



Researching the Potential of Economically Important Medicinal and Aromatic Plants of Tokat Province

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Abstract: Tokat province is located in the Yeşilirmak Basin that is between the Middle Black Sea and the Inner Anatolia regions, and is important in terms of ecosystem and plant biological diversity. Nowadays, researching plant species that are economically important has become a necessity in the province. In this study, the potential of economically important medicinal and aromatic plants of Tokat province was researched by utilizing new Geographic Information Systems (GIS) methodologies and questionnaire techniques. The research was completed three main steps. First, an original GIS database for the flora of Tokat province was created by utilizing geo-referenced data collected from the field between 2008 and 2016. Then, a questionnaire prepared by the economists and plant taxonomists were applied to the target audiences selected among the local people and plant sellers in 2016. Finally, the questionnaire results and the GIS database were evaluated together in order to map important plant species areas. According to the questionnaire results, a total of 40 medicinal aromatic plant species were identified as economically important. These medical aromatic plant species have been evaluated as spice (1 species), spice-cosmetic (2 species), herbal tea-spice (2 species), herbal tea (3 species), herbal tea-spice-cosmetic (7 species), herbal tea-cosmetic (10 species) and herbal tea-cosmetic-perfume (15 species) in the study area. After querying the GIS database, 16 of these species were found in the Tokat flora and their locations were mapped. These species can be summarized as *Allium sativum* L., *Calendula officinalis* L., *Hypericum perforatum* L., *Laurus nobilis* L., *Matricaria chamomilla* L., *Melissa officinalis* L., *Mentha piperita* L., *Mentha pulegium* L., *Mentha spicata* L., *Nigella orientalis* L., *Rosa canina* L., *Thymus leucotrichus* Hal., *Thymus praecox* Opiz, *Tilia rubra*, *Tilia tomentosa*, and *Trigonella foenum graecum* L. These results are important for researchers, plant vendors, farmers and decision-makers.

Keywords: Economy, GIS, medicinal and aromatic plants, Tokat, Yeşilirmak Basin

Tokat İli'nin Ekonomik Olarak Önemli Tıbbi ve Aromatik Bitki Potansiyelinin Araştırılması

Öz: Tokat ili Orta Karadeniz ile İç Anadolu bölgesi arasında kalan Yeşilirmak havzasında yer almaktadır ve ekosistem ve bitki biyolojik çeşitliliği bakımından önemlidir. Günümüzde, ekonomik açıdan önemli olan bitki türlerinin araştırılması ilde bir zorunluluk haline gelmiştir. Bu çalışmada Tokat ilinin ekonomik açıdan önemli tıbbi ve aromatik bitkilerinin potansiyeli yeni Coğrafi Bilgi Sistemleri (CBS) metodolojileri ve anket teknikleri kullanılarak araştırılmıştır. Araştırma üç ana aşamada tamamlanmıştır. İlk olarak, Tokat ilinin florası için orijinal bir CBS veri tabanı, 2008-2016 yılları arasında araziden toplanan coğrafi referanslı veriler kullanılarak oluşturulmuştur. Daha sonra, ekonomistler ve bitki taksonomistleri tarafından hazırlanan bir anket, yerel halk ve bitki satıcıları arasından seçilen hedef kitlelere 2016 yılında uygulanmıştır. Son olarak, anket sonuçlarına göre, toplam 40 tıbbi aromatik bitki türü ekonomik olarak önemli olarak tanımlanmıştır. Çalışma alanındaki bu tıbbi aromatik bitki türleri, baharat (1 tür), baharat-kozmetik (2 tür), bitki çay baharatı (2 tür), bitki çayı (3 tür), bitki çay-baharat-kozmetik (7 tür), bitki çay-kozmetik (10 tür) ve bitki çay-kozmetik-parfüm (15 tür) olarak değerlendirilmiştir. CBS veri tabanı sorgulandıktan sonra, Tokat florasında bu türlerden 16'sı bulunmuş ve lokasyonları haritalanmıştır. Bu türler, *Allium sativum* L., *Calendula officinalis* L., *Hypericum perforatum* L., *Laurus nobilis* L., *Matricaria chamomilla* L., *Melissa officinalis* L., *Mentha piperita* L., *Mentha*

pulegium L., Mentha spicata L., Nigella orientalis L., Rosa canina L., Thymus leucotrichus Hal., Thymus praecox Opiz, Tilia rubra, Tilia tomentosa ve Trigonella foenum graecum L. olarak özetlenebilir. Bu sonuçlar, araştırmacılar, bitki satıcıları, çiftçiler ve karar vericiler için önem arz etmektedir.

Anahtar Kelimeler: Ekonomi, CBS, Tıbbi Aromatik Bitkiler, Tokat, Yeşilirmak Havzası

1. Introduction

Plants, commonly found since 12th century and used whether alone or mixed for different treatments and pharmaceutical industry to make medicine, are called as medicinal plants. Herbal medicines are processed or unprocessed material that are containing one or more components from a plant or plants which have therapeutic or beneficial effects on people's health. Under this definition, there are three types of herbal medicines including unprocessed plant material, processed plant material and medical herbal products (Van Overwalle 2007). Aromatic plants, however, are used for the smell and taste in cosmetics and perfumery sectors (Anon 2005). Today, increasing environmental awareness and conscious healthy lifestyle have brought a rapid going towards natural life. For this reason, herbal products have been started to widely use in medicine, cosmetics, paint and food industry in developed countries. As a result, the demand for herbal products in the pharmaceutical, cosmetic, perfumery and food sectors in the world has been continuously increasing. This trend has been symbolized by the slogan "Return to Nature", and emphasized the importance by using striking names like "Green Wave" and "Green Revolution" (Bayramoğlu et al. 2009).

The developed countries are especially oriented towards the plant resources in the treatment. A significant proportion of the medicines used in the treatment are drugs of natural origin. The rate of use of natural medicines is 60% in developed countries and 4% in developing countries (Anon 2010). However, in developing countries, about 80% of the population continues to use traditional herbal and herbal medicines for their health (Mukerji 1997). In India, 65% of the population in rural areas use traditional medical methods to meet basic health care needs (Faydaoğlu 2011). It has been reported that traditional medicine in

China accounts for about 40% of all health services, 71% of the population in Chile and 40% of the population in Colombia use similar methods of medicine. According to the World Health Organization, the number of medical and aromatic plants used in herbal treatments, which are becoming increasingly widespread in the world, is around 20.000. Of these, 4.000 drugs are widely used, while 2.000 plants in the worldwide and 500 plants in Western Europe are still being traded (Comtrade 2009).

According to researches conducted in 2000s, 17% of 422.000 flowering plants in the world (approximately 72.000 plants) have medicinal value. 5.000 of them have been taking part in world trade. Only the number of medicinal and aromatic plants bought and sold in the German market is over 1.500 (FAO 2012). World herbal medicine trade volume was about 18-20 billion dollars annually in 2007, and it is expected to increase further in the following years. The export value of world volatile oil was reported 2.5 billion dollars in 2008 (Comtrade 2009).

Turkey is a centre of origin of numerous globally important plants. In the book Flora of Turkey, 9222 plant species and 12006 taxa have been recognized and revised to date, and 2891 species and 3778 taxa have been determined as endemics (Davis 1965–1985, Guner et al. 2001, Erik and Tarikahya 2004, Avcı 2005). In Turkey, some of the medicinal and aromatic plants have been cultivating and some have been collecting from nature as well as in many parts of the world. It is estimated that about 500 medicinal plants are used in Turkey. On the other hand, it has stated that there are about 200 medical and aromatic plants having export potential (Faydaoğlu, 2011).

Turkey is the 18th rank among 110 countries exporting medical herbs. Among the Eastern and South Eastern European countries, Turkey have ranked as the 5th importer country and 8th exporter country. The export value of 16 plants,

which is important for Turkey's exports, rose from \$ 52 million to \$ 94 million between 2001 and 2009 (Anon 2011). Total 68 thousand tons of exports (186 million dollars) and 148 thousand tons of imports (277 million dollars) were realized in Turkey in 2011. The export import coverage ratio of medical and aromatic plants was reported as 67% in 2011. The increase in the amount of import caused the decrease of the import coverage ratio of exports in 2011. Although Turkey is one of the most important countries of the world in terms of medical and aromatic plants, it could not increase the export amount and value at desired levels (Yücer 2012). On the other hand, Turkey has been attracting worldwide attention in some plants. For instance, Turkey is one of the few laurel exporter countries in the world. Approximately, 90% of world laurel need has been supplying from Turkey (Özgüven et al. 2005).

Studies on medicinal and aromatic plants started to progress rapidly all over the world and have been continuing without losing interest. Turkey is rich in medicinal and aromatic plants due to its geographical location, agricultural potential, climate, and plant diversity. Tokat province, located in the Yeşilirmak basin between Central Black Sea and the Central Anatolia regions, is thought to have a high potential for these plants. According to the floristic studies conducted in recent years, 1086 plant taxa have been identified in Tokat province and 114 of them are endemic (the endemism rate is 10.50%) (Anonymous 2014). However, in the province, there are no sound studies on which crops are subject to trade and which are collected or grown. With the ever changing economic and social structure in Tokat province, demands for medical and aromatic plants and farmers' interest for alternative sources of income are increasing. Nowadays, researching the plant species that are important in terms of economy has become a necessity for Tokat province.

This study aimed to investigate the economically important medicinal and aromatic plant potential of Tokat province by using

survey techniques and Geographic Information Systems (GIS) methodologies. The study focuses primarily on identifying plants that are used for commercial purposes or that are heavily used by the local population. Once important plants have been identified, their distribution areas will be determined using spatial databases and will be evaluated on district basis. The resulting information is thought to be important for researchers, plant sellers, farmers and decision makers.

2. Material and Method

This research was conducted in Tokat province of Turkey. The study area is located in the transition zone between the Middle Black Sea and Inner Anatolia regions, and covers 9912 km² area. This area is also located in the intersection of Euro-Siberian and Irano-Turanian regions (Davis 1965–1985 and Davis 1988). The province consists of 12 administrative districts called as Centre, Zile, Almus, Reşadiye, Erbaa, Turhal, Niksar, Artova, Sulusaray, Başçiftlik, Pazar, and Yeşilyurt (Figure 1). Four seasons (autumn, winter, spring, and summer) are recognized in this region. According to the Emberger classification system, the climate of the study area shows 'Semi-arid Upper Mediterranean Bioclimate' characteristic with cold winters (Akman and Daget 1971, Akman 1999). The topographic features of the area shows mountainous characters and elevation changes between 85 and 2416m (Figure 1). Yeşilirmak and Kelkit are the main rivers in the study area. Main landmarks can be summarized as: Canik mountains (1646 m) in the north, Köse mountains and Asmalı mountain (2416 m) in the east, Deveci mountains in the south, Buzluk mountains in the west, and Yaylacık (1622 m) and Mamo (1792 m) mountains in the interior part (Figure 1). Tokat province has a rich floristic structure because of geographic location and topographic characteristics. According to the floristic studies conducted in recent years, 1086 plant taxa have been identified in Tokat province and 114 of them are endemic (the endemism rate is 10.50%) (Anonymous 2014).

In this study, the potential of economically important medicinal and aromatic plants of Tokat province has been researched by utilizing new Geographic Information Systems (GIS) methodologies and questionnaire techniques. The research has been completed in three main steps. First, an original GIS database for the flora of Tokat province has been created by in order to map economically important plant species areas. The produced plant species map has been clipped using district boundaries and thus transformed into individual plant distribution maps for each district.

utilizing archival geo-referenced data collected from the field between 2004 and 2016 (Dogan et al. 2004-2016). Then, a questionnaire prepared by the economists and plant taxonomists has been applied to the target audiences selected among the local people and plant sellers in 2016. Finally, the questionnaire results and the GIS database have been evaluated together. Consequently, areas covered by important plant species have been identified and evaluated on a district basis.

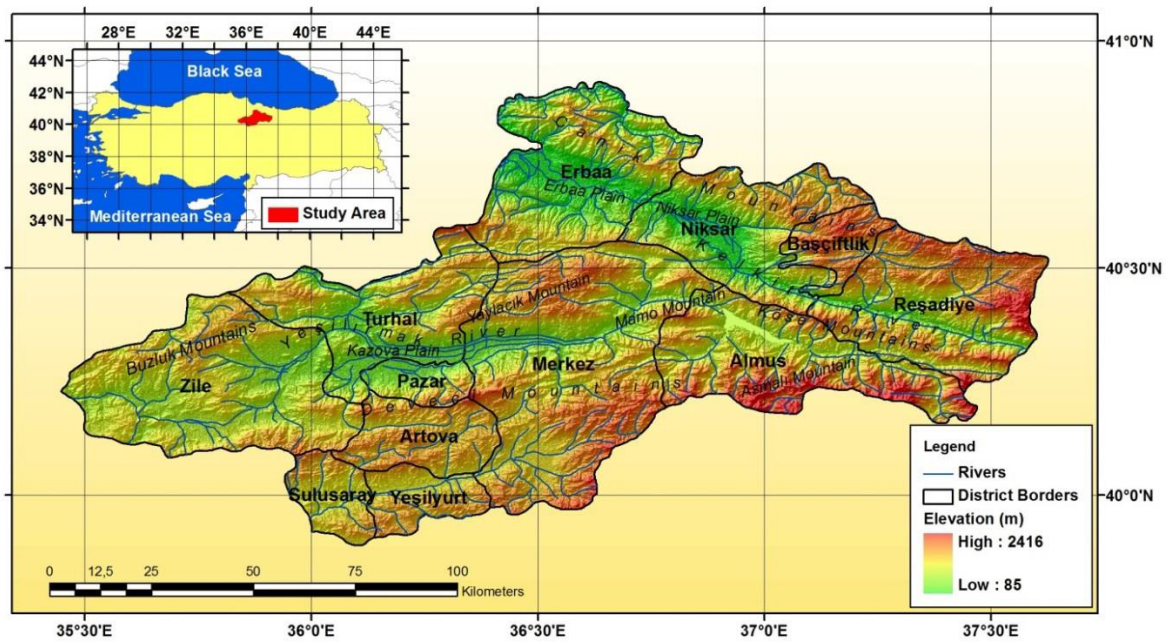


Figure 1. Geographic location, physical geography, and administrative districts of the study area.
Şekil 1. Çalışma alanının coğrafik lokasyonu, fiziki coğrafyası ve ilçeleri.

3. Results and Discussion

According to the questionnaire results, a total of 40 medicinal aromatic plant species were identified as economically important (Table 1). These medical aromatic plant species have been evaluated as spice (1 species), spice-cosmetic (2 species), herbal tea-spice (2 species), herbal tea (3 species), herbal tea-spice-cosmetic (7 species), herbal tea-cosmetic (10 species) and herbal tea-cosmetic-perfume (15 species) in the study area. After querying the GIS database, 16 of these species were found in the Tokat flora and their locations were mapped.

These species can be summarized as *Thymus leucotrichus* Hal., *Thymus praecox* Opiz (Figure 2a), *Mentha pulegium* L., *Mentha piperita* L. (Figure 2b), *Rosa canina* L., *Mentha spicata* L. (Figure 2c), *Allium sativum* L., *Trigonella foenum graecum* L. (Figure 2d), *Melissa officinalis* L., *Calendula officinalis* L. (Figure 2e), *Hypericum perforatum* L. *Matricaria chamomilla* L. (Figure 2f), and *Nigella orientalis* L., *Laurus nobilis* L. (Figure 2g). *Tilia rubra*, and *Tilia tomentosa* species could not given in Figure 2 because they covered very small areas in Erbaa, Niksar and Reşadiye districts. After this stage, *Tilia rubra*, and *Tilia*

tomentosa species were excluded from assessed. evaluation and the remaining 14 species were

Table 1. Economically important plant species in Tokat province according to survey results
Çizelge 1. Anket sonuçlarına göre Tokat ilinde ekonomik açıdan önemli bitki türleri

NO	Scientific and Turkish Name of Plant Species (Turkish names were given in parenthesis)	Area of use
1	<i>Achillea millefolium</i> sbsp. <i>Millefolium</i> (Civanperçemi)	Medical-Aromatic, Herbal Tea, Cosmetics and Perfume
2	<i>Artemisia incana</i> (Pelin otu)	
3	<i>Calendula officinalis</i> (Aynısafa)	
4	<i>Cichorium intybus</i> (Hindiba)	
5	<i>Cinnamomum aromaticum</i> , <i>Cinnamomum verum</i> (Tarçın)	
6	<i>Foeniculum vulgare</i> (Rezene)	
7	<i>Jasminum officinale</i> (Yasemin)	
8	<i>Lavandula angustifolia</i> (Lavanta)	
9	<i>Matricaria chamomilla</i> (Alman papatyası)	
10	<i>Ocimum basilicum</i> (Fesleğen-Reyhan)	
11	<i>Pimpinella anisum</i> (Anason)	
12	<i>Piper nigrum</i> L. (Karabiber)	
13	<i>Primula acaulis</i> sbsp. <i>Acaulis</i> (Akşamçuha çiçeği)	
14	<i>Salvia fruticosa</i> (Adaçayı)	
15	<i>Vaccinium myrtillus</i> Ayı üzümü (Yaban Mersini)	
16	<i>Capsicum annuum</i> (Kırmızı pul biber)	Medical-Aromatic, Herbal Tea, Spice, Cosmetics
17	<i>Cuminum cyminum</i> (Kimyon)	
18	<i>Linum usitatissimum</i> (Keten tohumu)	
19	<i>Mentha piperita</i> (Tıbbi nane)	
20	<i>Mentha pulegium</i> (Yarpuz (Nane))	
21	<i>Mentha spicata</i> (Eşek nanesi)	
22	<i>Thymus leucotrichus</i> (Dağ kekiği), <i>Thymus praecox</i> (Yayla kekiği)	
23	<i>Betula pendula</i> (Huş ağacı)	Medical-Aromatic, Herbal Tea, Cosmetics
24	<i>Echinaceae purpurea</i> (Ekinezya)	
25	<i>Euphorbia rigida</i> (Sütleğen)	
26	<i>Glycyrrhiza glabra</i> (Meyan kökü)	
27	<i>Hypericum perforatum</i> (Sarı Kantaron)	
28	<i>Melissa officinalis</i> (Melissa-Oğulotu)	
29	<i>Origanum majorana</i> (Mercanköşk)	
30	<i>Rosa canina</i> (Kuşburnu)	
31	<i>Tilia rubra</i> (Kafkas ıhlamuru), <i>Tilia tomentosa</i> (Gümüşi ıhlamur)	
32	<i>Urtica Dioica</i> (Isırgan)	
33	<i>Laurus nobilis</i> (Defne)	Medical-Aromatic, Herbal Tea, Spice
34	<i>Rosmarinus officinalis</i> (Biberiye)	
35	<i>Allium sativum</i> L. (Sarımsak)	Medical-Aromatic, Spice, Cosmetics
36	<i>Nigella orientalis</i> (Çörekotu)	
37	<i>Althaea hirsuta</i> (Gülhatmi)	Medical-Aromatic, Herbal Tea
38	<i>Rumex crispus</i> (Labada)	
39	<i>Rumex patientia</i> (Efelek)	
40	<i>Trigonella foenum-graecum</i> (Çemen)	Medical-Aromatic, Spice

As a result of the spatial analysis of the detected plants in the CBS, it was seen that the largest area (12552.6 da) of the province

covered by *Thymus leucotrichus* species (Figure 3). This was followed by *Thymus praecox* (Yayla kekiği), *Mentha pulegium* (Yarpuz-

Nane), *Mentha piperita* (Tibbi nane), *Rosa canina* (Kuşburnu), *Mentha spicata* (Eşek nanesi), *Allium sativum* L. (Sarımsak), *Trigonella foenum-graecum* (Çemen), *Melissa officinalis* (Melissa-Oğulotu), *Calendula officinalis* (Aynısafa), *Hypericum perforatum* (Sarı Kantaron), *Matricaria chamomilla* (Alman

papatyası), *Nigella orientalis* (Çörekotu) ve *Laurus nobilis* (Defne), respectively (Figure 3). This ranking also showed the economic importance of the determined plants for Tokat province. The total area covered by the 14 plant species in Tokat province was determined as 41776.4 da.

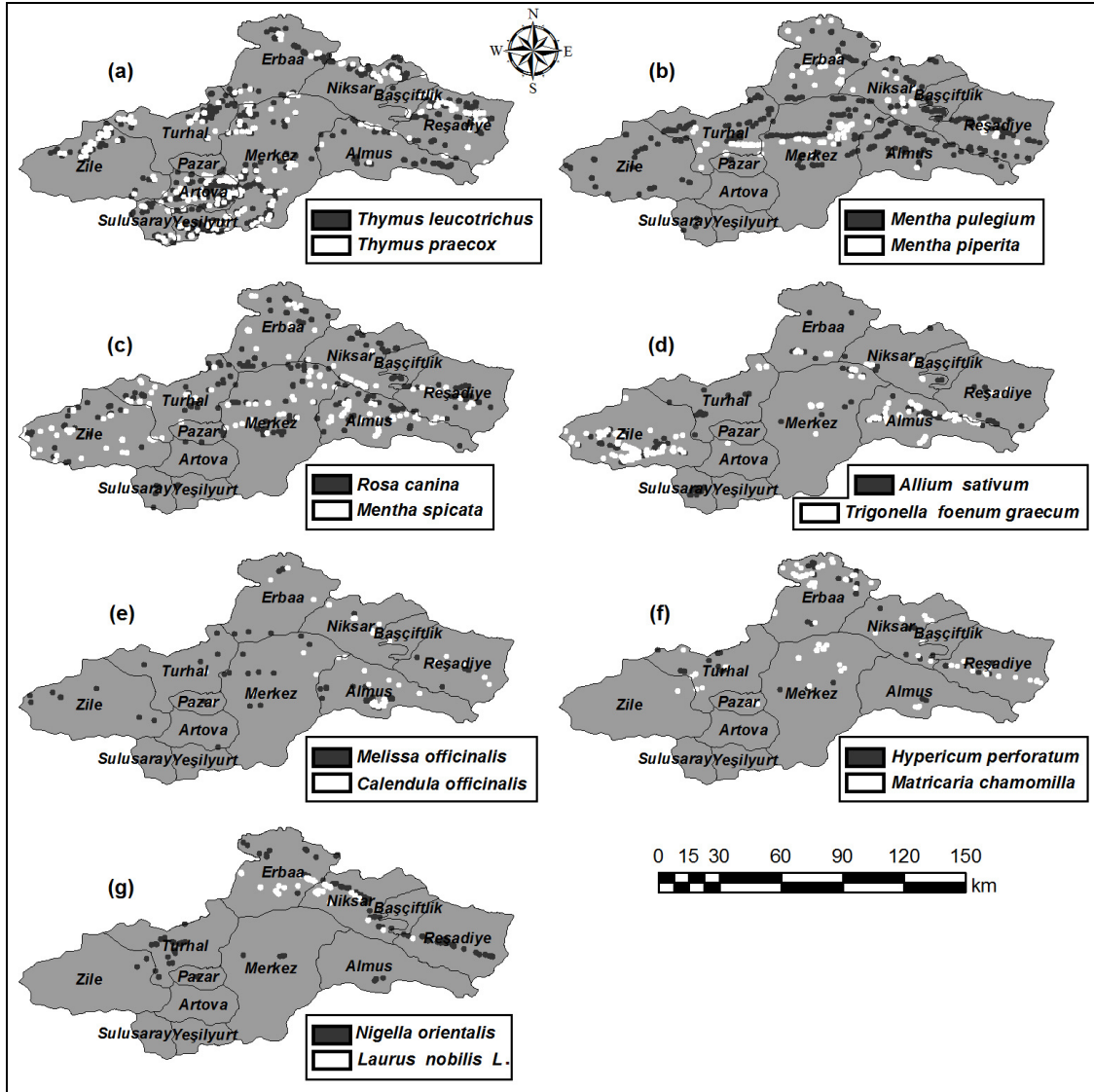


Figure 2. Spatial distribution of determined economically important plant species of Tokat province
Şekil 2. Tokat ilinin ekonomik olarak önemli bitki türlerinin mekansal dağılımı

In terms of total coverage area of determined plant species, Erbaa (7197.8 da), Almus (7118.6 da), Niksar (6901.5 da), Reşadiye (5416.3 da) and Center (4278.3 da) districts have been stand out (Figure 4). These districts were followed by Zile (3576.1 da), Turhal (2630.9 da), Artova

(1616.3 da), Pazar (1192.6 da), Sulusaray (832.3 da), Yeşilyurt (691.9 da), Başçiftlik (323.8 da) districts. In terms of the number of plant species (richness), Erbaa, Almus, Niksar and Reşadiye districts stand out with 14 species. In another words, all of the determined species have been

found in these districts. These districts were followed by Center (13 species), Turhal (13 species), Pazar (11 species), Zile (10 species), Artova (6 species), Sulusaray (6 species), Başçiftlik (6 species) ve Yeşilyurt (4 species) (Figure 4). In terms of both total coverage area

and species richness, Erbaa, Almus, Niksar and Reşadiye districts, which stand out, are located in the geographical locality known as Lower Kelkit Basin, where the plant biological diversity is high (Figure 4).

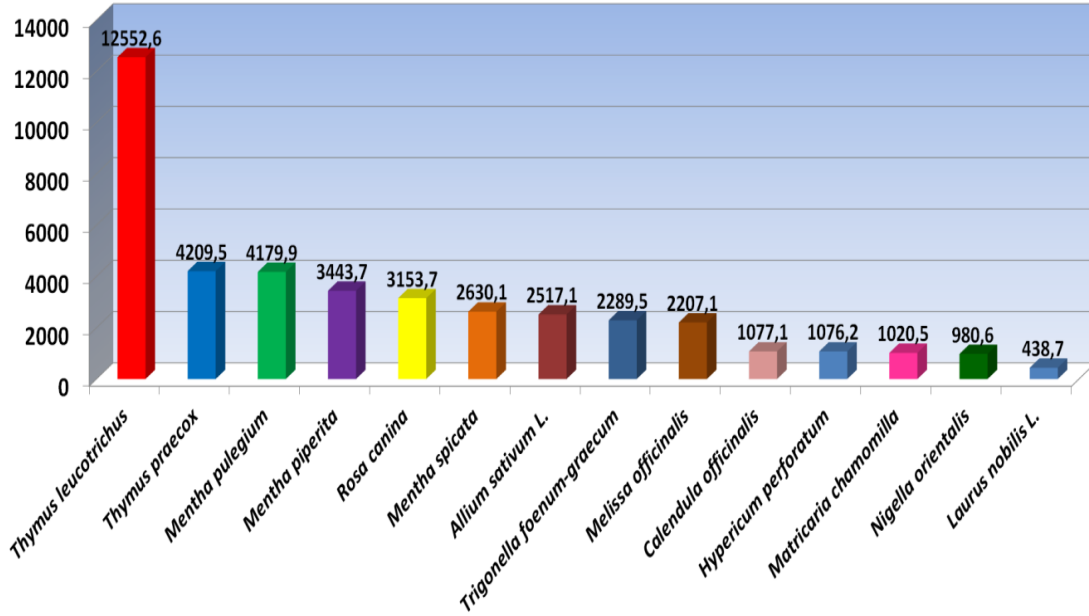


Figure 3. Total cover areas (da) of determined economically important plant species of Tokat province.

Şekil 3. Tokat ilinin ekonomik açıdan önemli bitki türlerinin toplam kaplama alanları (da)

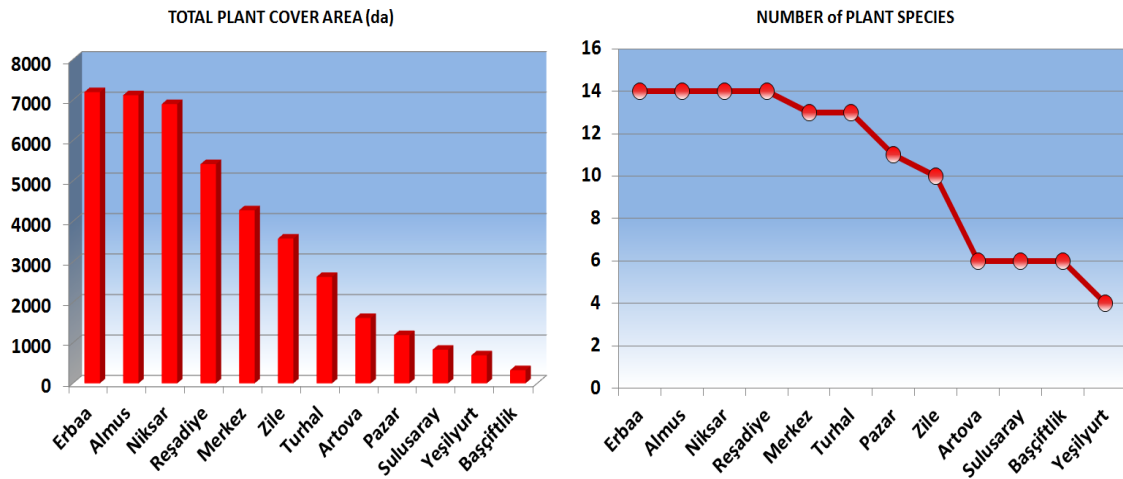


Figure 4. Distribution of total plant coverage areas and species numbers by district basis

Şekil 4. Toplam bitki kaplama alanlarının ve tür sayısının ilçe bazında dağılımı

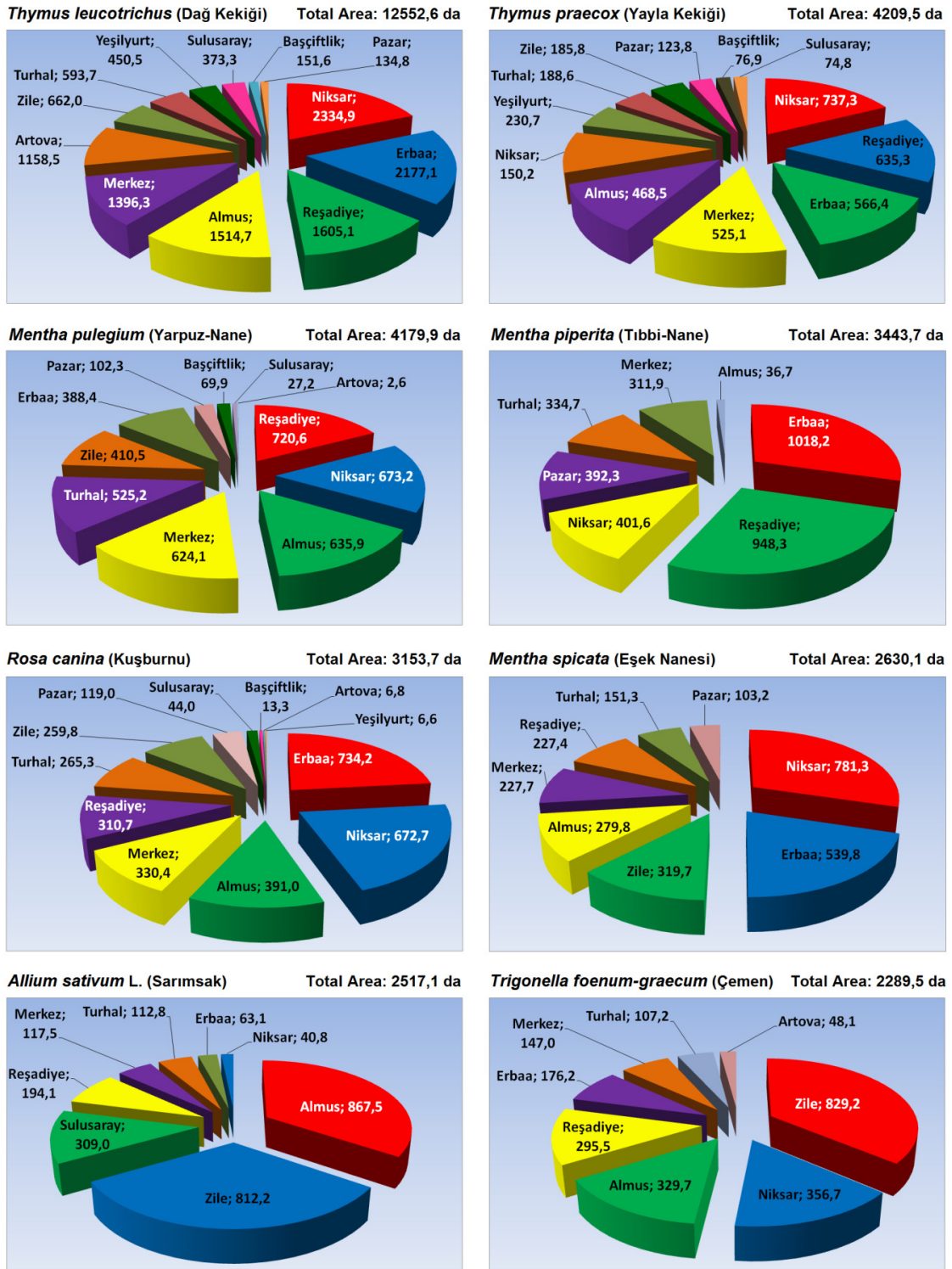


Figure 5. Distribution of cover areas (da) of determined economically important plant species in district basis (total species cover areas >2250 da)

Şekil 5. Belirlenen ekonomik açıdan önemli bitki türlerinin ilçe bazında kaplama alanlarının dağılımı (toplam tür kaplama alanları > 2250 da olanlar)

The distribution of the total cover areas of the determined plant species were also analyzed in district basis. Plant species having the cover area more and less than 2250 da were shown in Figure 4 and Figure 5, respectively. For example, *Thymus leucotrichus* has the highest total cover area (12552.6 da) in the province level. The distribution of this area in terms of districts were found as Niksar 2334.9 da, Erbaa 2177.1 da, Reşadiye 1605.1 da, Almus 1514.7

da, Center 1396.3 da, Artova 1158.5 da, Zile 662.0 da, Turhal 593.7 da, Yeşilyurt 450.5 da, Sulusaray 373.3 da, Başçiftlik 151.6 da, Pazar 134.8 da, respectively (Figure 5). On the contrary, *Laurus nobilis* has the lowest total area (438.7 da) in the province level, and the distribution of this area in terms of districts were determined as Niksar 233.0 da, Erbaa 191.7 da, Reşadiye 13.4 da, and Almus 0.6 da (Figure 6).

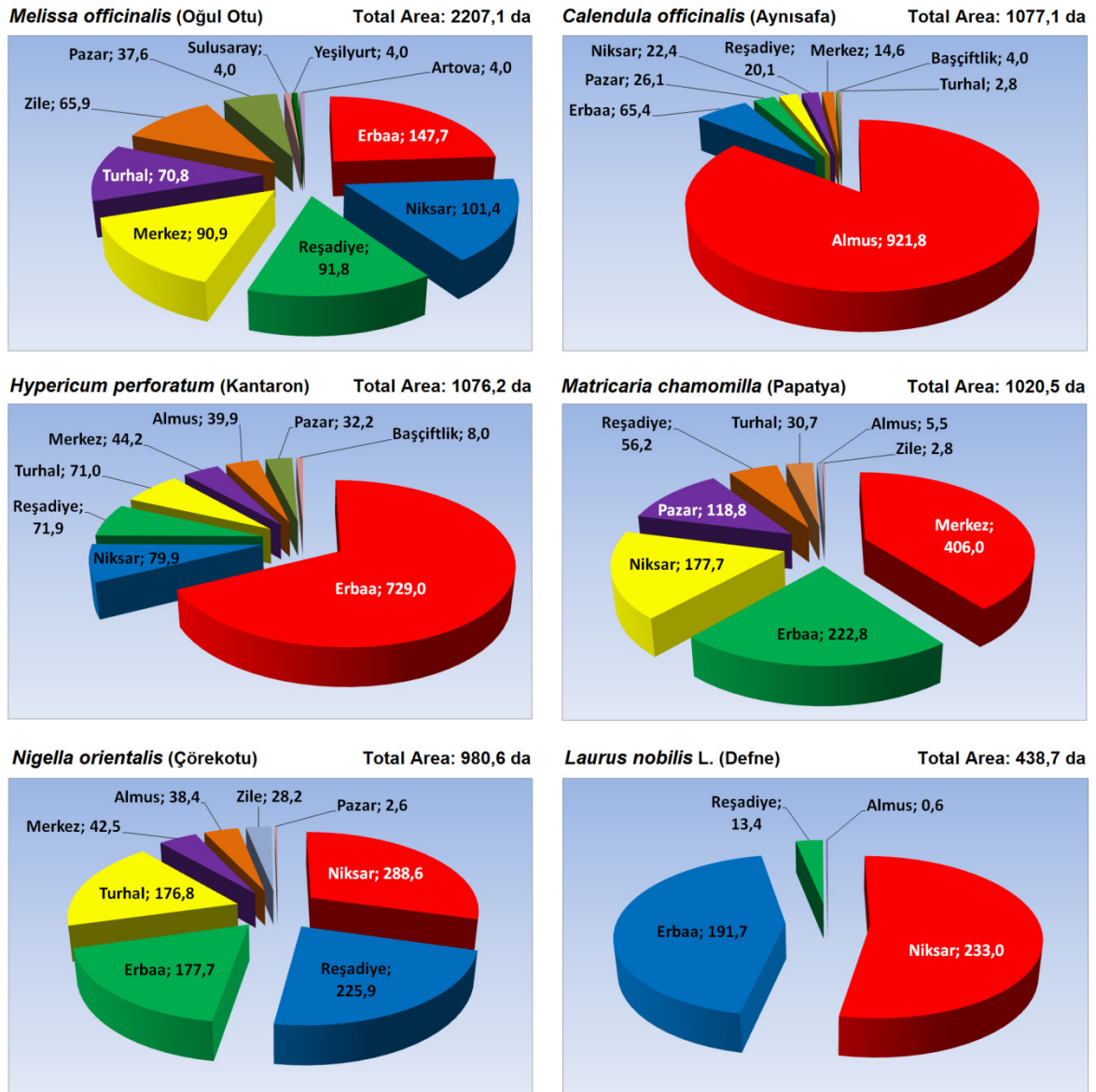


Figure 6. Distribution of cover areas (da) of determined economically important plant species in district basis (total species cover areas < 2250 da)

Şekil 6. Belirlenen ekonomik açıdan önemli bitki türlerinin ilçe bazında kaplama alanlarının dağılımı (toplam tür kaplama alanları < 2250 da olanlar)

4. Conglusion

As a result of this study, potential of economically important medicinal and aromatic plants of Tokat province were determined in concrete terms for the first time. Total 40 medicinal aromatic plant species that actively traded in the study area were determined, and 16 of these plants were found in Tokat flora. Among these species, cover areas of 14 species were found important, and they were statistically evaluated and interpreted. These species are *Thymus leucotrichus* (Dağ kekiği), *Thymus praecox* (Yayla kekiği), *Mentha pulegium* (Yarpuz-Nane), *Mentha piperita* (Tıbbi nane), *Rosa canina* (Kuşburnu), *Mentha spicata* (Eşek nanesi), *Allium sativum* L. (Sarımsak), *Trigonella foenum-graecum* (Çemen), *Melissa officinalis* (Melissa-Oğulotu), *Calendula officinalis* (Aynısafa), *Hypericum perforatum* (Sarı Kantaron), *Matricaria chamomilla* (Alman papatyası), *Nigella orientalis* (Çörekotu), and *Laurus nobilis* (Defne). Erbaa, Almus, Niksar and Reşadiye districts have stood out both in terms of total coverage area and species richness. These districts are located in the geographical locality known as Lower Kelkit Basin, where the plant biological diversity is high. This study has also brought a new methodological perspective for the researchers, and showed how to produce concrete information about planning by integrating scientific questionnaire techniques, plant surveys, and GIS applications. At the same time, outcomes of this study gave important clues to decision makers and investors by mapping the important plant species areas. Undoubtedly, this plant list will expand with more detailed studies.

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