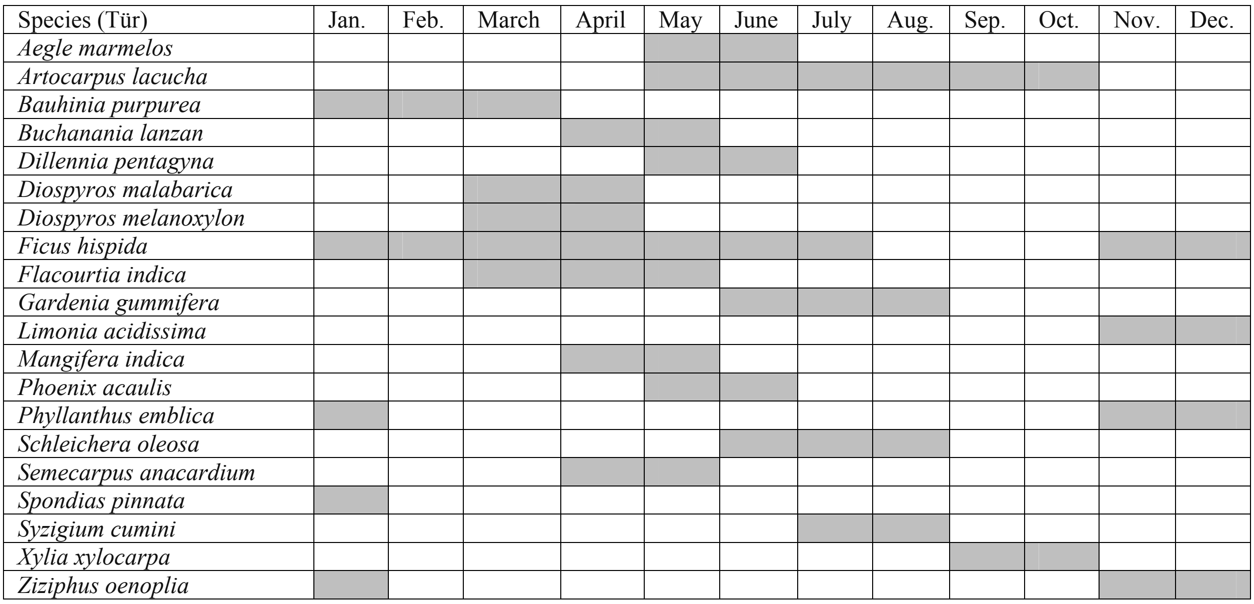

Figure 1. Fruiting calendar of 20 common wild fruit species (Shaded segments show period of fruiting) in India.
Şekil 1. Hindistan'da 20 yaygın yabani meyve türünün fenolojik takvimi (gölgeli kesimler meyve verme dönemini gösterir).

Table 7. Total anthocyanin (TA), total phenolic content (TPC), antioxidant activity (β-carotene and FRAP) and free radical scavenging capacity (DPPH) of samples.
Çizelge 7.Toplam antosiyanin (TA), toplam fenolik içerik (TPC), antioksidant aktivite (β-carotene and FRAP) ve serbest radikal giderme gücü (DPPH).

Genotypes Genotip	TA (mg cyaniding-3-glucoside eq./100 g FW)		TPC (mg GAE/100 g FW)		DPPH (µmol/g FW)		FRAP (µmol/TE g FW)		B-carotene bleaching assay (%)	
ART1	149	b	390	ab	35.0	ab	48.75	de	84.66	bc
ART2	138	c	424	a	37.4	a	54.35	b	87.45	ab
ART3	155	ab	406	ab	34.4	ab	53.40	bc	85.34	bc
ART4	168	a	379	b	36.1	ab	51.10	cd	83.10	cd
ART5	134	b	404	ab	35.4	ab	45.60	ef	84.88	bc
ART6	147	b	349	bc	34.8	ab	49.80	d	83.70	c
ART7	160	ab	352	bc	33.6	ab	52.15	c	83.01	cd
ART8	160	ab	397	ab	36.7	ab	54.10	bc	86.67	b
ART9	157	ab	346	bc	33.6	ab	47.90	e	82.34	d
ART10	138	c	358	bc	33.8	ab	56.30	a	83.07	cd
Chester	147	b	310	c	33.1	b	45.00	f	82.40	d
BHT									89.67	a

Different latter indicate the statistical difference within same column among genotypes at 5% level.

Biodiversity loss in cultivated (grafted) plants A sample Carob (*Ceratonia siliqua* L.)

In a study that conducted in the main carob growing areas in Turkey (Mediterranean and Aegean regions) on wild populations and grafted genotypes (unnamed types grafted on seedlings) (Tetik *et al*., 2011) . A total of 70 carob trees from various areas (38 wild trees and 32 grafted accessions) were analyzed in this research during 2009-2010 (Fig. 2). The average values for pod dimensions (width, length and thickness), pod mass, seed mass, seed number, pulp mass, seed and pulp ratio, acidity, SSC and pH were determined.

A considerable number of variations in most of the traits were found between and within wild and grafted genotypes of carob. The genotypes were plotted on three dimensions based on their PCA results (Fig. 2). The grafted and the wild genotypes of carob were grouped together. The grafted genotypes were easily separated from the wild genotypes. Another interesting finding was that grafted genotypes showed lower diversity than wild genotypes (Figure 2).

S allele diversity in wild accessions

Halasz *et al*. (2013) carried out a study to determine of the *S*-genotypes of 63 wild-growing Turkish apricots (*Prunus armeniaca* L.) grown in Erzincan, Turkey by PCR amplification of the *S-RNase* intron regions and *SFB* gene in order to characterise their sexual (in)compatibility phenotype (Fig. 3).

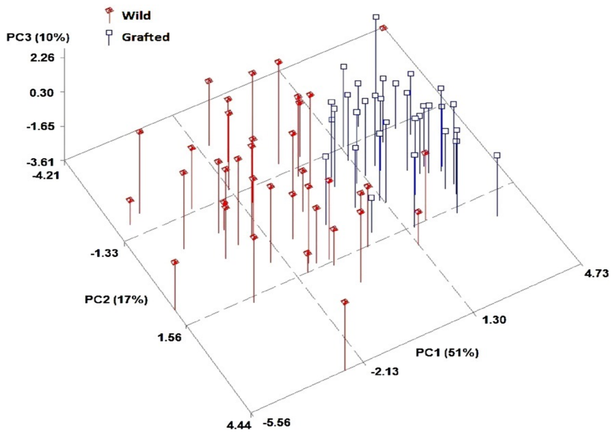

Figure 2. PCA plot of the first three PCs depicting relationships among *C. siliqua* genotypes.
Şekil 2. *C. siliqua* genotipleri arasındaki ilişkileri gösteren ilk üç PC'nin PCA gösterimi.

They identified ten previously described and two new *S*-alleles (provisionally labelled S_X and S_Y) were identified in the genotypes. They also determined a total of 36 different *S*-genotypes were assigned to the tested accessions. The S_C-allele responsible for self-compatibility in apricot was not present, indicating that all accessions are self-incompatible. The analysis of *S*-allele frequencies allowed to conclude the allele richness in wild apricot populations. The *S*-RNase alleles detected in commercial Turkish cultivars as described by Halász *et al*. (2010) (A) and wild-grown accessions (B) in the Erzincan region.

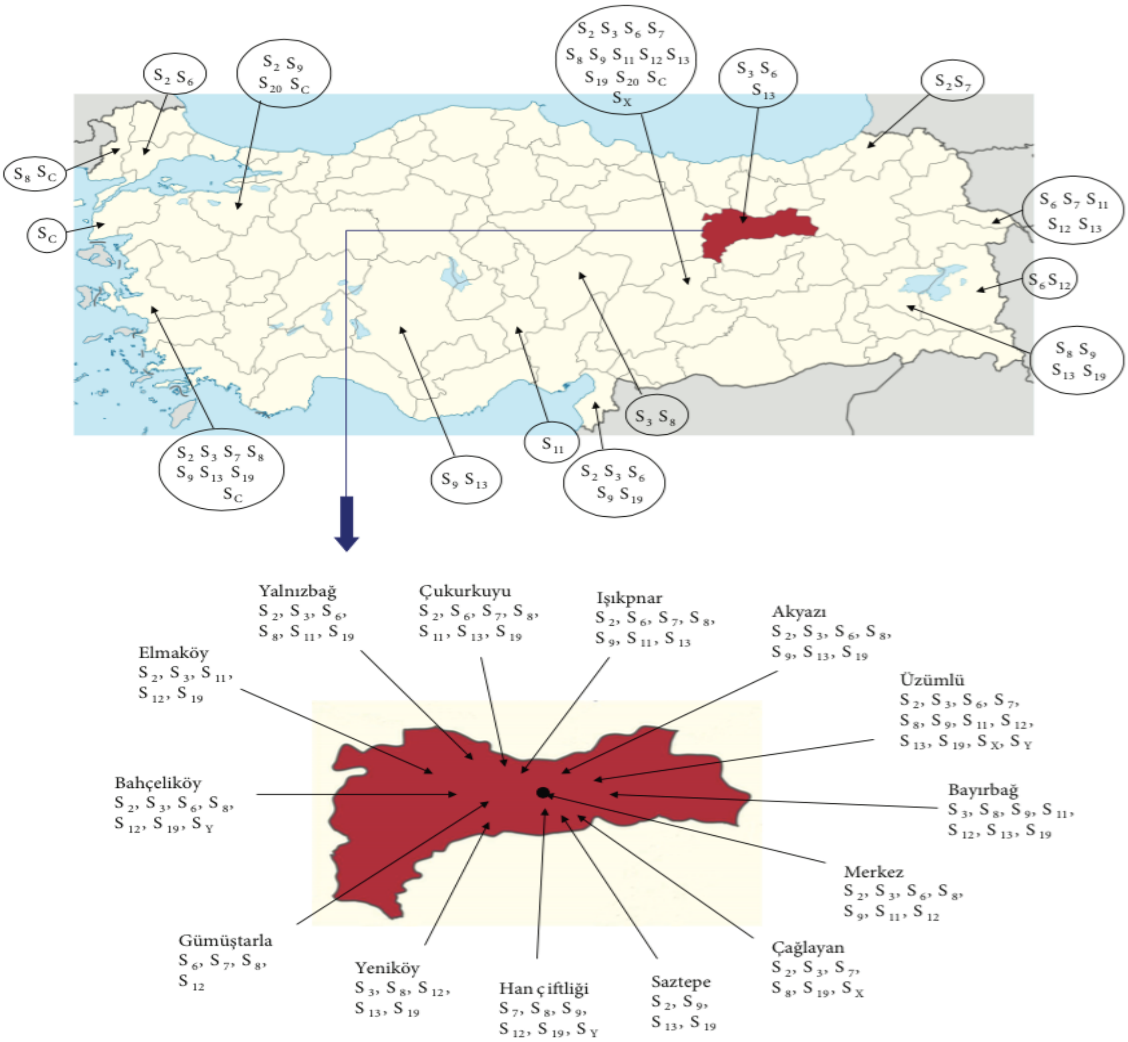

Figure 3. The spread of apricot self-incompatibility ribonuclease alleles in Turkey.
Şekil 3. Türkiye' de kayısı' da kendine uyuşmaz ribonükleaz allelerinin dağılımı.

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