

IMPORTANCE OF PHYTOCHEMICAL SCREENING STUDIES AND RESEARCHES CARRIED ON IN TURKEY

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SUMMARY

Phytochemical screening studies are the first step of phytochemical investigations. These help researchers in choosing the proper plant/plants on which they want to study with a distinct group of compound. Our research group have dealt with the plants both sistematically and phytochemically in certain districts. In the first screening study(between 1981-1983) 340 species growing in Ermenek-Mut-Gölnar triangle on the Taurus Mountains belonging to ten families that are known as bearing medicinal plants were examined for their volatile oil, alkaloid, saponin, cardioactive glycoside, coumarin, flavonoid, anthocyanin, anthraquinone derivative and tannin content. By the result of this study we proposed about 50 plants being worthy for further studies. Our second study(between 1987-1990) was carried on the plants of Idris Mountain(near Ankara). 268 species from 48 families were screened as done in previous study. The results show that 11 families of 48 were rich in saponin content, among them we can recommend at least 6 species for further investigations. 114 species of 268 gave strong flavonoid reaction while 142 of 268 species gave positive reaction for coumarin.

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INTRODUCTION

Phytochemical screening studies are one of the research methods and are the first step of phytochemical investigations.

The procedure of such a study is generally and briefly as follows. First of all a distinct region, an area or a mountain is chosen from a part of the country where the flora is less known. Several excursions are made to the area in different seasons of the year and at different vegetation periods of the plants. Research material are kept either in small bags or in ethanol 70°. The collection material is placed and kept in the herbarium after determination. This is important because reliable results depend on correct sources, I mean one has to be sure of the plant which he works on.

Screening studies can be evaluated from two aspects; at the end of this kind of a study new taxa, new endemic plants, new localities etc. can be found; these are valuable findings both for taxonomy and for the flora of the country. On the other hand, phytochemical screenings studies throw light on the phytochemical researches; thus species which contain different active principles such as alkaloids or volatile oils or coumarins etc. are established, and their richness are pointed out. These knowledge is quite important for a researcher at the very beginning also in choosing the plant. To have healthy results, those who intend to work in the field of phytochemistry should cooperate the researchers who have knowledge and experience in plant taxonomy.

The flora of Anatolia is very rich and includes very different species most of them haven't been investigated phytochemically yet, but the existence of some plants among them, which can be used medicinally or as raw material is possible(1).

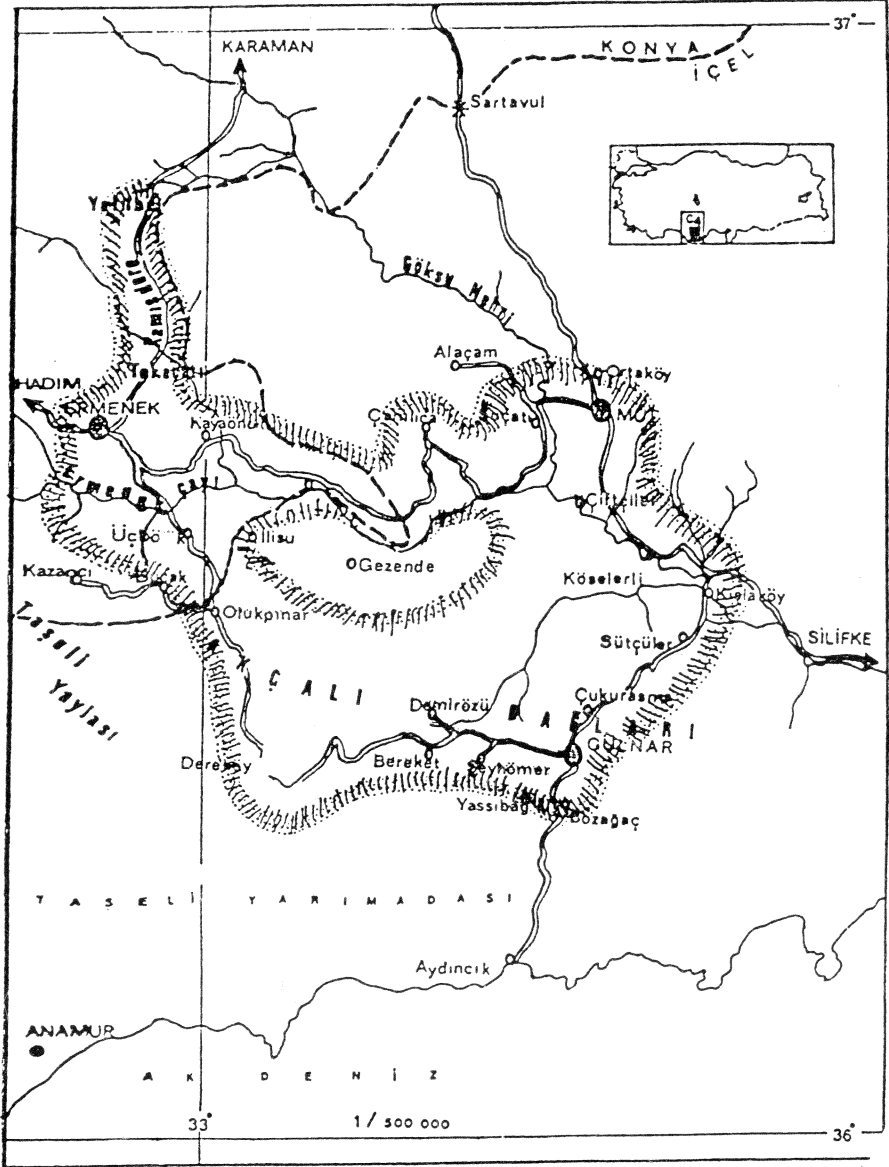
The number of screening studies in our country is not much, one has been carried on by two members of Pharmacognosy Department, Baytop and Çubukçu from University of İstanbul Faculty of Pharmacy in 1968(2). The other two were realised by our research group, from Pharmaceutical Botany Department of University of Ankara(3-9). There are also one research carried on by two researchers one of which a Pharmacist from our Pharmaceutical Botany Dept. and the other from Faculty of Science, Botany Dept.(a Taxonomist) as we have expressed above(10).

MATERIAL AND METHOD

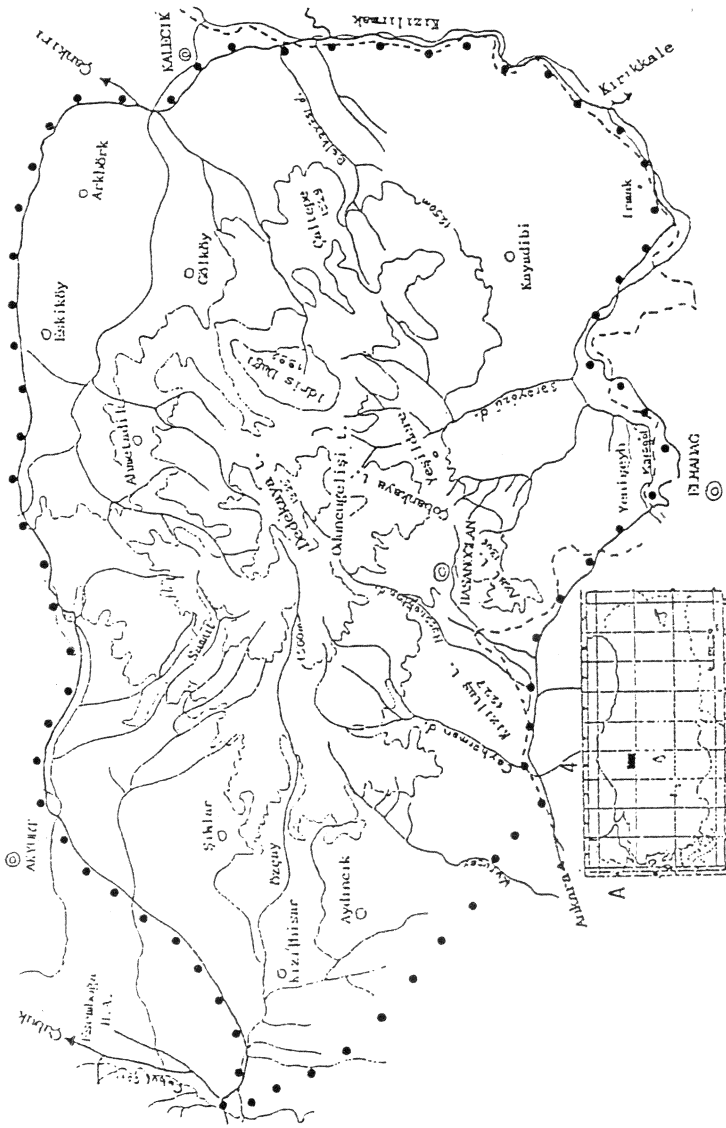
Our first wide research started in 1981, in Ermenek-Mut-Gölnar triangle on Taurus mountains(Map 1). Eight excursions were made between the years of 1981 and 1983, from May to September. Specimen from 422 taxa have been collected. These include 158 genera 392 species, 20 subspecies and 10 varietas(Table 1,2).

Our second research district was İdris Dağı, a mountain at north-east of Ankara about 60 km far from the city and the highest point is about 1992 meters(Map 2). The area includes A₄ square according to the Davis's grid system. Ten excursions from April to September were made to the area between 1987 and 1990. 410 taxa belonging 59 families were collected and screened. The taxa which found very few were left out of the screening.

Phytochemical screening methods are generally classical that need small amount of plants usually 1-3 g from powdered material(7,11-14) and symbol '+' is used to express the existence or amount of an active principle.



Map 1. Ermenek-Mut-Gülnar district



Map 2. Idris Dağı The map of research area. ○ Village, ⊙ Town, — Road, ——— Railway, ● The border of research area.

Table 1. Numerical Distribution of the Taxa in the Families in Ermenek-Mut-Gölnar District

| Families | Genera | Species | Subsp. | Var. | Total Number of Taxa |
|------------------|--------|---------|--------|------|----------------------|
| Leguminosae | 32 | 97 | 6 | 5 | 108 |
| Compositae | 51 | 93 | 4 | 5 | 102 |
| Labiatae | 24 | 63 | 6 | - | 69 |
| Liliaceae | 14 | 47 | 1 | - | 48 |
| Scrophulariaceae | 9 | 29 | 2 | - | 31 |
| Ranunculaceae | 7 | 20 | - | - | 20 |
| Papaveraceae | 6 | 20 | - | - | 20 |
| Rosaceae | 11 | 15 | 1 | - | 16 |
| Rhamnaceae | 3 | 5 | - | - | 5 |
| Solanaceae | 1 | 3 | - | - | 3 |

RESULTS AND DISCUSSION

Distribution of the species of Ermenek-Mut-Gölnar in accordance with to the families are given in Table 1. Among these plants 95 taxa found to be endemic, 16 of which are local endemics. The taxa which found rarely or have no economic value were left out of the screening, so 340 species examined.

Now, let's have a look at the screening results (Table 2). The table only one family (Leguminosae) is given as an example, because there are still many tables like that. From this family 108 taxa have been identified, 7 were new record for C₄ square; 22 taxa were endemics and one was local endemic. 85 specimen among them examined for their active principles. Analysis were carried on the plant organs where the occurrence of active principle is possible according to the literature, so, cardioactive glycoside, volatile oil, flavonoid, anthocyan, saponin, anthraquinone, coumarine and tannins were determined. The occurrence of compounds marked with symbol '+'; the number of '+' indicates the intensity of the reaction (colour or precipitate); empty space means that determination hasn't been done.

Table 2. Phytochemical screening on Leguminosae plants of Ermenek-Mut-Gülnar district

| Screened species | Month | Used part | Volatile oils | Tannins | Alkaloids | Coumarins | Flavonoids | Anthocyanins | Saponins(F.I.) | Cardiac Glycosides | Anthraquinones |
|---------------------------------|--------|------------|---------------|---------|-----------|-----------|------------|--------------|----------------|--------------------|----------------|
| LEGUMINOSAE | | | | | | | | | | | |
| Anagyris foetida | 5 | f f,l | - | + | +++ | ++ | + | - | + | - | - |
| Anthyllis tetraphylla | 4 | f f,l | - | | | - | ++ | - | 125 | - | - |
| vulneraria ssp hispidissima | 6 | f f,l | - | | | - | ++ | - | | - | - |
| ssp.praepropera | 6 | f f,l | - | + | | - | +++ | ++ | 100 | - | - |
| ssp.variegata | 7* | f f,l | - | - | | - | ++ | - | 100 | - | - |
| Astragalus acicularis | 8 | h | - | + | | - | + | - | | - | - |
| angustifolius | 6 | f,l | - | | | - | ++ | - | | - | - |
| asterias | 6 5 | h fr,l | - | + | | (+) | ++ | + | | - | - |
| cadmicus | 6 | h | - | + | | - | + | - | | - | - |
| chrysochlorus | 6 | h | - | + | | (+) | + | - | | - | - |
| commagenicus | 6 | l | - | + | | - | ++ | + | | - | - |
| gossypinus | 6 | h | - | + | | - | ++ | - | | - | - |
| hamosus | 6 | fr,l fr | - | + | | - | +++ | - | | - | - |
| leporinus | 4 | h | - | + | | - | +++ | - | | - | - |
| lydius | 6 | h | - | + | | (+) | + | +++ | | - | - |
| macrocephalus ssp. finitimus | 6 | l f | - | + | | (+) | +++ | - | | - | - |
| mesogitanus | 6 | f,l | - | + | | - | +++ | +++ | | - | - |
| pinetorum | 6 | h | - | + | | - | +++ | - | | - | - |

(Continued)

| | Month | Used part | Volatile oils | Tannins | Alkaloids | Coumarins | Flavonoids | Anthocyanins | Saponins (F.I.) | Cardiac Glycosides | Antraquinones |
|---|-------|----------------|---------------|---------|-----------|-----------|------------|--------------|-----------------|--------------------|---------------|
| <i>pisidicus</i> | 4 | l | - | + | - | - | ++ | - | - | - | - |
| <i>roseocalycinus</i> | 6 | h | - | + | - | (+) | + | - | - | - | - |
| <i>suberosus</i> | 5 | h | - | + | - | - | ++ | - | - | - | - |
| <i>tmoleus</i> | 7 | h | - | + | - | - | + | - | - | - | - |
| <i>zederbaueri</i> | 6 | h | - | - | - | (+) | +++ | + | - | - | - |
| <i>Calicotome villosa</i> | 4 | f f,l | - | - | - | - | +++ | - | - | (+) | - |
| <i>Cercis siliquastrum</i> <i>ssp.hebecarpa</i> | 5 | f f,l | - | + | - | - | +++ | +++ | - | - | - |
| <i>Colutea cilicica</i> | 5 | f f,l | - | + | - | - | + | - | - | - | - |
| <i>Coronilla emerus</i> <i>ssp.emeroides</i> | 5 | h l,fr f | - | + | - | - | + | - | - | - | - |
| <i>grandiflora</i> | 6 | h f | - | + | - | - | ++ | - | - | (+) | - |
| <i>parviflora</i> | 5 | h f | - | + | - | +++ | +++ | ++ | - | (+) | - |
| <i>scorpioides</i> | 4 | h | - | + | - | +++ | ++ | - | - | - | - |
| <i>varia</i> | 6 | h f | - | + | - | +++ | +++ | ++ | + | - | - |
| <i>Dorycnium pentaphyllum</i> <i>ssp.haussknechtii</i> | 6 | h | - | + | - | - | +++ | +++ | - | - | - |
| <i>Genista albida</i> | 6 | h fr | - | + | +++ | - | +++ | - | - | - | - |
| <i>involutrata</i> | 4 | f,l fr,l | - | + | + | - | ++ | - | - | - | - |
| <i>Glycyrrhiza flavescens</i> | 5 | l | - | + | - | - | ++ | - | 100 | - | - |
| <i>Gonocytisus angulatus</i> | 7 | f,l | - | - | - | - | +++ | - | - | - | - |
| <i>Hippocrepis</i> <i>unisiliquosa</i> | 6 | h fr | - | - | - | - | + | - | - | - | - |

(Continued)

| | Month | Used part | Volatile oils | Tannins | Alkaloids | Coumarins | Flavonoids | Antocyanins | Saponins(F.I.) | Cardiac Glycosides | Antraquinones |
|--|-------|-------------|---------------|---------|-----------|-----------|------------|-------------|----------------|--------------------|---------------|
| <i>Hymenocarpus circinnatus</i> | 4 | h | - | + | - | - | + | - | - | - | - |
| <i>Lathyrus aphaca</i> var. <i>pseudoaphaca</i> | 4 | h | - | + | - | - | + | - | - | + | - |
| <i>cicera</i> | 4 | h | - | + | - | ++ | ++ | + | - | + | - |
| <i>cilicicus</i> | 5 | f f, l | - | + | - | - | ++ | +++ | - | - | - |
| <i>inconspicuus</i> | 4 | h | - | + | - | ++ | ++ | - | - | - | - |
| <i>marmoratus</i> | 5 | h fr | - | - | - | + | - | - | - | - | - |
| <i>saxatilis</i> | 5 | h | - | + | - | + | ++ | + | - | - | - |
| <i>setifolius</i> | 5 | h fr | - | + | - | (+) | ++ | + | - | - | - |
| <i>Lens orientalis</i> | 5 | h | - | + | - | - | ++ | + | - | - | - |
| <i>Lotononis genistoides</i> | 6 | h | - | + | - | - | +++ | - | - | - | - |
| <i>Lotus aegaeus</i> | 6 | h | - | + | - | - | +++ | - | - | - | - |
| <i>Lupinus varius</i> | 4 | f, l fr | - | - | +++ | - | ++ | +++ | - | - | - |
| <i>Medicago coronata</i> | 6 | fr, l fr | - | - | - | + | ++ | - | - | - | - |
| <i>rigidula</i> var. <i>agrestis</i> | 5 | h fr | - | - | - | ++ | ++ | - | + | - | - |
| <i>sativa</i> | 6 | f f, l | - | - | - | + | + | + | 100 | - | - |
| <i>Onobrychis caput-galli</i> | 4 | h | - | + | - | (+) | + | - | - | - | - |
| <i>cornuta</i> | 6 | h | - | + | - | (+) | +++ | +++ | - | - | - |
| <i>oxyodonta</i> | 6 | f, l h | - | + | - | - | ++ | ++ | - | - | - |
| <i>Ononis adenotricha</i> | 6 | h | - | + | - | (+) | +++ | - | + | - | - |
| <i>basiadnata</i> | 5 | h | - | + | - | ++ | +++ | - | - | - | - |
| <i>pubescens</i> | 6 | h | - | + | - | + | ++ | - | + | - | - |

(Continued)

| | Month | Used part | Volatile oils | Tannins | Alkaloids | Coumarins | Flavonoids | Antocyanins | Saponins(F.I.) | Cardiac Glycosides | Antraquinones |
|--|-------|-----------|---------------|---------|-----------|-----------|------------|-------------|----------------|--------------------|---------------|
| <i>pusilla</i> | 6 | h | - | + | | - | + | - | | | |
| <i>spinosa</i> ssp. <i>antiquorum</i> | 6 | f,l | - | + | | (+) | + | - | 142 | | |
| <i>viscosa</i> ssp. <i>breviflora</i> | 6 | h | - | + | | + | +++ | - | 250 | | |
| <i>Pisum sativum</i> ssp. <i>elatius</i> | 5 | f,l | - | + | | + | +++ | +++ | | | |
| <i>Podocytisus</i> <i>caramanicus</i> | 6 | f,l f | - | + | | - | +++ | - | | | |
| <i>Prosopis farcta</i> | 5 | l | - | + | | (+) | +++ | - | | | |
| <i>Psoralea bituminosa</i> | 6 | f,l | - | - | - | + | +++ | +++ | | | |
| <i>Scorpiurus muricatus</i> var. <i>subvillosus</i> | 4 | h fr | - | + | | +++ | +++ | - | | | |
| <i>Spartium junceum</i> | 6 | f,l f | - | + | +++ | + | +++ | - | | | |
| <i>Trifolium boissieri</i> | 4 | f,l | - | + | | - | ++ | - | | | |
| <i>cherleri</i> | 4 | h f | - | + | | + | + | + | | | |
| <i>echinatum</i> | 4 | h f | - | + | | ++ | + | + | | | |
| <i>lucanicum</i> | 4 | h | - | + | | + | + | + | | | |
| <i>physodes</i> | 4 | f,l | - | + | | +++ | ++ | + | | | |
| <i>pratense</i> | 6 | f,l f | - | + | | ++ | ++ | + | | | |
| <i>Trigonella fischeriana</i> | 5 | h | - | + | | ++ | ++ | - | | | |
| <i>macrorrhyncha</i> | 4 | h | - | + | | + | ++ | + | | | |
| <i>spicata</i> | 5 | f,l f | - | + | | ++ | ++ | + | | | |
| <i>spruneriana</i> | 4 | h | - | + | | ++ | ++ | - | | | |
| <i>strangulata</i> | 5 | h | - | + | | +++ | ++ | - | | | |
| <i>velutina</i> | 6 | h | - | + | | + | +++ | - | | | |
| <i>Vicia ervilia</i> | 5 | fr h | - | + | | - | +++ | - | | | |

(Continued)

| | Month | Used part | Volatile oils | Tannins | Alkaloids | Coumarins | Flavonoids | Antocyanins | Saponins (F.I.) | Cardiac Glycosides | Anthraquinones |
|-------------------------------|-------|-----------|---------------|---------|-----------|-----------|------------|-------------|-----------------|--------------------|----------------|
| narbonensis var. serratifolia | 4 | h | + | + | | + | + | + | | - | - |
| peregrina | 5 | h | - | + | | - | +++ | +++ | | - | - |
| sativa ssp. incisa | 4 | h | - | + | | (+) | ++ | + | | - | - |
| sericocarpa | 4 | h | - | + | | - | +++ | - | | - | - |
| villosa ssp. dasycarpa | 5 | h | - | + | | + | +++ | ++ | | - | - |

Abbreviations:

"-" Not found; "(+)" Trace; "+" Present; F.I.= Foaming Index.
h. Herb; l. Leave; f. Flower; fr. Fruit;

Even passing very quickly through these tables, one easily can notice that flavonoid reactions were positive for almost every specimen, while anthraquinone and volatile oil results were negative as expected (flowers of *Spartium junceum* were fade during excursion, this caused the negativ result for volatile oil). Coumarin containing plants seemes to be quite enough in number, 31 of 85 plants.

What we have recommend according to these results?

- Those who want to study flavonoids or who prefers alkaloid bearing plant or who finds interesting to study anthocyanins may choose one of these plants from the tables.

According to the results, here in foam reaction, if the height of foam were 1-9 mm, this shown with one "+"; when it is higher than

1 cm, then Foaming Index was determined (Table 3,5). We can summarize the results of the phytochemical screening of İdris Dağı plants as follows (Table 3-5);

-In Labiatae family, 25 of 32 species contain volatile oil: in Umbelliferae it is 9 of 13; but in Rosaceae all the specimens contain volatile oil

-105 of 251 species give strong flavonoid reactions; Compositae is at the first position both in flavonoid 37 of 42 species and in coumarin, 31 of 42 species.

-Positive reaction in 43 species for alkaloids and in 142 for coumarins.

-Saponin containing plants were found mostly in two families in Labiatae and Leguminosae, but the richest species were seen in the others such as Boraginaceae, Caryophyllaceae., Geraniaceae, Ranunculaceae, Scrophulariaceae as you see in Table 5.

These are some examples, showing the meaning of screening studies. We can recommend following species for further investigations; *Anchusa leptophylla*, *Veronica oxycarpa*, *Petrorhagia alpina*, *Geranium pyrenaicum*, *Ononis spinosa* and *Adonis aestivalis*.

As a conclusion phytochemical screening studies must be in the scope of Pharmaceutical Botany Departments programme, because of the composition of the research team and cooperation of Pharmacists and Botanists.

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Table 3. Phytochemical screening of Idris Dağı plants

| Screened species | Used part | Month | Cardiac Glycosides | Volatile oils | Flavonoids | Antocyanins | Alkaloids | Saponins (F.I.) | Antraquinones | Coumarins | Tannins |
|--|-----------|-------|--------------------|---------------|------------|-------------|-----------|-----------------|---------------|-----------|---------|
| PTERIDOPHYTA | | | | | | | | | | | |
| <i>Cystopteris fragilis</i> (L.) Bernh. | h | 6 | - | | | | - | | - | + | |
| <i>Dryopteris pallida</i> (Bory) Fomin | h | 9 | - | | + | - | - | | - | - | + |
| APOCYNACEAE | | | | | | | | | | | |
| <i>Vinca herbacea</i> Waldst. & Kit. | h | 5 | | | + | - | + | | - | - | - |
| ASCLEPIADACEAE | | | | | | | | | | | |
| <i>Cynanchum acutum</i> L. subsp. <i>acutum</i> | l, f | 8 | - | | + | - | - | | - | + | (+) |
| BERBERIDACEAE | | | | | | | | | | | |
| <i>Berberis crataegina</i> DC. | l | 8 | - | | + | - | + | | - | - | + |
| | fr | 8 | | | + | + | + | | - | - | + |
| CAMPANULACEAE | | | | | | | | | | | |
| <i>Asyneuma limonifolium</i> (L.) Janchen subsp. <i>limonifolium</i> | h | 6 | - | | + | + | - | | - | + | (+) |
| CAPRIFOLIACEAE | | | | | | | | | | | |
| <i>Lonicera etrusca</i> Santi var. <i>etrusca</i> | h | 6 | - | | + | + | - | | - | + | + |
| <i>Sambucus nigra</i> L. | l | 8 | - | | + | + | - | | - | - | - |
| | fr | 8 | - | + | + | + | - | | - | - | - |
| CARYOPHYLLACEAE | | | | | | | | | | | |
| <i>Arenaria ledebouriana</i> Fenzl subsp. <i>ledebouriana</i> | h | 6 | - | | + | - | - | + | - | - | - |
| <i>Dianthus crinitus</i> Sm. var. <i>crinitus</i> | h | 6 | - | | + | - | - | + | - | - | - |
| <i>D. lydus</i> Boiss. | h | 6 | - | | + | - | - | 250 | - | - | + |
| <i>D. micranthus</i> Boiss. & Heldr. | h | 6 | - | | + | - | - | + | - | - | - |
| <i>D. zonatus</i> Fenzl var. <i>zonatus</i> | h | 6 | - | + | + | - | - | - | - | - | + |
| var. <i>aristatus</i> (Boiss.) Reeve | h | 6 | - | | + | - | - | - | - | - | + |
| <i>Herniaria incana</i> L. | h | 6 | | | + | - | - | 200 | - | + | + |
| <i>Minuartia juniperina</i> (L.) Maire & Petitm. | h | 6 | - | + | + | - | + | - | - | (+) | - |
| <i>Petrorhagia alpina</i> (Habl.) Ball & Heywood subsp. <i>olympica</i> (Boiss.) Ball & Heywood | h | 6 | - | | + | - | - | 500 | - | - | - |
| <i>Silene alba</i> (Miller) Krause subsp. <i>divaricata</i> (Reichb.) Walters | h | 6 | | | + | - | - | + | - | + | - |

Abbreviations:

"-" Not found; "(+)" Trace; "+" Present; F.I. = Foaming Index.

h. Herb; l. Leaf; f. Flower; fr. Fruit;

Table 4. The number of species and their distribution to the families which gave positive reaction to the tests.

| Families | No. of spec. | Cardiac Glycosides | Volatile oils | Flavonoids | Anthocyanins | Alkaloids | Saponins (F.I.) | Anthraquinones | Coumarins | Tannins |
|------------------|--------------|--------------------|---------------|------------|--------------|-----------|-----------------|----------------|-----------|---------|
| Pteridophyta | 2 | - | - | 1 | - | - | - | - | 1 | 1 |
| Apocynaceae | 1 | - | - | 1 | - | 1 | - | - | - | - |
| Asclepiadaceae | 1 | - | - | 1 | - | - | - | - | - | - |
| Berberidaceae | 1 | - | - | 1 | 1 | 1 | - | - | 1 | 1 |
| Boraginaceae | 12 | - | - | 12 | 5 | 1 | 8 | - | 4 | 2 |
| Campanulaceae | 1 | - | - | 1 | 1 | - | - | - | 1 | 1 |
| Caprifoliaceae | 2 | - | 1 | 3 | 2 | - | - | - | 1 | 1 |
| Caryophyllaceae | 11 | - | 2 | 11 | - | 1 | 7 | - | 4 | 4 |
| Chenopodiaceae | 4 | - | - | 4 | - | - | - | - | - | 3 |
| Compositae | 42 | - | 12 | 37 | 3 | 4 | - | - | 31 | 3 |
| Convolvulaceae | 1 | - | - | 1 | - | - | - | - | 1 | - |
| Crassulaceae | 3 | - | - | 3 | 2 | - | - | - | 2 | 1 |
| Cruciferaeae | 17 | - | - | 16 | 4 | 1 | - | - | 12 | 2 |
| Cucurbitaceae | 1 | - | - | 1 | - | - | - | - | 1 | 1 |
| Cupressaceae | 1 | - | 1 | 1 | - | - | - | - | 1 | 1 |
| Dipsaceae | 3 | - | - | 3 | - | - | - | - | 2 | - |
| Elaeagnaceae | 1 | - | - | 1 | - | - | 1 | - | - | 1 |
| Ephedraceae | 1 | - | - | 1 | - | 1 | - | - | 1 | 1 |
| Euphorbiaceae | 2 | - | - | 2 | 1 | - | - | - | 2 | 2 |
| Fagaceae | 1 | - | - | 1 | - | - | - | - | 1 | 1 |
| Fumariaceae | 4 | - | - | 3 | 2 | 3 | 3 | - | 2 | - |
| Geraniaceae | 4 | - | - | 4 | 1 | - | 3 | - | 1 | 3 |
| Globulariaceae | 1 | - | - | - | - | 1 | - | - | - | - |
| Guttiferae | 3 | - | - | 2 | 2 | 1 | - | - | - | 1 |
| Iridaceae | 1 | - | - | 1 | - | - | - | - | - | - |
| Labiatae | 32 | - | 25 | 30 | 8 | 1 | 17 | - | 12 | 9 |
| Leguminosae | 24 | - | - | 22 | 5 | 3 | 20 | - | 12 | 5 |
| Liliaceae | 7 | - | - | 7 | 4 | - | 4 | - | 3 | 6 |
| Linaceae | 1 | - | - | 1 | 1 | - | 1 | - | 1 | - |
| Malvaceae | 1 | - | - | 1 | 1 | - | 1 | - | 1 | - |
| Morinaceae | 1 | - | - | 1 | - | - | - | - | - | - |
| Orobanchaceae | 1 | - | - | 1 | 1 | - | - | - | 1 | 1 |
| Papaveraceae | 7 | - | - | 7 | 2 | 7 | 3 | - | 2 | 1 |
| Plantaginaceae | 2 | - | - | 2 | - | - | - | - | - | 1 |
| Polygonaceae | 5 | - | - | 3 | 2 | 1 | - | 1 | - | 5 |
| Primulaceae | 1 | - | - | 1 | - | - | 1 | - | - | 1 |
| Ranunculaceae | 13 | 1 | - | 11 | 6 | 6 | 6 | - | 6 | 4 |
| Resedaceae | 1 | - | - | 1 | - | - | - | - | - | - |
| Rhamnaceae | 1 | - | - | 1 | - | - | - | 1 | 1 | 1 |
| Rosaceae | 21 | 1 | 21 | 1 | - | - | - | 13 | 14 | - |
| Rubiaceae | 4 | - | - | 4 | - | 1 | - | 2 | 4 | 2 |
| Rutaceae | 1 | - | - | 1 | - | 1 | - | - | 1 | - |
| Salicaceae | 1 | - | - | 1 | - | - | - | - | 1 | - |
| Scrophulariaceae | 10 | 1 | - | 10 | 4 | 3 | 9 | - | 3 | 3 |
| Solanaceae | 1 | - | - | 1 | 1 | 1 | 1 | - | 1 | 1 |
| Thymelaeaceae | 1 | - | - | 1 | - | - | - | - | - | - |
| Umbelliferae | 13 | - | 9 | 10 | 2 | 3 | - | - | 11 | 1 |
| Zygophyllaceae | 1 | - | - | 1 | - | 1 | - | - | 1 | - |
| Total | 268 | 2 | 51 | 251 | 62 | 43 | 85 | 4 | 142 | 86 |

Table 5. The species rich in Saponins and their estimated foaming index(F.I.).

| Families | Species | Used Part | F.I. |
|------------------|---------------------------------|-----------|------|
| Boraginaceae | <i>Anchusa leptophylla</i> | h | 1000 |
| Caryophyllaceae | <i>Dianthus lydus</i> | h | 250 |
| | <i>Herniaria incana</i> | h | 200 |
| | <i>Petrorhagia alpina</i> | h | 500 |
| Elaeagnaceae | <i>Hippophae rhamnoides</i> | l | 143 |
| Fumariaceae | <i>Corydalis solida</i> | h | 125 |
| | <i>Fumaria cilicica</i> | h | 200 |
| Geraniaceae | <i>Geranium pyrenaicum</i> | h | 500 |
| Leguminosae | <i>Astragalus angustifolius</i> | h | 125 |
| | <i>Genista sessilifolia</i> | h | 100 |
| | <i>Lotus corniculatus</i> | h | 111 |
| | <i>Medicago sativa</i> | h | 333 |
| | <i>Trifolium ambiguum</i> | h | 250 |
| Liliaceae | <i>Allium scorodoprassum</i> | h | 111 |
| | <i>Muscari neglectum</i> | h,bl | 250 |
| Primulaceae | <i>Lysimachia vulgaris</i> | h | 167 |
| Ranunculaceae | <i>Adonis aestivalis</i> | h | 500 |
| Scrophulariaceae | <i>Scrophularia scopolii</i> | h | 143 |
| | <i>Veronica orientalis</i> | h | 125 |
| | <i>V.oxycarpa</i> | h | 1000 |
| | <i>V.multifida</i> | h | 167 |
| Solanaceae | <i>Hyoxyamus reticulatus</i> | h | 167 |

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