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Review

Economic importance of *Gypsophila* L., *Ankyropetalum* Fenzl and *Saponaria* L. (Caryophyllaceae) taxa of Turkey

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***Gypsophila* L. is the third biggest genus of Caryophyllaceae family in Turkey. The genus has 55 species in the country. 33 species are endemics and total number of the taxa is 58. *Ankyropetalum* Fenzl is a small genus with 3 species and 1 of them is endemic. *Saponaria* L. has 20 taxa of 18 species and 10 taxa of them are endemics to Turkey. Turkey is the gene center of all the genera. All of the genera are known as coven, female coven and halva root and developed roots or rhizomes are economically very important. Extract produced from the roots are known as fire extinguisher, gold polishing, cleaner and softener of delicate fabrics and crispness giving to halva. The extracts are often used for making liqueur, herbal cheese, ice cream and some foods. Some taxa are Boron (B) hyperacumulators, so they can be planted and used for destroyed agriculture to control erosion. *Gypsophila paniculata* L. is very important in horticulture. *Gypsophila bicolor*, *Gypsophila arrostii, Gypsophila perfoliata*, *Ankyropetalum gypsophiloides* and *Saponaria officinalis* L. are very important because of their saponin contents. In this paper, economic importance of the plants in the light of our observations and literatures was given.**

Key words: *Gypsophila*, *Ankyropetalum*, *Saponaria*, economy, saponin.

INTRODUCTION

Turkey is known as a gene center of many economic plants. There are 32 genus and about 500 species of the Caryophyllaceae family (Davis, 1967; Güner et al., 2000). It is reported that there are many species of *Gypsophila* L. growing in Turkey, Caucasia, north Iraq and north Iran. 75 of 126 *Gypsophila* species in the world are found in these regions. In Turkey, there have been 55 *Gypsophila* species in 10 sections (Inan, 2006; Korkmaz, 2007; Korkmaz and Özçelik, 2011). In the world, *Ankyropetalum* Fenzl genus has 4 species and 3 of them are grown in Turkey. *Saponaria* L. has 20 taxa of 18 species and 10 taxa are endemic to Turkey (Huber-Morath, 1967). The gene center of all of the genera is Turkey (Özçelik and Muca, 2010; Korkmaz and Özçelik, 2011). The main purpose of this study was to give detailed knowledge about the importance and the areas where the plants were used.

In general, soaproot (or soap worth) is the name of woody roots of some perennial *Gypsophila*, *Saponaria* and *Ankryopetalum* species. However, it is reported that *Saponaria* is not used as soaproot in Turkey (Kiliç et al., 2008). According to Ivanov et al. (2005) *Saponaria officinalis* that is also known as soaproot and its rhizomes are obtained from soils in autumn and dried in shade and used for similar purposes. Saponin ratio of the root parts is about 20% (Kiliç et al., 2008).

For nearly 30 years, collection of soaproots from natural flora has increasingly been continuing in the eastern and south-east Anatolia (Kiliç et al., 2008). Since 1800s soaproot has been exported from Anatolia (Turkey). The leading ones are *Gypsophila bicolor, Gypsophila arrostii* and *Ankyropetalum gypsophiloides* (Radix Gypsohilae) (Baytop, 1984; Özçelik and Özgökçe, 1995). Turkish coven is commonly obtained from

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Gypsophila graminifolia Barkoudah. *G. arrostii* Guss. var. *nebulosa* (Boiss. and Heldr.) Barkoudah, *Gypsophila eriocalyx* Boiss, *G. bicolor* (Freyn and Sint.) Grossh., *Gypsophila perfoliata* L., *Gypsophila venusta* Fenzl subsp. *venusta* and *A. gypsophiloides* Fenzl. (Inan, 2006; Kiliç et al., 2008). But some species such as *Gypsophila ruscifolia* Boiss and *Gypsophila bitlisensis* Barkoudah are less preferred.

Ankyropetalum Fenzl is represented by 3 species in Turkey. One of these is endemic and the others are rare. The genus is essentially pervasive in south-west Asia including Turkey. Regarding the phytogeography the genus grows in the south-east part of Turkey; that is in Irano-Turanian and Mediterranean regions (Özçelik and Özgökçe, 1995; Afifi and Abu-Irmaileh, 2000). The species belonging to the *Ankyropetalum* genus in Turkey are *Ankyropetalum arsusianum* Ky, *Ankyropetalum reuteri* Boiss and Hausskn (endemic) and *A. gypsophiloides***.** The genus is found in south-east Anatolia and its neighbor countries in borders (Davis, 1967; Özçelik and Özgökçe, 1995; Afifi and Abu-Irmaileh, 2000).

S. officinalis L. is the most known species and called as “Sabunotu, Tıbbi sabunotu, Karga sabunu and Köpürgen” by local public. It is widely cultivated as an ornamental plant, and also grown as a source of soap on account of its saponin-rich rhizomes and leaves. It distributes between 0 to 2000 m roadsides, stream sides, damp woods and shady places in natural habitats. It is also planted in public parks, gardens, graveyards, city roadsides etc. All of the taxa belonging to *Ankyropetalum*, *Gypsophila* and *Saponaria* genera are generally known as “Çöven, Çöğen, Çeğen, Dişi çöven, Çöven otu and Helva kökü, Tarla çöveni, Helva çöveni, Şark çöveni” and used for different purposes by the public. *Ankyropetalum* members look like perennial *Gypsophila* species and they are distinguished hardly from *Gypsophila*. They are known as the same name and used for the same purposes. In Europe, *Gypsophila* species are widely known as “Baby’s Breath”. For the word *Gypsophila* “soaproot” or “soapworth” terms are used.

Petrorhagia alpina (Habl.) Ball and Heywood from Caryophyllaceae family are also known as soaproot by the public. Roots of the plants are used for soaproot production and medicinal purposes such as urine remover, transpirator, body temperature degreaser, body relaxer, moviter and myx remover (Öztürk and Özçelik, 1991). *Acantholimon* Boiss. spp. (Pişik geveni) from Plumbaginaceae family, *Astragalus* L. spp. (Geven), *Onobrychis cornuta* (L.) Desv. from Fabaceae family and *Scorzonera rigida* Aucher (Dağ çöveni) from Asteraceae family are used as soaproot in East Anatolia region. Their upper parts are used as fuel material and under soil parts are sold as soaproots. But, their roots do not have saponin chemicals (Baytop, 1984).

It was reported that the saponins are found in the different parts of the plants in different doses. They were first obtained from the rhizomes of *S. officinalis* L. and are called “saponin” (Baytop, 1984). It is reported that as the roots of soaproot are obtained from various *Gypsophila* species, the saponin amounts in the roots which are used in the trade differs between 4 to 10% and 20 to 25% (Sezik, 1982). Used as Turkish soaproot in the *G. bicolor* (Van Çöveni), the saponin amounts have been found to be 20 to 25%, in the *G. arrostii* var. *nebulosa* (Konya Çöveni, Beyşehir Çöveni, Isparta Çöveni) 19 to 22%, in the *G. perfoliata* (Niğde Çöveni) 15 to 19% and in the *Gypsophila eriocalyx* (Çorum - Yozgat Çöveni) 10 to 14% (H´erold and Henry, 2001). They have found out that in the *G. paniculata* L. the saponins are synthesized only in the roots and then moves through the other parts of the plant. In the dried material there is nearly 4% saponin content. It is reported that related with the soaproot originated from Anatolia, the amount of raw saponin is changing from 10 to 25% and in the researches on the taxa of *G. bicolor*, *G. perfoliata* var. *anatolica, G. venusta* subsp. *venusta, G. eriocalyx* and *G. arrostii* var. *nebulosa*; the amounts of saponin are 19.58, 14.44, 12.65, 12.39 and 11.58%, respectively (Battal, 2002) and the amounts of protein are 8.01, 7.80, 8.38, 8.15 and 6.92%, respectively (İnan, 2006). It is stated that in the roots of *G. paniculata* species, the synthesis of saponin has been increased considerably with the effect of the uridine 5'-diphospho (UDP)-glucuronosyltransferase enzyme. In order to define the activity of this enzyme which has a versatile role in the plant, *G. paniculata* species would be a good model plant (H´erold and Henry, 2001).

Gypsophila taxa contain 15 to 20% saponin glycoside and also contain gypsogenine which is a pentacyclic and sugars as galactose, ksilose, arabinose, fructose and rhamnose. Their rhizomes are dirty white in colour, perpendicular acute lined, slightly smelling and bitter in taste. The underground parts and leaves have bubbling character as soap. The roots and rhizomes are taken out from the soil in early and late springs and are dried under the sun. Finally soaproot is produced by breaking the rhizomes into pieces (Maranki and Maranki, 2008; Battal, 2002). The extract of soaproot is composed of sugar, resin and saponin. Saponins are highly molecular glycosides which have the characteristic of dissolving in water. It keeps the plant away from germs and fungus and in some species it increases the nutritional value of the plant as well as simplifying the digestion (Anonymous, 2010a).

AREAS IN WHICH TURKISH SOAPROOTS ARE USED

Uses in food industry

It is known that root parts of *A. gypsophiloides* were

formerly exported from Siirt and Batman and are known as “Helva kökü, Çöven otu, Sabun otu and Helva otu”. It is especially used in preparing a local food called “Siirt sweet”. *A. reuteri* is called “çöven” by the local public around Gölbaşı (Adıyaman) and it is used for animal feeding by mixing with straw (Özçelik and Muca, 2010; Baytop, 1984; Öztürk and Özçelik, 1991). Apart from these, it is utilized for the production of delight and ice-cream. In Thracian region, because of its characteristic of whitening wax and its power to make crisp soaproot, it is utilized in the “köpük halvah” which has a white and spumy form. Furthermore, in some parts of Turkey while making “hellim cheese” some soaproot is cooked and added to the brine so that the cheese does not spoil (Korkmaz, 2007; Anonymous, 2010a; Orman Genel Müdürlüğü, 1991). Some genotypes of *G. arrostii* var. *nebulosa* are economically important taxa in Beyşehir (Konya) and it is called as “dişi çöven” (female soaproot) because of its fast multiplying character. Underground parts of the other soaproots known as “erkek çöven (male soaproot)” are not widely used in trade. They have saponin, resin and sugar in their rhizomes. Because they are widely used in production of “tahini halvah” in Turkey and near east, they are called “helvacı çöveni (halvah soaproot)”. In some cities of Turkey and Cyprus during the preparation of “hellim cheese” which is boiled and salted, some soaproot is added to its water to prevent spoiling. In Thracian region, a white spumy halvah known as “köpük halvah” is produced by soaproot (Battal, 2002). In the Eastern Anatolia, the underground parts of some soaproots are used in preparing a local and original type of food “herbal cheese” (Korkmaz, 2007; Özçelik and Özgökçe, 1999, 1995). The use of extract of soaproot is the first obligation for making “tahin helvası (halvah)”. Otherwise, it is impossible to make the halvah crisp. In Mersin (especially in Erdemli town), it is specially used in preparing a local food called as “Kerebiç sweet” by local people. This food is in the form gel, in high saponin level and very expensive. It is prepared with milk in special days and times by local people (especially in Ramadan month).

It is stated that the delight obtained by mixing syrup whitened by soaproot extract with pure delight is called “sultan delight” and the maximum saponin amount should be 0.1% (İnan, 2006). The main reasons why soaproot is most preferred for the halvah production are because, the saponin in the soaproot whitens the sugar wax, saponin softens the sugar and makes it like sponge and it has a function like emulgator by enabling the sesame oil to mix with sugar. In halvah production, the amounts used are 52 to 65% tahin, 35 to 48% sugar, 0.5% soaproot, respectively (H´erold and Henry, 2001).

In the production of “köpük halvah” soaproot and sugar are boiled in water and added after it takes the wax form. Soaproot water is used in production of “köpük halvah” which is half-liquid and has a little hard stiffness. When adding soaproot water there are two points to be taken into consideration; first, its amount should not exceed the average level and second, just after adding soaproot the pot should be covered, otherwise the air absorbed leads to over-bubbling. When making “köpük halvah”, it can be used about 60 to 65% glucose syrup, 30 to 35% water and 0.01% soaproot water (Anonymous, 2010a). Saponin content of soaproots that keeps the plants from germs and fungus increases the nutritional value of the plants as well as simplifying the digestion. As a result of this, they are used for preparing çöven bread. The extract of soaproot (juice) is used for preparing local bread named as “Çöven Ekmeği” in Bartın and its neighbor cities. Soaproot increases the volume of the bread about 10%, it increases softness of the bread and decreases oldness and it also decreases the total number of micro-organisms, yeasts and molds in bread (Çağlayanlar, 2006).

Uses in chemistry and hygiene Industry

Soaproots are also used in the manufacturing of saponin which is a valuable chemical substance (Korkmaz, 2007; Babaoğlu et al., 2004). Saponins are components which have pervaded in wide districts and are in the form of heavy molecular steroidal or triterpenoid glycosides. Also, they have a great biological activity on plants, insects, fungus and microorganisms. Their lower doses help the plants to develop their roots however, higher doses decrease root growing (Inan, 2006).

Çevrimli (1990), reported that because of the negative impacts of alkyl and aril sulfanat types of detergents on environmental pollution and human health, the usage of saponin present in *G. arrostii* var. *nebulosa* as an active surface substance of detergent will be more beneficial and the saponin present in the plant will be easily used as an active surface substance in both extinguishers and soap industry. Saponin in rhizomes of the plant is about 18% (Inan, 2006).

Since soaproot has a good characteristic of bubbling, it is being utilized for soap, shampoo materials or fabric softener in hygiene industry. The silky and delicate fabrics and the deteriorated fabrics are better cleaned using the cool water obtained from boiled under-ground parts of the soaproots. Fabrics or clothes are cleaned by being dipped into the cool water obtained and are kept for a few hours without spoiling their colours and brightness. Moreover, in some regions they are used to clean the wool obtained from animals (Korkmaz, 2007; Anonymous, 2010a; Orman Genel Müdürlüğü, 1991). The under-ground parts of *G. arrostii* var. *nebulosa* have

been used as a cleaner and a removal of stain since ancient times. (Babaoğlu et al., 2004). The taxon is also used for cleaning houses, furniture and clothes. It is a hard cleaner (Özer, 2009).

Roots of *S. officinalis* and *Quercus* ash are used for transpirating, scabies disease and preventing baldness. Trabzon date (*Diospyros kaki* L.) is used as cleaner because of its saponin content. Aerial parts of *Alcea apterocarpa* plant (Fatmagül in Turkish) are used for cleaning laundry and as fabric cleaner. The gum obtained from *Scorzonera eriophora* is used to hinder mouth scent and to clean the tooth. In addition to these plants, there is saponin in *Sambucus* L. spp., *Thymus* L. spp., *Rosmarinus officinalis* L., *Borago* officinalis L., *Viola* L. spp. and *Verbascum* L. spp. (Yentür et al., 2002). Seeds of *S. officinalis* L. and leaves of *Morus nigra* L. are used for cleaning of organic dirt by people in Mediterranean region. Most of these plants are poisonous and some of them are used as spice.

Uses in medicine

It is reported that in the anthrax vaccine which is against anthrax disease seen among animals and which is produced in Turkey, the saponin amount has been found to be 0.1 to 0.5%. It has been found out that saponins are in the seeds, limbs, leaves, flowers and roots of plants and that when the plants containing saponin are eaten by animals, the bitter-flavored saponins have irritated mucosa cells in throat. Such types as *G. paniculata* and *G. arrostii* var. *nebulosa* are used as a cough and respiration system diseases deterrent besides being used as a myx remover (İnan, 2006). Soaproot has some features such as urine remover, exudative and myx remover (Anonymous, 2010a). As for drug, it has a function in some drugs compound when they are brewed because of its characteristics such as myx and urine remover (Orman Genel Müdürlüğü, 1991). It is also used to lower body temperature. The water obtained from boiled and cooled soaproot is used for the treatment of liver and kidney diseases (Maranki and Maranki, 2008). *S officinalis* is known by the names; “Sabunotu, Tibbi sabunotu, Karga sabunu and Köpürgen in Turkish”. It is used as myx and urine remover. Also, it is a drug for cough, bronchitis, stomach disorders, bone deformations, rheumatism, pimples, skin diseases, bile disorders, liver problems and respiratory system diseases (Ivanov et al., 2005).

Antimicrobial and toxic effects

Saponin has an antimicrobial effect and prevents the plants from some insects in soil. Besides this, it is estimated that it has an important role of increasing the plant resistance to disease in some parts of plants. It is reported that the soil in which the saponin containing plant grows, there has been found to be saponin in certain amounts and this saponin in the soil has some impacts on some bacteria. It has been found that soil bacteria such as *Aquaspirillum dispar* and *Aquaspirillum* spp., have been in great numbers in the roots of *G. paniculata*. In the search of antiviral impacts of *Gypsophila* species, it has been expressed that *G. arrostii* var. *nebulasa, G. bicolor*, *G. perfoliata* and *G. eriocalyx* species have impacts on *Vesicular stomatitis* virus. They have no impact on *Parafainfluenza* type-1 virus. *G. bicolor* species has effectiveness against the other viruses (*Poliovirus* type-1, *Herpes simplex* type-1, type-2, *V. stomatitis* and *Influenza* A_2) except *Parafainfluenza* type-1 virus (İnan, 2006).

Saponin chemicals may have toxic effect on humans. During saponin biosynthesis, there is retarded growth of leaves in the plant. In fact, these chemicals may be toxic to the plants. But, the plants can supply these chemicals in a harmless way. In the case of the spread of these chemicals in to the environment, other plants do not grow nearby (Poslu, 2006).

Saponins can have strong degree complex with cholesterol and this situation leads to hemolysis in cells. So, saponins are kept in vacuoles (Poslu, 2006) and saponins which have toxic effects are called Sapotoxin. They have no toxic effect if they are taken by oral way. However, saponins injected into the blood vessel are at least 10 times more toxic. Toxicity level of saponins is 50/100 mg/kg body weight. The poison effect depends on the rate of absorption of intestine. Saponins could not be absorbed easily in the blood (Çağlayanlar, 2006).

Uses in horticulture

Gypsophila species are regarded as one of the most important alternatives of product diversification in the sector of flower cutting. *G. paniculata* is used as fresh and dry cut flower and attract attention as being one of the most indispensable elements of arrangement and bouquet in domestic market (İnan, 2006; Korkmaz, 2007).

It has been reported that in Eurasia continent, there have been found to be 125 species of Gypsophila and the most significant of those to be used as ornamental plant is *G. paniculata.* Although the plant is perennial, it has been grown annually and that because it cannot enable blossoming in short time and because it has no genetic evolution, it is more advantageous to multiply it by cutting. It has been expressed that *G. paniculata* has a great importance in the trade of cut flower. Although with the reparation studies, the desired plants have been

obtained from these plants whose seeds are cultivated. The desired plants will not be able to obtain and that they may have genetic evolution so the plants should be grown with vegetative organs. They have found that in the *G. paniculata* species which is used in horticulture, their harvest should have done when their petals have exceeded 50% blossoming, the vase lifespan in plants has reached about 55 days with the blossoms of buds in vase and that during 82 days, the flower harvest can be done on plants. In *G. paniculata* species which is used in horticulture, in the flower buds, the flowers should be harvested when they blossomed 30% and so the vase lifespan increases. They have informed that because there is much more the floral deportation obtained in unit area for the production of *G. paniculata,* it is recommended to cultivate it around coastal parts of the Mediterranean region (İnan, 2006). Species in Section Capituliformes of genus *Gypsophila* have high potential in the sector of flower cutting. But, nowadays the species are not grown in Turkey. *S. officinalis* is produced in cemeteries, in gardens of the houses and in parks and gardens of the cities for nice looking flowers and good smells in high amount. Other *Saponaria* species also have high importance in saponin level but *S. officinalis* is being preferred only in the horticulture.

Uses in mining

As a result of the studies on natural growing of four *Gypsophila* species in the district of boron (B) mine in Eskişehir Kırka, it has been observed that *G. sphaerocephala* Fenzl ex Tchihat. var. *sphaerocephala* and *G. perfoliata* have been the first ones which have a characteristic of a potential boron hyper accumulator. These species grow successfully in concentrations as high total soil boron (8900 mg/kg) and suitable soil boron (277 mg/kg). As a result of the analysis conducted, it has been found out that the upper soil parts of the *G. sphaerocephala* contain boron in extremely high concentrations (in seeds; 2093 ± 199 SD mg/kg, in leaves; 3345 ± 341 SD mg/kg). But in roots it has contained far less concentrations of boron (51 ± 11 SD mg/kg). In the respect of Boron amount, this has been followed by *G. perfoliata.* Boron contents of *Gypsophila* species have been given in Table 1. It has been stated that by growing *G. sphaerocephala* in the soils which have some signs of high Boron toxin, vegetative mining can be conducted by hyper accumulation. So, the soils containing Boron in toxic amounts can be refined by vegetative ways (Yentür et al., 2002). In this way, the agricultural fields in which fertilizers have long been used can be prevented to become barren and during reparation process it will be possible to evaluate the agricultural fields which have become dormant. Hyper accumulator plants are thought to be potential cleaning tools for these toxic areas and many studies are continuing on the topic. The name of this new technology is Fitoremediasyon (Hakkı et al., 2006).

Other uses

Apart from these, the cool water obtained from the boiling of soaproot under-ground parts is used in the process of whitening gold and treasures. Furthermore, this solution is used as a spray in the structure of film emulsion and extinguishers. It is known that the rhizomes of perennial soaproot sold to Israel from Isparta and extractions of them are used in the production of fire extinguishers (Korkmaz, 2007; Babaoğlu et al., 2004). The most important characteristics of the soaproots are fire extinguisher and their usages in the structure of fire enduring materials.

A Turkish researcher named Faruk Durukan from Edremit (Balikesir) town produced a fire extinguisher that is made by converting rocks to liquid and adding soaproot extract to this liquid. He stated that this solution was used for forest fires in Greece and Turkey in 2009 and successful results were gained. The success was published by multimedia organizations in a number of days.

PICKING, DRYING AND STORING THE UNDERGROUND PARTS AND EXTRACT PRODUCTION

The under-ground parts of the plants are generally utilized; from just after the precipitation season to the time of plant's fruit, that is, between May and July the plants are picked. The local public utilizes its root when its leaves are on land area or when they are in the time of blossoming, they can distinguish *Gypsophila* species between others and they can extract its rhizomes by means of such tools as anchor. Because of the unconscious picking of under-ground parts of the plants, they are endangered. The parts which are picked are cleaned and after washing them, they are dried under the sun. In order to dry well and in order to enable some fresh air during this process the rhizomes should not be laid down thick. The under-ground organs are brought in bundles and are stored in suitable, dry and moisture free places (Orman Genel Müdürlüğü, 1991).

It was reported that some dryness have been found in the roots of soaproot plants which can be grown in barren and hillside areas because of extreme damp and it is not suitable to harvest them before four years old. Their trade

Table 1. Boron contents of *Gypsophila* species that are grown in toxid soils by Boron.

Taxa	Root (mg/kg)	Stem (mg/kg)	Leave (mg/kg)
G. sphaerocephala var. *sphaerocephala*	51 ± 11	232 ± 40	3345 ± 341
G. perfoliata	57 ± 16	64 ± 22	1490 ± 172

(Babaoğlu et al., 2004).

situation should be considered before harvesting and if necessary the product should be waited in the field until the roots extracted by fork or tractor plough have dried in 2 to 3 months and from 2.5 kg raw root to about 1 kg dry root has been obtained and that in one decade of field totally, 4000 to 5000 kg dry roots are extracted (İnan, 2006).

For the production of soaproot extract, approximately 30 kg of soaproot is boiled some time in water. After that the upper part of the water (extract) is filtered and the process is repeated 5 times. This process takes nearly 20 h and at the end of this, 50 L soaproot extract is produced (Velioğlu, 2001; Korkmaz et al., 2010).

TRADE OF SOAPROOTS AND THEIR STANDARDIZATION

There is not a general accepted standard for roots of soaproot but they can be classified in three different qualities in terms of commercial purposes. According to where they grow: Those growing in Van-Isparta are of the first quality, those obtained from Niğde are of second quality and those obtained from Yozgat-Çorum are of third quality (Orman Genel Müdürlüğü, 1991).

In the usage of soaproot for industry, the hemolysis and bubble indexes of them; as for food industry the bubble indexes are of importance. So, in the quality evaluation, these rates should be taken into consideration. Both the bubble and hemolysis indexes of Van (*G. bicolor*) and Isparta-Beyşehir soaproot (*G. arrostii* var. *nebulosa*) are high. Also their raw saponozoide rates are more than the others (Table 2).

There is still Van soaproot (*G. bicolar*) on market and is sold as being the first quality. The oldest commercial soaproot is this species, so its populations have been greatly damaged. Isparta-Beyşehir soaproot *(G. arrostii*) has decreased extremely on the market. But this species has been produced in fields (Atabey Plain) by some farmers. Furthermore, Isparta Regional Directorate of Forestry cultivated about 15 to 20 kg seeds 3 years ago in order to be a financial support to Sütçüler and Aksu villagers in the future and enable the continuation of the species generation. The hemolysis index of Niğde soaproot (*G. perfoliata* var. *anatolica*) is high but its bubble index and raw saponozoide percentage is low. Despite its features similar to first quality, it should be regarded as second quality. Çorum-Yozgat soaproot (*G. eriocalyx)* is one type of soaproot having the lowest rates. In these respects it should be regarded as the third quality (Sezik, 1982).

Soaproots are exported to many countries including Israel, Germany, Egypt, and Greece at the outset (Orman Genel Müdürlüğü, 1991). Between 1989 and 1996, the average annual export of soaproot roots was 140 tons. In 1997, it decreased to 93.3 tons. Today, the average export of soaproot root from Turkey is about 90 tons yearly. In 2004, $ 80000 has been earned from the soaproot root exportation for 85 tons. According to the statistics of year 2005, 92 tons of soaproot roots were exported from Turkey and $ 66000 has been gained. In 2006, despite 153 tons exportation the income was $ 61000 in an unparalleled way (Yentür et al., 2002).

DISCUSSION AND RECOMMENDATIONS

Turkish soaproot is widely obtained from 6 species of *Gypsophila* (*G. graminifolia*, *G. bicolor*, *G. arrostii* var. *nebulos*a, *G. eriocalyx*, *G. perfoliata* var. *anatolica* and *G. venusta*), one species of *Ankyropetalum* (*A. gypsophiloides*) and one species of *Saponaria* (*S. officinalis*). The gene center of all genera is Turkey (Özçelik and Muca, 2010). Besides collecting plants in an uncontrollable way from nature, industrialization, urbanization, extension of agricultural fields and extreme grazing, tourism, reparation of barren fields, agricultural struggle and pollution, unconscious forestation and fires are leading factors that threaten the plants of the country, except from *S. officinalis* which is cultivated in many parts of the country. Many natural plants are used in medicines, exported and used in domestic markets traditionally. They are constantly being picked from nature and increasingly disappearing (İnan, 2006).

Soaproot plants have been utilized in medicine, food, hygiene, as ornamentals in parks and gardens, in chemistry industry in order to produce saponin. It has the ability to extinguish fires, whiten gold and clean silky and delicate fabrics. It also enables cleaning the contaminated soil by removing the Boron. They can be cleaned by cultivating *G. sphaerocephala* and other *Gypsophila* species. Also, it is possible to make

Table 2. Some chemical analysis of *Gypsophila* species.

Taxa	Hemolysis index	Bubble index	Raw saponozoide (%)
G. bicolor	6.667 to 6.925	9.000 to 10.000	20 to 25
G. arrostii var. *nebulosa*	5.295 to 6.667	9.600 to 10.034	19 to 22
G. perfoliata var. *anatolica*	9.778 to 10.000	4.650 to 5.000	15 to 19
G. eriocalyx	3.385 to 3.659	1.800 to 2.000	10 to 14

(Çağlayanlar, 2006).

vegetative mining by Boron hyper acumulation to the upper surface of the plant on soil. Because they are utilized in many different areas, agriculturalists, food engineers, chemists, pharmacists, landscapists, textile workers and jewelers are all interested in them (İnan, 2006). In Turkey, the general name of *Gypsophila*, *Ankyropetalum* and *Saponaria* species are "Çöven, Çövenotu, and Sabunotu". But some researchers name the plants whose under-ground parts are economically valuable as "Çöven". Regarding this, soaproot is the name of a raw material and is an extract obtained from a plant (Özçelik and Muca, 2010; Korkmaz and Özçelik, 2011). *Gypsophila* species yielding soaproot, their locations and some properties are as follows (Koyuncu et al., 2008):

(1) *G. bicolor* (Turkish names: Van çöveni and Tarla çöveni): This species is distributed around Van, Bitlis and Artvin provinces. Its rhizomes are hard and difficult to break down. Saponin content is 20 to 25%. This value is higher than that in other soaproot yielding plants. This is the most preferred soaproot, also known as the soaproot of the highest quality.
(2) *G. arrostii* var. *nebulos*a (Turkish names: Isparta çöveni, Beyşehir çöveni and Konya çöveni): Saponin content is 19 to 22%. This is also considered to be of good quality. This species also has a narrow distribution. Halvah makers in Konya especially use this soaproot.
(3) *G. eriocalyx* (Turkish name: Çorum çöveni and Yozgat çöveni): Grows around Ankara, Çankırı, Çorum, Eskişehir, Kayseri, Sivas and Yozgat provinces in steppe habitats with gypsum. This is an endemic species for Turkey.
(4) *G. perfoliata* (Turkish name: Niğde çöveni): Grows around Ankara, Kayseri, Sivas, Erzincan, Konya, Niğde, and Denizli provinces. It is considered to be of third quality.
(5) *G. venusta* subsp. *venusta* (Turkish name: Konya çöveni): Grows around Ankara, Çankırı, Konya, Gaziantep, Urfa, Sivas, Malatya, and Erzurum provinces in step habitats or arable fields and yield soaproot.
(6) *G. graminifolia* (Turkish name: Başkale çöveni and Dağ çöveni): This local endemic species also grows in Van province (only around Başkale). Three species of *Ankyropetalum* genus grow naturally in Turkey and all of them are endemic. However, only *A. gypsophiloides* rhizomes are known as the name "helva (halvah) root" around Siirt province and used as soaproot.
(7) *A. gypsophilloides* (Turkish name: Siirt çöveni, Helvacı çöveni, Helva kökü): This species grows around Şanlıurfa, Mardin, Gaziantep, Batman, and Siirt provinces. Its rhizomes are collected in Siirt and used by local halva producers (Öztürk and Özçelik, 1991; Anonymous, 2010b).

Genus *Saponaria* L. has 20 taxa of 18 species and 10 taxa of the genus are endemics for Turkey. *S. officinalis* is the most known species of the genus. It is also known as soaproot and its rhizomes are obtained from soils in autumn and dried in shade and used for similar purposes. Saponin rate of the rhizomes is about 20%. It is used as myx and urine remover, drug for cough, bronchitis, stomach ache, bone deformations, rheumatism, pimple, skin, bile disorder, liver problems and respiration system diseases (Ivanov et al., 2005). *S. officinalis* is produced in cemeteries, in gardens of houses and in parks and gardens of the cities for nice looking flowers and good smells in high amount.

Because of the roots and rhizomes of these plants, they are generally used and the harvest time is in March to June months. The plants do not produce seeds so; they do not enable seeds for the latter year. These plants which are constantly taken from nature due to exportation and domestic consumption and this increase their disappearance and are on the verge of extinction. This problem becomes more important especially when the plants are endemics. Except for *G. paniculata* which is used for cut flower and cultivated, *Gypsophila* species which are used for exportation and domestic consumption and some of which are endemic are taken directly from nature. This brings the danger of extinction although economically, these plants are a source of biological richness of Turkey. Most of them are endemic species having narrow distributions. Since they are not cultivated but collected directly from nature, populations of these plants in nature deteriorate, their generations

diminish or become extinct, and the balance of nature is disturbed (Anonymous, 2009; Korkmaz et al., 2010). According to some trading companies, cheaper soaproot having better quality is being imported from Afghanistan and re-exported after the extraction of their juices. This soaproot juice (extract) is sold to halvah producers in Turkey. So, there is no need to collect soaproot in Turkey anymore. Soaproot has been collected for years due to the high unemployment rate in the region and the demand.

In order to preserve these species and also have regular exports, feasibility studies should be conducted and a determined quantity of a given quality should be cultivated. Soaproot should not only be collected from nature and its cultivation should be scheduled. Decrease in collection due to decreasing demand and soaproot imports from Afghanistan are good news. Soaproot imports may stop someday, but soaproot usage will continue and so we should take necessary precautions. Soaproot collection in Turkey should be stopped or at least alternation should be applied to collection areas. Cultivation of soaproot yielding plants should be studied and encouraged. Standardized extract of soaproot should be prepared. Soaproot yielding other perennial species and their saponin contents should be determined and new soaproot resources should be identified and their cultivation and marketing possibilities should be studied. Information must be given to the public to preserve biological richness.

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