ANADOLU, J. of AARI
ISSN: 1300 - 0225
27 (2) 2017, 54 - 61
MFAL

Sea Beets [Beta vulgaris subsp. maritima (L.) Arcang.] Wild Edible Beets and Home Garden Beets of Turkey

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Received (Geliş tarihi): 24.08.2017 Accepted (Kabul tarihi): 10.11.2017

ABSTRACT: *Beta (beet) species is included in **Betoideae** subfamily in the **Amaranthaceae** family. This genus has several wild species and cultivar groups, the sugar beet, the root vegetable known as the beetroot or garden beet, the leafy vegetables chard and spinach beet and mangel, which is a fodder crop. **Beta (Beet)** species are the important genitors for cultivated beets. Turkey is being one of the centre of origin for beet, has important genetic base of beets belong to section Beta and Section **Corollinae**. So the most of the species of section Beta and all species of Section **Corollinae** distributed in Turkey. Most of the wild species are edible and used in local food by local people in the distribution areas. Sea beet, **Beta vulgaris** subsp. **maritima**, is most common edible among wild beet species and is the wild ancestor of all cultivated beets, such as Sugar-beet, Swiss chard and Beetroot. Sea Beet grows in coastal places at tidelines, on shingle beaches, cliffs and sea-walls, and in saltmarshes. Leaf beet and beet root landraces are also grown by farmers and in vegetable gardens. The diverse forms and landraces of vegetable, table and fodder beets have been grown and used locally for generations in Turkey. Different landraces for different uses are found. To assess the diversity of **Beta** species survey, collection, **ex-situ** conservation at the National Seed Gene Bank of the Aegean Agricultural Research Institute (AARI) and also morphological evaluation studies were carried out. Result of morphological characterization of **Beta** species in Turkey showed continuous variation in most of the characteristics resulting from the gene flows between wild and cultivated forms. Among section Beta, variation was observed in pigmentation, hairiness, plant habit, flowering, flower and seed clusters, pollen fertility and leaf types, whereas the section **Corollinae** samples exhibited broad variation in flower and leaf characteristics. As priority species of Biodiversity for Food and Nutrition Project of Turkey detailed survey and socioeconomic surveys were conducted on sea beet. The socio-economic studies were conducted for detail data with monography technic. The data recorded from face to face questioners and analyzed. During surveys ethno-botanical information and traditional farming systems were recorded. The food composition of sea beets collected from Aegean Region was also determined to evaluate nutritional value of sea beet.*

Keywords: *Beet, **Beta**, sea beets, **Beta vulgaris** ssp. **maritima**, morphological characters, diversity, variability, socio-economic study, traditional knowledge, food composition.*

Türkiye'nin Kıyı Pancarları [Beta vulgaris subsp. maritima (L.) Arcang.] Yabani Yenilebilir Pancarları ve Bahçe Pancarları

ÖZ: Beta *(pancar) türleri **Amaranthaceae** familyasındaki **Betoideae** alt familyasına dahildir. Bu cins yabani tür ve şeker pancarı, pancar veya bahçe pancarı olarak bilinen kök sebze, yapraklı sebze pazı ve ıspanak pancarı ve mangel gibi kültür*

*formlarını içerir. **Beta (**Beet) türleri, kültür pancarı için önemli genitördürler. Türkiye'nin pancarın olası orijin merkezlerinden biri olarak, **Beta** ve **Corollinae** seksiyonlarına ait türler içerdikleri genetik varyasyon ve pek çok genle kültür pancarları için önemli bir genetik potansiyele sahiptirler. Beta seksiyonundaki türlerin çoğu ve seksiyon **Corollinae**'nin tüm türleri Türkiye'de yayılış göstermektedir. Yabani türlerin çoğu yenilebilmekte ve dağıtım bölgelerindeki yerel halk tarafından yerel gıda maddelerinde kullanılmaktadır. Kıyı pancarı, **Beta vulgaris** subsp. **maritima**, yabani pancar türleri arasında en yaygın yenilebilir tür olup şeker pancarı ve diğer kültür pancarlarının yabani atasıdır. Kıyı pancarı, kıyı bölgelerinde deniz kenarlarında, kumsallarda, deniz kayalıkları ve deniz kıyıları, ve tuz bataklıklarında yetişir. Yaprak pancarı ve kök pancarları çiftçiler tarafından sebze bahçelerinde yetiştirilmektedir. Sebze, sofra ve yemlik pancar yerel çeşitleri Türkiye'de nesiller boyu yetiştirilmekte ve kullanılmaktadır. Farklı yerel çeşitler yöresel olarak farklı şekillerde kullanıma sahiptir. **Beta** türlerinin çeşitliliğini değerlendirmek için, toplama, Ege Tarımsal Araştırma Enstitüsünün (ETAE) Ulusal Tohum Gen Bankası'ndaki **ex situ** koruma ve morfolojik değerlendirme çalışmaları yapılmaktadır. Türkiye'de Beta türlerinin morfolojik karakterizasyonu sonucu, yabani ve kültür formları arasındaki gen akışından kaynaklanan sürekli bir varyasyon saptanmıştır. Beta seksiyonunda pigmentasyon, tüylülük, bitki tipi, çiçeklenme, çiçek tohum kümeleri, polen fertilitesi ve yaprak tiplerinde varyasyon gözlemlenirken, **Corollinae** seksiyonunda çiçek ve yaprak özelliklerinde geniş varyasyon görülmüştür. Türkiye'nin Gıda ve Beslenme Biyoçeşitlilik Projesi için öncelikli türlerinden biri olarak kıyı pancarı üzerinde ayrıntılı etüdler ve sosyo-ekonomik araştırmalar yapılmıştır. Sosyo-ekonomik çalışmalar, monografi tekniği ile ayrıntılı veriler için yürütülmüştür. Veriler, yüz yüze yapılan anketlere kaydedilmiş ve analiz edilmiştir. Anketler sırasında etno-botanik bilgi ve geleneksel tarım sistemleri kaydedilmiştir. Ege Bölgesi'nden toplanan pancarların gıda bileşimi de deniz pancarının besin değerini değerlendirmek için belirlenmiştir.*

***Anahtar Sözcükler:** Pancar, **Beta**, kıyı pancarı, **Beta vulgaris** ssp. **maritima**, morfolojik karakterler, çeşitlilik, değişkenlik, sosyo-ekonomik çalışma, geleneksel bilgi, gıda bileşimi*

INTRODUCTION

Beta (beet) species is included in Betoideae subfamily in the Amaranthaceae family. This genus has several wild species and cultivar groups, the sugar beet, the root vegetable known as the beetroot or garden beet, the leafy vegetables chard and spinach beet and mangel, which is a fodder crop.

Zohary and Hopf (2000) noted that beet is linguistically well identified and the earliest known written mention of the beet comes from eighth century BC Near East. In the 1st century BC, domestic beet was represented in the Mediterranean basin primarily by leafy forms (chard and spinach beet) and later very probably also by beetroot cultivars. Early uses of beet as a wild vegetable, herb or medical plant were followed by cultivation, which most likely began in Asia Minor, one of the natural habitats of the species (Biancardi *et al*., 2012). So, sea beet the ancestor of modern cultivated beets, prospered along the coast of the Mediterranean and Aegean Sea, is known from prehistory for food and above all for medicinal uses. After domestication, beet became more important, especially after its most recent use as a sugar crop. But also the cultivation for leaves (chard and spinach beet) and root (beetroot) to be used as vegetables and cattle feed (mangel) retains its economic value. *Beta vulgaris* ssp. *maritima* has become crucial as source of useful characters. Beets are also used as medicinal plant, ornamental plant, dye and as renewable resource.

Sea beets are very tolerant and have a large environmental adaptability to conditions such as high salinity and poor soil, which is related to its extreme genotypic and phenotypic variation. *Beta vulgaris* ssp. *maritima* crosses efficiently with sugar beet and produces viable seeds.

Turkey is being one of the center of origin for beet, has important genetic base of beets belong to section *Beta* and Section *Corollinae*. So the most of the species of section *Beta* and all species of Section *Corollinae* distributed in Turkey (Box 1). Most of the wild species are edible and used in local food by local people in the distribution areas since centuries. The primitive cultivars and land races of garden beets are still grown by farmers and at home gardens. The beetroots and chards are most common as home garden plants. Gardens

have been made in Turkey since ancient times. Traditional Turkish houses always had a garden, no matter what the size of the house was itself. Bahce/Bostan refers to the traditional land use system around a homestead, where several species of plants (mostly vegetables and fruit species) are grown and maintained by household members. They are important sources of food, fodder, fuel, medicines, spices, ornamentals, construction materials and income. Home gardens are also important contributors to the food security and livelihoods of farming communities. Their products are primarily intended for the family consumption, for family incomes are sold in the local markets. Mangel landraces are also grown by farmers as fodder plant (Tan, 1992, 1993, 1994; Tan *et al.*, 2000; Tan *et al.*, 2003a; 2003b; Tan and Inal, 2004).

MATERIALS AND METHODS

MATERIALS

Beet species collection at National Gene Bank of Turkey was the material of the research. For the detailed study on sea beet as priority species of Biodiversity for Food and Nutrition Project of Turkey sea beets from Aegean Region of Turkey are also the material of the study.

METHODS

Surveys

For the distribution patterns of beets were conducted. This study was essential first step in the development of a comprehensive strategy for the conservation and use of beet plant genetic resources of Turkey.

Before conservation and use of beet species, surveys were conducted for a basic understanding of the taxonomy, genetic diversity, geographic distribution, ecological adaptation and ethnobotany of a plant group as well as of the geography, ecology, climate and human communities of the target region and the beets growing areas. So, eco-geographical surveys, ethnobotanical surveys and socioeconomic-surveys (for sea beets only) were studied and data were recorded. Socio-economic study was planned to investigate in detail the process from the collection to consumption for the aim of analysis and conclusion of process from collection/harvest to consumption; generate the idea on marketing opportunity; to upload the relevant information about the traditional knowledge on use of sea beet. Monographic research technique was used in the study. Information on this technique was obtained through questionnaires. At the same time, preliminary data collection work was carried out in selected areas in villages and markets.

Box 1. *Beta* Species Found in Turkey (Türkiye'deki *Bet*a türleri).

Beta* Section *Beta
Wild Species
Beta vulgaris ssp. *adanensis* (A. Pamuk. ex Aellen) Ford-Lloyd & J.T. Williams
Beta vulgaris ssp. *maritima* (L.) Arcang. – sea beet (incl. *Beta vulgaris var. trojana* (Pamukç.) Ford-Lloyd & J.T. Williams)
Cultivated species
Beta vulgaris ssp. *provulgaris* (ancestral form)
Beta vulgaris ssp. *vulgaris* – common beet (incl. beetroot, sugar beet and mangel)
Beta vulgaris ssp. *cicla* (L.) W.D.J. Koch – chard (incl. spinach beet)

Beta* Section *Corollinae
B. lomatogona Fisch. et Mey.
B. macrorhiza Stev.
B. foliosa (sensu Haussk.)?
B. corolliflora Zoss.
B. trigyna Wald. Et Kit.
B. intermedia Bunge.

Collection and Conservation

Seed collection was made in according to the standards for acquisition of germplasm and Genebank standards for orthodox seeds (Anonymous, 2014a). All seed samples were accompanied by associated data as detailed in the FAO/Bioversity Multi-Crop Passport Descriptors (Guarino *et al*., 1995).

Morphometric Analysis

For the existing variation of sections *Beta* and *Corollinae* of genus *Beta* samples collected and conserved at National Gene Bank of Turkey, morphometric analysis was carried out. The experiment was under uniform conditions, and morphological characters of Descriptors for Beta (Anonymous, 1995) were observed, recorded and analysed by means of Principles Component Analysis (PCA).

Food Composition Analysis

In this study some sea beet samples from Aegean region were collected and analyzed to demonstrate the nutritional value of some wild edibles in Turkey. Proximities, dietary fiber (DF), vitamins and minerals were assayed using standard methods and reference materials. Moisture was determined according to AOAC 964.22, fat content was determined gravimetrically by AOAC 920.39. Total protein was determined from the nitrogen content by the Kjeldahl method using conversion factors. Total dietary fiber was determined according to the AOAC enzymatic method 991.43. Ash was determined by incinerating at 500°C in a muffle furnace for 6h by the AOAC 942.05 (Anonymous, 2014b). Minerals were determined using ICP-MS (Agilent 7500cx) according to NMKL 186 method. Vitamin C analysis was performed according to procedure described by Gokmen *et al*., 2000.

RESULT AND DISCUSSION

Surveys

Field survey studies were planned from the southern regions and sea level to the northern regions and higher altitudes depending on the flowering period of Beta species. The distribution and habitats of Beta species found in Turkey were also re-determined (Box 2). The herbarium species are also collected during survey to maintain the specimens at AARI herbarium as the reference of the beet collection and for further identification. Seed collection periods were estimated based on flowering periods.

During surveys the information on home garden beets were recorded. The home gardens are the microenvironments within the surrounding ecosystem and there is relation with a household or a social group. They are multifunctional and diverse plant composition. The home garden beets are the local cultivars of *Beta vulgaris* (including, different forms of leaf beets and beetroots which are vary on the color range includes golden, orange, yellow, pink, red, white and roots with pink and white rings when sliced. Mostly The yellow and white forms of beetroot also provide particularly good foliage for food and vary in shape (the globe forms mostly).

Through questionnaires data analysis annual consumption of sea beets per household determined as 11.1 kg/year and consumption of sea beets per capita was 3 kg/year. Consumption frequency was given in Figure 1.

Young leaves of sea beets are collected and sell at local markets to use for medicinal purposes and as food raw or cooked. An annual collected amount of sea beet is 911 kg/year. The distribution use pattern of collected amounts of sea beet is given in Figure 2. Marketing status of sea beet were also determined and given in Table 1.

Collection and Conservation

The missions are programmed to collect the existing *Beta* genetic resources within the frame work of Industrial Crops Genetic Resources Group and the *Beta* landraces, wild relatives and weedy forms were collected and conserved *ex situ* at the national genebank at AARI in applying the genebank standards.

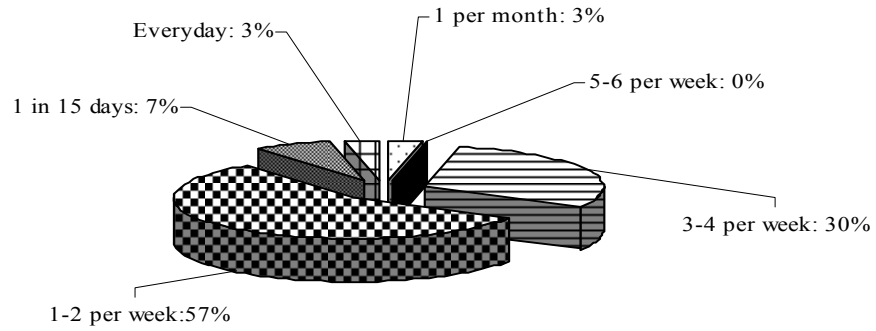

Figure 1. Sea beets consumption frequency.
Şekil 1. Kıyı pancarı tüketim aralıkları.

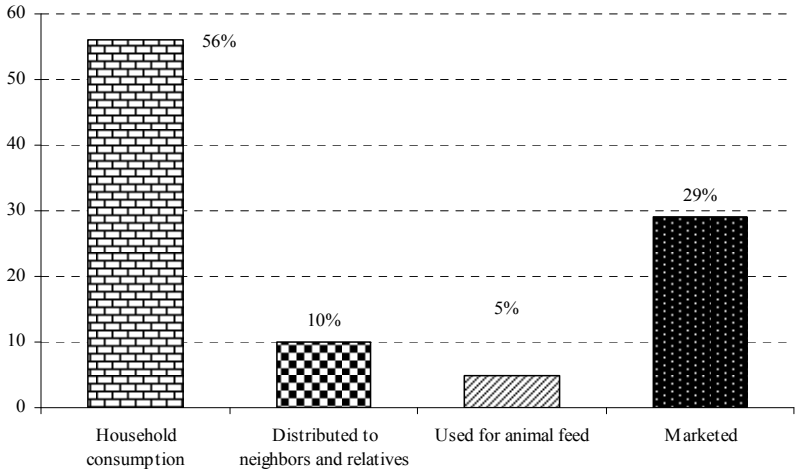

Figure 2. Distribution use pattern of collected amounts of sea beet.
Şekil 2. Kıyı pancarlarının toplanan miktarlarının kullanımı.

Table 1. Marketing status of sea beet.
Çizelge 1. Kıyı pancarının pazarlama durumu.

Average distance to market (km) Markete ortalama uzaklık (km)	Proportion of selling to consumers at local market (%) Yerel pazarda tüketicilere satış oranı (%)	Proportion of selling to trader at local market (%) Yerel pazarda tüccarlara satış oranı (%)
33	78	22

Box 2. Habitats of *Beta* Species in Turkey (Türkiye'deki *Beta* türlerinin yaşam alanları).

***Beta* Section *Beta* Species**
Sea level to 700 m.
Mainly in coastal areas but found at inland habitats influenced from littoral regions.
Weeds in cultivated fields
Field borders
Road sides

Beta* Section *Corollinae
550 to 2300 m.
Inland mountainous areas
Field borders
Weeds in cultivated fields
Road sides
In vegetation of woody perennials mainly in (Quercus woodlands)
In vegetation of herbaceous and woody perennials

Morphometric Analysis

Beta sect. *Beta* accessions generally have green hypocotyl colour, while some are red. Some of the accessions flowered in first year and some in second year. Plant types are variable within and among population: erect, erect-procumbent, procumbent, erect-prostrate and prostrate plant types were observed. Tepals are convex in general and periant segment was keeled. Anthers are longer then stigma, yellow, mostly fertile. Few samples are fertile and sterile pollens are found. Leafs are mostly glabrous or sparsely hairy. Leaf size has high variation. No swelling in the roots in wild forms was observed. Seed clusters mostly are 2-4. Main branching is mostly one. Interspesific and intraspesific variation were observed. *Beta* sect. *Corollinae* accessions had green, pink and red hypocotyl colour. All perennial and most of them flowered in second year, third and fourth year flowering were also observed. Flowering asynchrony was found within and between populations. Plant type generally erect procumbent. Tepal shape is convex or straight, flower clusters 1, 2, 3 and keel absent or available. Fasciation was observed in some samples.

According to Principles Component Analysis (PCA) among the section *Beta*, continuous variation were observed on pigmentation, hairiness, plant habit, flowering, flower clusters and leaf types; whereas *Corollinae* section individuals exhibited large variation related to their flower characteristics and leaf types. From the result of two distinct groups were obtained for wild and primitive root types of section *Beta* among the first two principal components. In the group of wild forms, the samples of *B. maritima, B. adanensis* and *B. trojona* originated from the form of *B. maritima* sensu lato were formed subgroups that were lacking in pattern. The leaf beets and *B. maritima* complex were far from clear-cut. However the leaf beet forms were distinctly separated from root types. The individuals of ancestral form of *B. vulgaris* (*B. provulgaris*) were distributed outside of these two main groups. It is assumed that the subgroups of *B. maritima* sensu lato complex resulted from the gene exchange occurred readily in their natural habitat. The results of cytological study also support this consideration. In section *Corollinae*, the picture was obtained from Principal Component Analysis. Two distinct groups were consisted of the individuals of *B. corolliflora* and *B. lomatogona* complex scattered within the first two exigent vectors. *B. lomatogona* sensu lato group was represented with *B. lomatogona, B. intermedia*, and *B. trigyna, B. corolliflora* sensu lato group was included within the general variation exhibited by *B. corolliflora*. It is considered that the infraspecific variation found in this section results from the existing facultative apomixes in some forms. In determined meiotic behaviours were observed in the intermediate forms of some *B. intermedia* individuals. With regard to the evaluation of results of this research,

the artificial classification has been avoided and the forms of genus Beta sections Beta and *Corollinae* were classified as their species complex. The scatter diagrams were shown in Figure 3 and Figure 4 for section *Beta* and Section *Corollinae* species.

Food Composition Analysis

Sea beet dietary fibre content is 5, 27g/100g and it can be considered as source of fibre according to Regulation (EC) No. 1924/2006. Proximate composition of sea beet per 100g is given in Table 2. Sea beet can also be highlighted for its high contribution to microelements nutritional intakes since a 100 g portion of their leaves would provide over 50 % of the RDA (for men) for iron. Mineral composition of sea beet mg/100g is given in Table 3.

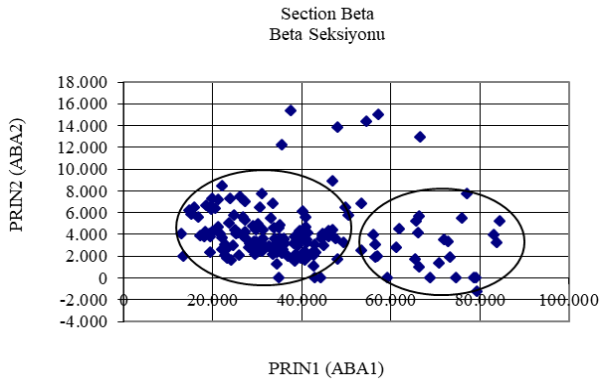

Figure 3. The distribution of the *Beta* sect. *Beta* samples.
Şekil 3. *Beta* seksiyon *Beta* örneklerinin dağılımı.

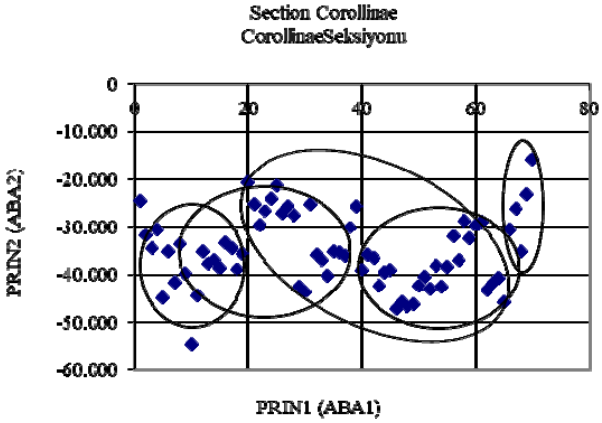

Figure 4. The distribution of the *Beta* sect. *Corollinae* samples.
Şekil 4. *Beta* seksiyon *Corollinae* örneklerinin dağılımı.

Most of the wild edible species can considerably contribute to requirements of dietary fiber, vitamin C and iron. So, these species could be a good alternative to other commonly consumed plants such as spinach, parsley, lettuce due to their high nutrient content. However, it should be noted that ways of consumption and preparation methods may affect nutrient content and bioavailability of foods so these factors should be evaluated while assuming their contribution to dietary requirements.

Table 2. Proximate composition of sea beet (per 100g).
Çizelge 2. Kıyı pancarının macro besin öğeleri (her 100 g).

Moisture (g) Nem (g)	Fat (g) Yağ (g)	Protein (g) Protein (g)	Carbohydrate (g) Karbonhidrat (g)	Ash (g) Kül (g)	Dietary Fibre (g) Hazmolabilir lif (g)
89.2±0.9	0.18±0.02	2.42±0.08	1.26±0.05	1.64±0.06	5.27±0.48

Table 3. Minerals and Vitamin C content of sea beet (mg/100g).
Çizelge 3. Kıyı pancarının mineral ve C vitamini içerikleri (mg/100g).

Ca	Na	Mg	P	Zn	Fe	Cu	Vitamin C
95.4±8.5	292.4±80.1	75.3±9.07	27.6±1.7	0.30±0.12	5.0±0.8	0.14±0.06	18.3±0.5

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