PLANTS USED AS NATURAL DYE SOURCES IN TURKEY[1]

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Key Words: Dye plant; traditional handcraft; Turkey.

Until the 19th century, dyes produced from natural plants formed the basis of the cosmetics industry (Harmancıoğlu 1955). In 1868, as a result of the synthetic production of alizarin by Graeke and Leiberman, the production of natural dyes was replaced by synthetic dyes (Algan 1976). The technology used in the production of natural dyes was known in China as early as 3000 B.C. and among the Indians, Phoenicians, Hebrews, and Venetians in the 13th century A.D. and later was passed on to the Greeks and Romans. It was also known in Africa, Mexico, and Peru (Anonymous 1991; Eyüboğlu et al. 1983). The Turks successfully used the techniques of natural dying, which was about to fade because of migrations in the Middle Ages, and introduced them to the world (Eyüboğlu et al. 1983). The French learned to dye cotton with natural root dyes from the Turks in 1715 (Atayolu 1933).

The world-famous dye called ''Turkish red'' or ''Edirne red,'' used in Izmir carpets, silk textiles of Anatolia and Syria, and cotton products of Thessalia and Macedonia, is produced from *Rubia tinctorum* L. (Başlar and Oflas 1996, Baykara 1992; Baytop 1974).

High-quality dyes and genuine patterned Turkish goods became famous during the Ottoman times because the natural dying techniques and certain styles were organized under the control of the government (Öztürk 1982). *Rubia tinctorum* has been planted in Persia, Anatolia, Egypt, and India since the beginning of the 16th century; it was also planted in European countries. The Ottomans produced two thirds of world's root dyes in the 1700s (Eşberk and Harmancıoğlu 1951; Eşberk and Köşker 1945). In the foreign trade during the Ottoman Empire, the most important customer of root dye exports, which came after the export of cereal and silk, was England (Baykara 1992). The production of cotton and tobacco has taken the lead over the production of root dye plants mainly because synthetic dye substances are cheaper to produce (Baykara 1992; Enez 1987). Turkish carpets that are dyed with synthetic dyes have lost their importance. Before the entrance of synthetic dye substances into Turkey, valuable woven carpets and rugs were dyed with natural dyes, had light purity and didn't glide and fade.

Plant-originated dyes are still used success-

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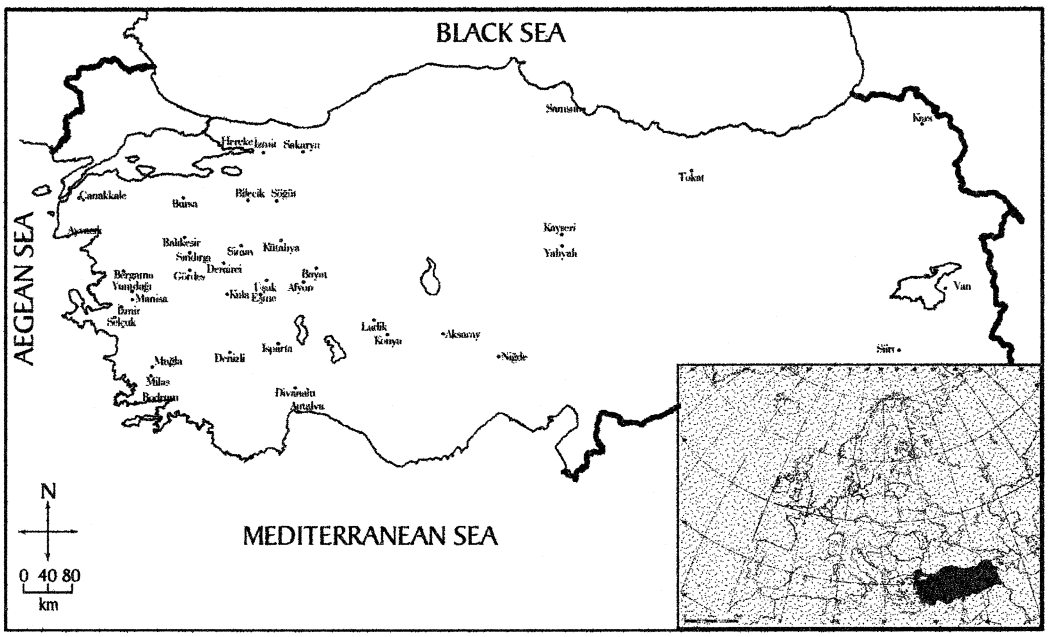

Fig. 1. Map of study area.

fully in several areas of arts and industry like carpets, rugs, textile, leather manufacturing, ceramics earthenware vessels, and fine arts (Doğan 1994). The use of natural dyes has begun to increase by the encouragement of the government with various scientific projects. Turkish carpets dyed with world famous ''Turkish Red'' have succeeded in taking a place among the most sought after carpets and outside demand has begun to increase rapidly. The export of carpets and rugs dyed by natural dyes produced in Yunt Mountain (Manisa), Ayvacik (Canakkale), Bayat (Afyon) has demonstrated the importance of traditional handcrafts using natural dyes. For this reason, we visited the regions where Turkish carpets and rugs were woven traditionally and observed the works. The aim of this study was to identify the regions of Turkey where traditional carpet-weaving methods are used. The study also aimed to identify types of dyeing substances used in those regions, whether natural or synthetic, and if they are natural, to identify the species and parts of the plant used as a natural dye source.

Material and Methods

In this study, the following important regions for the art of hand weaving were selected as the research area: İzmir (Bergama, Selçuk), Manisa (Yunt Dağı, Demirci, Kula, Gördes), Çanakkale (Ayvacık), Balıkesir (Sındırgı), Deniz, Muğla (Milas, Bodrum), Uşak (Eşme), Afyon (Bayat), Konya (Ladik), Kayseri (Yahyalı), Antalya (Divanaltı), Isparta, İzmit (Hereke), Sakarya, Bilecik (Söğüt), Bursa, Samsun, Tokat, Niğde, Aksaray, Kars, Van, Siirt (Fig. 1). In these cities, the plants used for natural dye production in each region were collected. After identification according to Davis (1965–1988), they were stored in the personal herbarium.

Table 1 shows the results of this study. The plants are presented in the table in alphabetical order. In the table, the families of the plant, whether it is distributed naturally, the parts of the plant (flower, leaf, stem, bark, etc.) used, and the color obtained from the plant are presented, and the findings are supported by other literature.

Results and Discussion

This study was carried out in the regions where handcrafts like rug- and carpet-weaving are produced by traditional methods in Turkey. It was found that the traditional methods are still common in weaving, but in some regions synthetic dyes are used and in others natural ones

TABLE 1. DYE PLANTS OF TURKEY.

Plant	Family	Part of plant	Color	Distribution	Supporting references
1. *Aesculus hippocastanum* L.	Hippocastanaceae	Bark of fruit	Brown, Green, Yellow	C	Anonymous 1991
2. *Agrimonia eupatoria* L.	Rosaceae	Leaf	Yellow, Green	N	Eyüboğlu et al. 1983
3. *Alkanna tinctoria* (L.) Tausch	Boraginaceae	Root	Yellow, Brown	N	Anonymous 1991; Eyüboğlu et al. 1983; Mert et al. 1993; Öztürk 1982; Seçmen et al. 1986; Uğur 1988
4. *Allium cepa* L.	Liliaceae	Dry outer leaf	Yellow, Brown	C	Anonymous 1991; Eyüboğlu et al. 1983; Mert et al. 1993; Öztürk 1982; Uğur 1988
5. *Alnus glutinosa* (L.) Gaertner	Betulaceae	Bark Leaf	Red, Brown Yellow	N	Anonymous 1991; Eyüboğlu et al. 1983; Mert et al. 1993; Uğur 1988
6. *Alnus orientalis* Decne.	Betulaceae	Bark Leaf	Red, Brown Yellow	N	Eyüboğlu et al. 1983
7. *Amygdalus communis* L.	Rosaceae	Leaf	Yellow	N	Anonymous 1991; Eyüboğlu et al. 1983; Mert et al. 1993; Uğur 1988
8. *Anthemis chia* L.	Asteraceae	Flower	Yellow, Green	N	Uğur 1988
9. *Anthemis tinctoria* L.	Asteraceae	Flower	Yellow	N	Anonymous 1991; Eyüboğlu et al. 1983; Mert et al. 1993; Öztürk 1982; Öztürk and Özçelik 1991
10. *Arbutus andrachne* L.	Ericaceae	Leaf	Yellow	N	Anonymous 1991; Eyüboğlu et al. 1983; Mert et al. 1993
11. *Armeniaca vulgaris* Lam.	Rosaceae	Leaf	Yellow	C	Mert et al. 1992
12. *Berberis vulgaris* L.	Berberidaceae	Root	Yellow	N	Anonymous 1991; Eyüboğlu et al. 1983; Mert et al. 1993; Uğur 1988
13. *Betula pendula* Roth.	Betulaceae	Leaf	Yellow	N	
14. *Brassica oleracea* L. var. *acephala* DC.	Brassicaceae	Leaf	Pink	C	Uğur 1988
15. *Brassica oleracea* L. var. *capitata* L.	Brassicaceae	Leaf	Pink	C	Uğur 1988
16. *Caltha polypetala* Hochst ex Lorent	Ranunculaceae	Aboveground	Yellow	N	Öztürk and Özçelik 1991
17. *Carlina oligocephala* Boiss. Kotschy.	Asteraceae	Leaf	Yellow	N	Öztürk and Özçelik 1991
18. *Carthamus tinctorius* L.	Asteraceae	Sepal of flower	Red, Yellow, Green	C	Anonymous 1991; Eyüboğlu et al. 1983; Mert et al. 1993; Öztürk 1982; Uğur 1988

TABLE 1. CONTINUED.

Plant	Family	Part of plant	Color	Distribution	Supporting references
18. *Carthamus tinctorius* L.	Asteraceae	Sepal of flower	Red, Yellow, Green	C	Anonymous 1991; Eyüboğlu et al. 1983; Mert et al. 1993; Öztürk 1982; Uğur 1988
19. *Castanea sativa* Miller	Fagaceae	Leaf, Bark	Yellow	N	Eyüboğlu et al. 1983; Mert et al. 1993; Uğur 1988
20. *Cerasus avium* (L.) Moench	Rosaceae	Bark Leaf	Orange Yellow, Grey	C	Mert et al. 1993
21. *Cerasus vulgaris* Miller	Rosaceae	Bark Leaf	Orange Yellow, Grey	C	Uğur 1988
22. *Cercis siliquastrum* L.	Caesalpiniaceae	Bark	Brown	N	Eyüboğlu et al. 1983; Mert et al. 1993; Uğur 1988
23. *Chrozophora tinctoria* (L.) Rafin	Euphorbiaceae	Aboveground	Purple	N	Mert et al. 1993; Öztürk and Özçelik 1991
24. *Cistus creticus* L.	Cistaceae	Leaf, Seed	Yellow, Brown	N	Anonymous 1991; Başlar et al. 2002; Eyüboğlu et al. 1983; Mert et al. 1993
25. *Cistus laurifolius* L.	Cistaceae	Leaf	Yellow, Brown	N	Başlar and Oflas 1990; Eyüboğlu et al. 1983; Mert et al. 1993
26. *Citrus sinensis* (L.) Osbeck.	Rutaceae	Bark of fruit	Brown	C	Anonymous 1991; Uğur 1988
27. *Convallaria majalis* L.	Liliaceae	Leaf	Orange, Yellow	N	Anonymous 1991; Eyüboğlu et al. 1983; Mert et al. 1993; Uğur 1988
28. *Corylus avellana* L.	Betulaceae	Leaf, Bark of fruit	Yellow, Green	N	Mert et al. 1993; Uğur 1988
29. *Corylus colurna* L.	Betulaceae	Leaf, Bark of fruit	Yellow, Green	N	Mert et al. 1993; Uğur 1988
30. *Corylus maxima* Miller	Betulaceae	Leaf, Bark of fruit	Yellow, Green	N	Mert et al. 1993; Uğur 1988
31. *Cotinus coggyria* Scop.	Anacardiaceae	Leaf, Shoot	Yellow	N	Anonymous 1991; Eyüboğlu et al. 1983; Mert et al. 1992
32. *Crocus sativus* L.	Iridaceae	Stigmata of flower	Orange, Yellow	N	Anonymous 1991; Eyüboğlu et al. 1983; Mert et al. 1993; Öztürk 1982
33. *Cryptomeria japonica* D. Don.	Taxodiaceae	Young shoot, Leaf, Bark	Brown	C	Eyüboğlu et al. 1983; Mert et al. 1992
34. *Cupressus sempervirens* L.	Cupressaceae	Cone	Pink, Brown	N	Eyüboğlu et al. 1983; Mert et al. 1993; Uğur 1988
35. *Curcuma longa* L.	Zingiberaceae	Root	Yellow	C	Eyüboğlu et al. 1983; Uğur 1988
36. *Cydonia oblonga* Miller	Rosaceae	Leaf	Brown	C	Anonymous 1991; Eyüboğlu et al. 1983; Mert et al. 1993; Uğur 1988
37. *Dahlia variabilis* Hort	Asteraceae	Flower	Yellow	C	Eyüboğlu et al. 1983; Mert et al. 1992

TABLE 1. CONTINUED.

Plant	Family	Part of plant	Color	Distribution	Supporting references
38. *Daphne gnidioides* Jaub. et Spach	Thymelaeaceae	Aboveground	Yellow, Green	N	Eyüboğlu et al. 1983; Mert et al. 1993; Uğur 1988
39. *Datisca cannabina* L.	Datiscaceae	Aboveground	Yellow	N	Mert et al. 1992
40. *Erica arborea* L.	Ericaceae	Stem, Leaf	Yellow	N	Enez 1987; Mert et al. 1992
41. *Erica manipuliflora* Salisb.	Ericaceae	Aboveground	Yellow	N	Anonymous 1991; Uğur 1988
42. *Eucalyptus camadulensis* Dehn.	Myrtaceae	Leaf Bark	Green Brown	C	Anonymous 1991; Eyüboğlu et al. 1983; Mert et al. 1993; Uğur 1988
43. *Euphorbia biglandulosa* Desf.	Euphorbiaceae	Aboveground	Yellow	N	Anonymous 1991; Eyüboğlu et al. 1983; Mert et al. 1993; Uğur 1988
44. *Euphorbia tinctoria* Boiss. & Huet	Euphorbiaceae	Aboveground	Blue, Yellow	N	Uğur 1988
45. *Euphorbia veneta* Wild.	Euphorbiaceae	Aboveground	Yellow	N	Anonymous 1991; Eyüboğlu et al. 1983
46. *Ficus carica* L.	Moraceae	Leaf	Green	N	Uğur 1988
47. *Filipendula ulmaria* (L.) Maxim.	Rosaceae	Rhizome Stem, Leaf	Black Green	N	Mert et al. 1993
48. *Frangula alnus* Miller	Rhamnaceae	Leaf	Yellow	N	Enez 1987; Mert et al. 1992
49. *Genista tinctoria* L.	Fabaceae	Stem, Flower	Yellow	N	Anonymous 1991; Eyüboğlu et al. 1983; Mert et al. 1993; Öztürk 1982; Uğur 1988
50. *Glycyrrhiza glabra* L.	Fabaceae	Leaf	Yellow	N	Mert et al. 1992; Uğur 1988
51. *Gossypium baradense* L.	Malvaceae	Leaf	Yellow	C	
52. *Gossypium herbaceum* L.	Malvaceae	Leaf	Yellow	C	
53. *Gossypium hirsutum* L.	Malvaceae	Leaf	Yellow	C	
54. *Hordeum vulgare* L.	Poaceae	Stem, Leaf	Yellow	C	Uğur 1988
55. *Hypericum calycinum* L.	Hypericaceae	Leaf	Yellow, Brown	N	Anonymous 1991; Eyüboğlu et al. 1983; Mert et al. 1993
56. *Hypericum empetrifolium* Willd.	Hypericaceae	Aboveground	Yellow, Green	N	Anonymous 1991; Eyüboğlu et al. 1983; Mert et al. 1993
57. *Hypericum perforatum* L.	Hypericaceae	Leaf	Yellow, Green, Brown	N	Anonymous 1991
58. *Inula viscosa* (L.) Aiton	Asteraceae	Aboveground	Yellow	N	Mert et al. 1992
59. *Iris germanica* L.	Iridaceae	Corolla of flower	Green	N	Anonymous 1991
60. *Isatis tinctoria* L.	Brassicaceae	Leaf, Stem	Blue	N	Anonymous 1991; Mert et al. 1993; Öztürk 1982; Uğur 1988

TABLE 1. CONTINUED.

Plant	Family	Part of plant	Color	Distribution	Supporting references
61. *Juglans regia* L.	Juglandaceae	Bark, Root, Leaf, Bark of fruit	Brown	C	Anonymous 1991; Eyüboğlu et al. 1983; Mert et al. 1993; Öztürk 1982; Öztürk and Özçelik 1991; Uğur 1988
62. *Juniperus communis* L.	Cupressaceae	Leaf	Green	N	Mert et al. 1992
63. *Laurocerasus officinalis* Roemer.	Rosaceae	Leaf	Yellow	N	Anonymous 1991; Eyüboğlu et al. 1983; Mert et al. 1993; Uğur 1988
64. *Lawsonia inermis* L.	Lythraceae	Leaf	Brown	C	Anonymous 1991; Eyüboğlu et al. 1983; Uğur 1988
65. *Ligustrum vulgare* L.	Oleaceae	Fruit	Green, Yellow	N	Mert et al. 1993
66. *Linaria grandiflora* Desf.	Scrophulariaceae	Flower	Red	N	Baylav 1963; Mert et al. 1992
67. *Malva sylvestris* L.	Malvaceae	Leaf	Green	N	Mert et al. 1992
68. *Matricaria chamomilla* L.	Asteraceae	Flower	Yellow	N	Mert et al. 1992
69. *Mentha spicata* L.	Lamiaceae	Aboveground	Grey, Brown, Green	N	Anonymous 1991; Eyüboğlu et al. 1983; Mert et al. 1993; Uğur 1988
70. *Mespulus germenica* L.	Rosaceae	Leaf	Brown, Green	N	Anonymous 1991; Eyüboğlu et al. 1983; Mert et al. 1993; Uğur 1988
71. *Morus alba* L.	Moraceae	Leaf	Yellow	C	Mert et al. 1992
72. *Morus nigra* L.	Moraceae	Leaf	Yellow	C	Mert et al. 1992
73. *Morus rubra* L.	Moraceae	Leaf	Yellow	C	Mert et al. 1992
74. *Myrtus communis* L.	Myrtaceae	Leaf	Yellow	N	Anonymous 1991; Mert et al. 1993; Öztürk 1982
75. *Nicotiana tabacum* L.	Solanaceae	Leaf	Green, Brown	C	Anonymous 1991
76. *Olea europaea* L.	Oleaceae	Leaf	Yellow, Green, Grey, Brown	N	Anonymous 1991; Eyüboğlu et al. 1983; Mert et al. 1993; Uğur 1988
77. *Papaver rhoeas* L.	Papaveraceae	Flower	Grey	N	Mert et al. 1992
78. *Papaver somniferum* L.	Papaveraceae	Flower	Purple	C	Mert et al. 1992
79. *Persica vulgaris* Miller	Rosaceae	Leaf	Yellow	C	
80. *Phillaria latifolia* L.	Oleaceae	Fruit	Green	N	Anonymous 1991; Eyüboğlu et al. 1983; Mert et al. 1993
81. *Phytolacca americana* L.	Phytolaccaceae	Fruit	Red, Yellow, Green	Nt	Anonymous 1991; Eyüboğlu et al. 1983; Mert et al. 1992; Seçmen et al. 1986; Öztürk 1982
82. *Pinus brutia* Ten.	Pinaceae	Bark	Brown	N	Anonymous 1991; Eyüboğlu et al. 1983; Mert et al. 1993; Uğur 1988
83. *Pistacia lentiscus* L.	Anacardiaceae	Leaf	Yellow	N	Anonymous 1991; Mert et al. 1992

TABLE 1. CONTINUED.

Plant	Family	Part of plant	Color	Distribution	Supporting references
84. *Pistacia terebinthus* L.	Anacardiaceae	Leaf	Yellow, Grey, Green	N	Anonymous 1991; Eyüboğlu et al. 1983; Mert et al. 1993
85. *Platanus orientalis* L.	Platanaceae	Bark	Red	N	Mert et al. 1992
86. *Polygonum cognatum* Meiss.	Polygonaceae	Leaf	Yellow	N	
87. *Prunus spinosa* L.	Rosaceae	Bark	Green, Brown	N	Anonymous 1991; Eyüboğlu et al. 1983; Mert et al. 1993; Öztürk 1982
88. *Pteridium acquilinum* (L.) Kuhn	Hypolepidaceae	Aboveground	Green	N	Anonymous 1991; Eyüboğlu et al. 1983; Öztürk 1982
89. *Punica granatum* L.	Punicaceae	Bark of fruit	Yellow	N	Anonymous 1991; Eyüboğlu et al. 1983; Mert et al. 1993; Öztürk and Özçelik 1991; Uğur 1988
90. *Pyrus communis* L.	Rosaceae	Leaf	Brown	C	Mert et al. 1992
91. *Quercus ithaburensis* Decne subsp. *macrolepis* (Kotschy) Hedge et Yalt.	Fagaceae	Cupula of fruit	Brown	N	Anonymous 1991; Eyüboğlu et al. 1983; Doğan et al. 2000; Mert et al. 1993; Öztürk 1982
92. *Reseda lutea* L.	Resedaceae	Aboveground	Yellow	N	Anonymous 1991; Doğan 2001; Eyüboğlu et al. 1983; Mert et al. 1993; Öztürk and Özçelik 1991; Uğur 1988
93. *Reseda luteola* L.	Resedaceae	Aboveground	Yellow	N	Anonymous 1991; Doğan 2001; Öztürk 1982
94. *Rhamnus petiolaris* Boiss.	Rhamnaceae	Fruit	Yellow	N	Anonymous 1991; Mert et al. 1992; Öztürk 1982
95. *Rhamnus tinctorius* Walds & Kit.	Rhamnaceae	Seed	Yellow, Green, Brown	N	Anonymous 1991; Eyüboğlu et al. 1983; Mert et al. 1993; Uğur 1988
96. *Rheum ribes* L.	Polygonaceae	Root	Blue	N	Öztürk and Özçelik 1991
97. *Rhus coriaria* L.	Anacardiaceae	Fruit	Yellow, Green, Brown, Grey	N	Anonymous 1991; Eyüboğlu et al. 1983; Mert et al. 1993; Öztürk and Özçelik 1991; Uğur 1988
98. *Rubia tinctorium* L.	Rubiaceae	Rhizome, Root	Red	N	Anonymous 1991; Başlar and Oflas 1990; Mert et al. 1993; Seçmen et al. 1986; Öztürk 1982; Öztürk and Özçelik 1991; Uğur 1988
99. *Rubus canescenc* DC.	Rosaceae	Young shoot Fruit	Yellow, Green, Grey Brown	N	Eyüboğlu et al. 1983; Mert et al. 1992
100. *Rumex obtusifolius* L. subsp. *subalpinus* (Schur) Celak	Polygonaceae	Leaf, Seed	Green, Yellow	N	Başlar and Oflas 1990; Eyüboğlu et al. 1983; Mert et al. 1993; Uğur 1988

TABLE 1. CONTINUED.

Plant	Family	Part of plant	Color	Distribution	Supporting references
101. *Rumex patientia* L.	Polygonaceae	Leaf	Green, Yellow	N	Anonymous 1991; Öztürk 1982
102. *Salvia officinalis* L.	Lamiaceae	Aboveground	Yellow, Brown, Green	N	Eyüboğlu et al. 1983
103. *Salvia tomentosa* Mill.	Lamiaceae	Aboveground	Yellow, Grey, Green	N	Mert et al. 1993
104. *Sambucus nigra* L.	Caprifoliaceae	Fruit Leaf	Black, Purple Yellow, Green	N	Anonymous 1991; Eyüboğlu et al. 1983; Mert et al. 1992; Uğur 1988
105. *Sanguineria canadensis* L.	Papaveraceae	Root, Stem	Orange, Pink	C	Eyüboğlu et al. 1983
106. *Senecio jacobaea* L.	Asteraceae	Flower	Yellow, Green	N	Eyüboğlu et al. 1983; Mert et al. 1992
107. *Senecio vulgaris* L.	Asteraceae	Flower	Yellow, Green	N	Eyüboğlu et al. 1983
108. *Spartium junceum* L.	Fabaceae	Stem, Flower	Yellow	N	Anonymous 1991; Mert et al. 1993; Mert et al. 1996; Uğur 1988
109. *Spiraea hypericifolia* L.	Rosaceae	Root Stem, Leaf	Black Yellow	N	Anonymous 1991
110. *Tanacetum vulgare* L.	Asteraceae	Leaf, Flower	Yellow	N	Eyüboğlu et al. 1983; Mert et al. 1992
111. *Taxus baccata* L.	Taxaceae	Leaf Bark	Yellow, Green Pink	N	Eyüboğlu et al. 1983; Mert et al. 1992
112. *Thymus zygioides* Griseb.	Lamiaceae	Aboveground	Yellow, Grey, Green, Brown	N	Anonymous 1991; Eyüboğlu et al. 1983; Mert et al. 1993; Uğur 1988
113. *Tilia argentea* Desf.	Tiliaceae	Bark, Flower	Brown	N	Mert et al. 1992; Uğur 1988
114. *Tilia rubra* DC.	Tiliaceae	Bark, Flower	Brown	N	Mert et al. 1992; Uğur 1988
115. *Triticum sativum* L.	Poaceae	Stem, Leaf	Yellow	C	Uğur 1988
116. *Trollius ranunculinus* (Swith) Stearn	Ranunculaceae	Root	Brown	N	Öztürk and Özçelik 1991
117. *Urtica dioica* L.	Urticaceae	Aboveground	Yellow	N	Mert et al. 1993; Uğur 1988
118. *Urtica pilulifera* L.	Urticaceae	Aboveground	Yellow	N	Mert et al. 1993; Uğur 1988
119. *Vaccinium arctostaphyllos* L.	Ericaceae	Fruit	Green	N	Uğur 1988
120. *Vaccinium myrtillus* L.	Ericaceae	Fruit	Purple	N	Anonymous 1991; Eyüboğlu et al. 1983; Mert et al. 1993; Öztürk 1982; Uğur 1988
121. *Vitex agnus-castus* L.	Verbenaceae	Leaf	Green	N	Anonymous 1991; Doğan and Mert 1998; Eyüboğlu et al. 1983; Mert et al. 1993; Öztürk 1982
122. *Vitis vinifera* L.	Vitaceae	Leaf	Yellow, Green	C	Anonymous 1991; Eyüboğlu et al. 1983; Mert et al. 1993; Öztürk 1982
123. *Zoegea leptaurea* L.	Asteraceae	Flower	Yellow	N	Öztürk and Özçelik 1991

N: Native, C: Cultivated, Nt: Naturalized.

are used in the dyeing processes of the products. It was identified that in those regions the number of plant species used as a dye source was 123 (from 50 families). Most of these findings were supported by the literature (Table 1).

Apart from *Pteridium aquilinum* (L.) Kuhn (Hypolepidaceae), which is a member of Pteridophyta, all 49 families (122 species) are members of the division of Spermatophyta. Among them, the families of Cupressaceae (*Cupressus sempervirens* L., *Juniperus communis* L.), Pinaceae (*Pinus brutia* Ten.), Taxaceae (*Taxus baccata* L.), and Taxodiaceae (*Cryptomeria japonica* D.Don) are members of Gymnospermae, and the rest of the 46 families (118 species) are members of Angiospermae. Among the Angiospermae members, Liliaceae (*Allium cepa* L., *Convallaria majalis* L.), Iridaceae (*Crocus sativus* L., *Iris germanica* L.), Poaceae (*Hordeum vulgare* L., *Triticum sativum* L.), and Zingiberaceae (*Curcuma longa* L.) families are Monocotyledoneae, and the rest of the 42 families (111 species) are Dicotyledoneae. The family Rosaceae has the largest number of taxa in the region with 14 species, followed by Asteraceae with 11 species, Betulaceae with six species and Ericaceae with five species (Fig. 2). The families represented by four species in the region are Anacardiaceae, Euphorbiaceae, Lamiaceae, Malvaceae, Moraceae and Polygonaceae; by three species are Fabaceae, Hypericaceae, Oleaceae, Papaveraceae and Rhamnaceae; by two species are Brassicaceae, Cistaceae, Cupressaceae, Fagaceae, Iridaceae, Liliaceae, Myrtaceae, Poaceae, Ranunculaceae, Resedaceae, Tiliaceae, and Urticaceae. The rest of the 23 families are represented by only one species.

Ninety-two plant species used in dyeing are native to Turkey; 30 of them are cultivated and one of them (*Phytolacca americana* L.) is naturalized. The results showed that the number of dye plants in this region is very high (75% of 123). This situation can be explained by the rich flora of the region. With over 9000 species, Turkey is one of the richest countries of Europe and the Middle East from the flora point of the view. Among them, more than 3000 are distributed as endemics. As a parallel of this floristic richness, the number of dye plants is relatively high in Turkey.

It is reported that natural dyeing substances are also raised from non-flowering plants (Eyüboğlu et al. 1983). According to Harmancıoğlu (1982), the dyeing substances mentioned above are produced from different organs like flower, fruit, leaf, stem, and root of plants. As a result of our investigation, it was identified that just one part or combination of more than one parts or all aboveground parts of the plants may be used as dye substances. For example, leaves of 62 species, flowers of 19 species, all aboveground parts of 19 species, barks of 14 species, stems of nine species, roots of nine species, shoots of three species, and seeds of three species are used as dye substances in the region (Fig. 3).

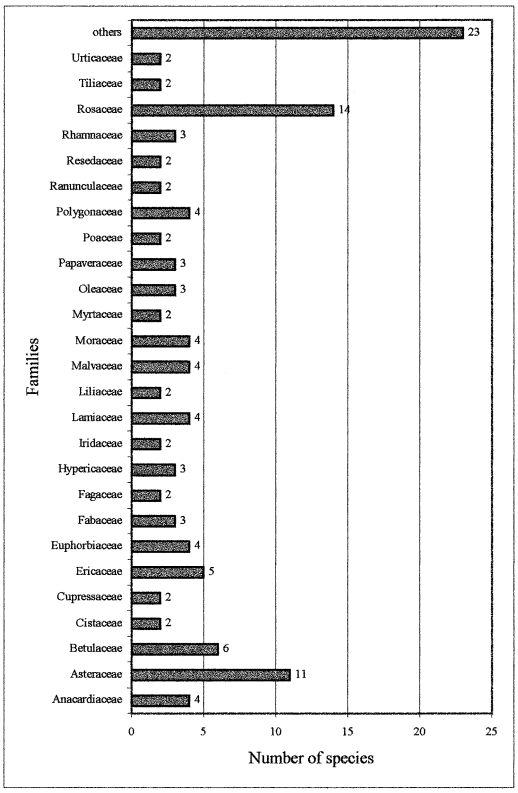

Fig. 2. The number of species according to families.

According to our study, from the investigated plants 10 different colors are gained. Some of these colors can be obtained from one plant, or different colors can be produced from different parts of the same plant. It is seen that the natural dyes obtained from these plants include three main colors: yellow, red, and blue. Uğur (1988) and Mairet (1948) reported that other colors can be produced from one plant, or from combina-

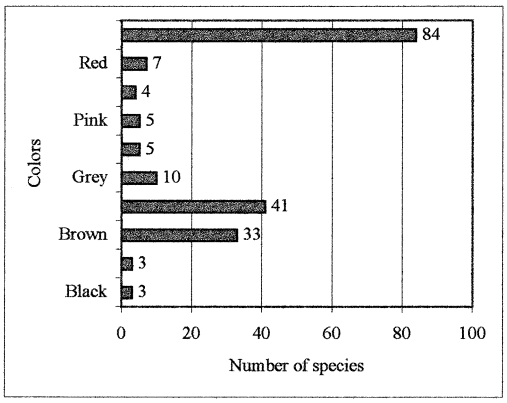

Fig. 3. The colors obtained from dye plants and their distributions according to the number of species.

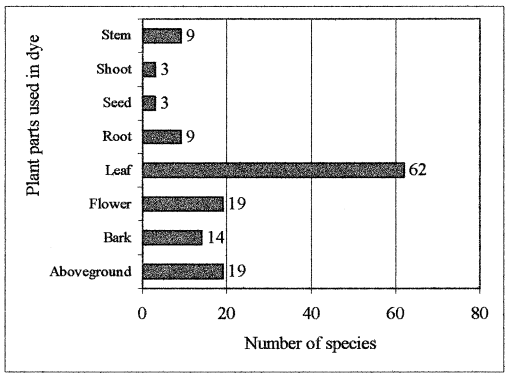

Fig. 4. Plant parts used in dye extraction and their distributions according to the number of species.

tions of the parts of different plants. These findings reported by the authors were supported by the results of our investigation. In our investigation, in the regions where natural dyeing is still alive, it was identified that the colors obtained from the number of species are as follows: yellow from 84 species, green from 41 species, brown from 33 species, grey from 10 species, red from seven species, pink from five species, orange from five species, purple from four species, blue from three species, and black from three species (Fig. 4). The results clearly show that the production of same color from different plants, like yellow obtained from 84 different plant species, illustrates how Turkey has a rich potential from the natural dye plants point of view.

Regardless of geographical regional differences, our study showed that in all regions the plant species known as ''Turkish red'' (*R. tinctorum*) is used. This plant, used during the ancient times, still has its importance and is still used by the local producers (Anonymous 1991).

Processes of dye production from plant parts are as follows: Plant parts are collected during the flowering or fruiting period. These parts are air dried in a shadowy place. They are then ground to a form of powder, and are stored in paper or cotton bags. For dyeing, one kg of wool fibers, 40 L of water and one kg of dried and ground plant parts are put into a large boiler pan and boiled over a low-flame fire for one hour with the wool fibers inside. To prevent water loss, the pan lid should be kept closed. Time to time, the mixture should be stirred to make dyeing homogeneous. After one hour of boiling, the mixture is left to cool. The next day, dyed wool fibers are taken out of the pan, rinsed with water, and hung on strings to air-dry. The liquid mixture remaining in the pan can be used for the second or even for the third time for dyeing the new wool fibers. However, the color of newly dyed materials is lighter and their purities are lower.

Although the dyeing substances are directly bound to the fibers themselves, the outcome is not good enough. Therefore, the producers need an extra substance to make the boundings tight by chemical or mechanical bindings, and the substance must not dissolve in the water. This substance is called mordant (Mert et al. 1992). The resistance of dyed fibers against rubbing, washing, sweat, temperature, light, etc. is called purity (Uğur 1988). The purity of dye of plants is very high (Anonymous 1991). To make dying substances purer, and to produce different colors, the use of mordant substances is common among producers. The mordant substances can be two types: natural and synthetic. The natural ones are cupula of oak, juice of unripe grape, vinegar, seville orange juice, spurge secretion, ox urine, rock algae, clay, lime, bread yeast, wood ash, mud with animal urine, etc. The chemical mordants are potassium aluminium sulfate-12-water ($KAl(SO_4)_2 \cdot 12H_2O$), copper (II) sulphate pentahydrate ($CuSO_4 \cdot 5H_2O$), iron (II) sulphate heptahydrate ($FeSO_4 \cdot 7H_2O$), sodium sulphate decahydrate ($NaSO_4 \cdot 10H_2O$), potassium dichromate ($K_2Cr_2O_7$), tin (II) chloride ($SnCl_2$), potassium bitartrate ($KHC_4H_4O_6$), etc.

Mordants in dyeing can be used in the following three ways:

1. Pre-application of mordant substance: In this application, wool fibers are kept in water-mordant mixture for 24 hours. Then, these fibers are dyed as explained above.
2. Mordanting while dying: Mordant is added to the boiler pan with dried and ground plant parts and the wool fibers are added to the pan for dyeing as explained above.
3. Post-application of mordant substance: Dyed material is put into the mordant water mixture for 24 hours. Then it is taken out from the mixture, rinsed with the water, and hung on strings for air-drying.

The amount of mordant needed for better results depends on the nature of the mordant substance. It can be changed from 3% to 20% of the amount of dyed wool fiber.

Carpets and rugs dyed by synthetic dyeing substances have less value from the quality and economy point of view because of their weak purity and fading characteristics (Öztürk 1982). Synthetic dyeing substances are preferred by the producers because, by using them, all colors can be produced and the dyeing process is simple. However, the difficulty of the deposition of the waste of the synthetic dying substances causes an environmental problem of throwing them away without any process of purification. Although the dyeing method in which the solvent is used reduces the problem, the purification of the wastewater requires extra effort and money (Shreve and Brink 1985). Since synthetic dyeing substances are not broken down in the water and are not hygienic, it can be said that natural dyes not only contribute to the quality of the traditional handcrafts like carpets and rugs, but also keep the environment clean.

CONCLUSION

Although Turkey has rich plant diversity, it was observed that natural dyeing was not common in some parts of the regions where traditional handcraft production is still alive. Encouraging the use of natural dyeing in these regions can make valuable contributions to the economy and the culture of the regions. Currently, in some regions, due to the cheapness and the ease of application, synthetic dyes are preferred by local producers. However, it is well known that authentically and from the quality point of view fibers dyed by natural dyes are more valuable and that buyers pay higher prices. Because of its geographical position, Turkey has a rich natural plant diversity as a natural dye source. Therefore, investigation of such plants for identification purpose and the use of them by local producers should be encouraged. We believe that the restart of the cultivation of *R. tinctorium,* which was famously known in the world as ''Turkish Red'' especially during the 1800s, and other natural dye plants, and the development of new easier methods of application is inevitable for the culture and the economy of the regions.

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