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Studies on Phytochemistry of 100 Plants in Chennai, India

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Authors' contributions

This work was carried out in collaboration between all authors. Author NKUP designed the study, managed the literature search, and wrote the protocol. Authors SB and AB carried sampling, performed analysis, wrote the first draft of the manuscript. Authors BR, RB, NS, LP, SS, SV, MC and SA performed the sampling of materials and analysis. All authors read and approved the final manuscript.

Research Article

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ABSTRACT

Aims: Knowledge on the plant phytochemistry provides a fundamental use of plants as a reservoir of chemical agents. Hence, the study on the presence of Phytochemicals in the aqueous extract of 100 different plant species belonging to 44 families collected from Chennai, India was detected.
Place and Duration: Plants distributed in the Chennai district of Tamil Nadu state in India were studied. The study was conducted during the period of November 2012 to January 2013.
Methods: Leaves of around 100 plant species belonging to different habit like trees, shrubs, herbs and creepers or climbers from Chennai and its surround districts of India were collected. The aqueous extract of air dried, pulverized leaf samples of collected plants were examined for the presence of Tannins, Phlobatannins, Saponins, Flavonoids,

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Terpenoids, Cardiac glycosides and Steroids using the standard techniques proposed by Evans (1996). The presence of individual secondary metabolites was calculated in percentage and their prevalence in different plant habit was studied.
Results: Around 29%, 20%, 23%, 48%, 22%, 30% and 44% of plants showed the presence of Tannins, Phlobatannins, Saponins, Flavonoids, Terpenoids, Cardiac glycosides and Steroids in that order. Further, the presence of secondary metabolites according to the plant habit like, tree, shrub, herb and creeper or climber was detected.
Conclusion: It was evident that the presence of Tannin, Phlobatannin, Flavonoids and Cardiac glycosides are found prevalent in trees, Steroids in herbs and Terpenoids in shrubs. However, further study on this aspect is recommended.

Keywords: Phytochemistry; flavonoids; terpenoids; tannins; steroids, plant habit.

1. INTRODUCTION

Since ancient times, plants are used as a major source for medicine as they found to possess a reservoir of chemical agents [1]. Folklore medicine is used by major population of developing countries [2]. World Health Organization (WHO) has reported that more than 80 % of the world's population relies on the traditional medicine for their primary healthcare because of the plant kingdom represents enormous biologically active compounds. Plants have been a common source of medicaments, either in the form of pure active principle or as traditional preparations and it are reasonable to use locally available plants [3]. Knowledge on the plant phytochemistry provides a fundamental use of plants as a reservoir of chemical agents in the field of medicine [4].

The phytochemical analyses of plants from different parts of the world were studied extensively. Iranian plants [5]; plants of Nepal [6]; Nigeria [7] and Qatar [8] were previously studied. In India, the plants of Eastern Ghats were studied by Siddiqui et al. [9]. Udayaprakash et al. [10,11] studied the bioefficacy and phytochemistry of weeds in Tanjore District, Tamil Nadu and Phytochemistry of common weeds from Northern districts of Tamil Nadu State in India. In this study, the phytochemistry of 100 plants occurring commonly in the state capital, Chennai is conducted. Knowing the importance of secondary metabolites in the field of medicine, the presence of Tannins, Phlobatannins, Saponins, Flavonoids, Terpenoids, Cardiac glycosides and Steroids was detected. Further, the prevalence of secondary metabolites according to the habit of plant was detected.

2. MATERIALS AND METHODS

2.1 Source of Plants

Plants totaling to 100, belonging to 44 different families, were chosen from Chennai city of the state of Tamil Nadu, India during the period of November 2012 – January 2013 for the study. The collected plants were identified using the manuals of Gamble [12] and Mathew [13]. The specimen of plant herbariums are deposited with the Research Park, Technology Business Incubator, Veltech Dr. RR Dr. SR Technical University, Chennai.

The fresh leaves collected were washed with water and dried in shade at room temperature for 4 – 10 days. Upon complete dried conditions, the leaves were milled to coarse powder using an electronic blender and stored for further use.

2.2 Preparation of Extract

Aqueous extracts of the leaves were obtained by mixing 5g of the plant material with 100 ml of distilled water. The solution was allowed to boil in a microwave oven for 2 minutes and then filtered using Whatman No.1 filter paper and the analysis was carried out immediately without storage.

2.3 Phytochemical Analysis

The aqueous extracts, so obtained from the dried leaves' powder of 100 plants, were tested for the presence of the phytochemicals – Tannins, Phlobatannins, Saponins, Flavonoids, Terpenoids, Cardiac glycosides and Steroids according to method described by Evans [14].

2.4 Tests for Tannins

To 5ml of the plant filtrate obtained, a few drops of 0.1% Ferric chloride were added. The presence of a brownish green or blue black color indicated that the plant material possessed Tannins.

2.5 Phlobatannins

Ten ml of the aqueous extract of the plant material was boiled with 1% HCl in a test tube. The presence of Phlobatannins was confirmed by the deposition of red precipitate in the tube.

2.6 Saponins

To 10 ml of the plant extract, 3 ml of distilled water was added and shaken well, so as to obtain froth. To the froth formed, a few drops of Olive oil were added. The formation of emulsion indicates the presence of saponins.

2.7 Flavonoids

A few drops of 1% liquor ammonia were taken in test tubes, to which the aqueous extract was added. Yellow coloration of the solution confirmed the presence of Flavonoids.

2.8 Terpenoids

Around 2 ml of chloroform and 3 ml of concentrated sulphuric acid were added consecutively to 5 ml of the aqueous extract of the plant material. A reddish brown interface in the solution denoted the presence of Terpenoids.

2.9 Cardiac Glycosides

To 5 ml of the aqueous extract, 2 ml of glacial acetic acid containing a drop of Ferric chloride was added. This was followed by the addition of 1 ml of concentrated sulphuric acid. The brown ring, thus obtained, yield positive result for the test.

2.10 Steroids

A couple of grams of plant powder were mixed with 10 ml of chloroform, followed by boiling and filtration. To the above 2 ml of the filtrate 2 ml acetic anhydride and a few drops of concentrated sulphuric acid was added. Stable presence of blue-green ring in the solution confirms the presence of steroids.

2.11 Presentation of Data

$$\text{Percent of Habit of plants} = \frac{\text{No. of plant habit (herb/shrub/tree/climber)}}{\text{Total No. of plants studied}} \times 100$$

$$\text{Percent occurrence of Phytochemicals} = \frac{\text{No. of plants in which phytochemical (Tannin/Phlobatannin etc.,) recorded}}{\text{Total No. of plants studied}} \times 100$$

3. RESULTS

A total of 100 plants belonging to 44 families were sampled and studied for their phytochemical constituents. Among the families, Fabaceae was represented by maximum number (13) of species. This was followed by the families, Euphorbiaceae (9 species), Asteraceae (6 species) and Solanaceae (5 species). Bignoniaceae, Cucurbitaceae, Lamiaceae and Moraceae are represented with 4 members each. Few of the families like, Myrtaceae, Nyctaginaceae and Verbenaceae were selected with 3 species in this study, nine other families are represented by couple of species each and all other remaining families are represented by single species. The list of families and the number of species belonging to individual family is presented in Table 1.

The habits of the plants studied were classified into Creeper or Climbers, Herbs, Shrubs and Trees. Among this, Maximum number of plant habit belongs to Trees. Shrubs and Herbs were equally represented with 20 % each. However, climbers or creeper were lower in number with representation of only 17 % to the total. The percent contribution of different habits of the plants is presented in Fig. 1.

Among the phytochemicals, flavonoids are present in maximum number of species and were recorded in 48% of the plants. This was followed by the presence of Steroids in 44 % of the plants. The phytochemicals like, Tannin and Cardiac glycosides were present in nearly 30 % of the plants studied. However, the presence of Phlobatannin, Saponin and Terpenoids was seen only in 20 -23 % of plants. The presence or absence of different phytochemicals like Tannins, Phlobatannin, Flavonoids, Saponins, Terpenoids, Cardiac glycosides and Steroids in different species and their percent occurrence are presented in Table 2.

Table 1. List of families and the number of species studied

S.No	Family	No. of species
1.	Acanthaceae	1
2.	Agavaceae	1
3.	Alangiaceae	1
4.	Amaranthaceae	2
5.	Anacardiaceae	2
6.	Annonaceae	1
7.	Apocynaceae	2
8.	Asclepediaceae	1
9.	Asteraceae	6
10.	Bignoniaceae	4
11.	Boraginaceae	1
12.	Cannaceae	1
13.	Caricaceae	1
14.	Casuarinaceae	1
15.	Combretaceae	1
16.	Commelinaceae	1
17.	Convolvulaceae	1
18.	Cucurbitaceae	4
19.	Euphorbiaceae	9
20.	Fabaceae	13
21.	Lamiaceae	4
22.	Lecythidaceae	1
23.	Liliaceae	1
24.	Lythraceae	1
25.	Malvaceae	2
26.	Meliaceae	2
27.	Menispermaceae	1
28.	Moraceae	4
29.	Moringaceae	1
30.	Myrtaceae	3
31.	Nyctaginaceae	3
32.	Nymphaeaceae	1
33.	Oleaceae	1
34.	Pedaliaceae	1
35.	Polygonaceae	1
36.	Rubiaceae	2
37.	Rutaceae	2
38.	Sapindaceae	2
39.	Sapotaceae	1
40.	Solanaceae	5
41.	Sterculiaceae	2
42.	Tiliaceae	1
43.	Verbenaceae	3
44.	Vitaceae	1

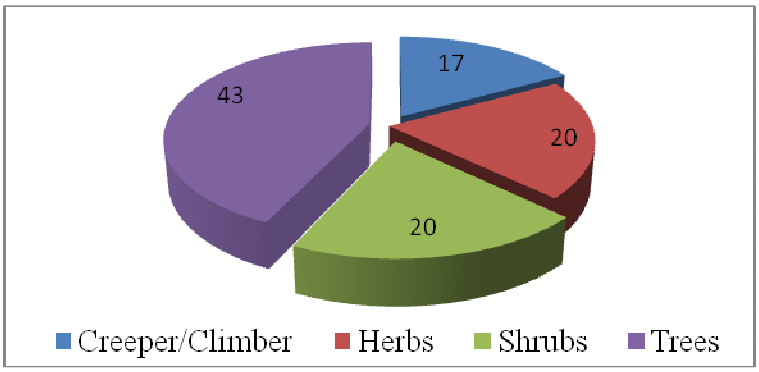

Fig. 1. Classification of plants studied (In Percentage) according to their habits

Table 2. List of plants from Chennai city studied for their presence of phytochemicals

Sl. No.	Species	Tan-nins	Phloba tannins	Sapo nins	Flavo noids	Terpen oids	Cardiac Glycosides	Ster oides
1.	*Abutilon indicum*	-	-	-	-	-	-	+
2.	*Acacia auriculiformis*	+	+	+	+	+	+	+
3.	*Acacia melanoxylon*	-	-	+	+	+	+	-
4.	*Acalypha indica*	-	-	-	-	-	-	+
5.	*Achyranthes aspera*	-	-	-	-	-	-	+
6.	*Adhatoda vasica*	+	-	-	+	-	-	+
7.	*Ageratum conyzoides*	-	-	+	-	-	-	-
8.	*Allangium salvifolium*	+	-	-	+	-	+	-
9.	*Amaranthus spinosus*	-	-	-	-	-	-	+
10.	*Anacardium occidentale*	+	-	+	+	+	+	-
11.	*Antigonon leptopus*	+	-	-	+	-	+	-
12.	*Artocarpus heterophyllus*	-	+	-	-	-	+	+
13.	*Asparagus officinalis*	-	+	-	+	-	-	-
14.	*Azadirachta indica*	-	-	-	+	+	-	-
15.	*Boerhavia diffusa*	-	-	+	-	-	-	+
16.	*Bougainvillea spectabilis*	-	-	-	-	-	-	+
17.	*Calotropis gigantea*	-	-	-	-	+	+	+
18.	*Canna indica*	-	-	-	-	-	-	-
19.	*Cardiospermum halicacabum*	-	-	-	-	-	-	+
20.	*Carica papaya*	-	-	-	+	-	+	-
21.	*Cassia alata*	-	-	-	+	-	-	-
22.	*Casuarina equisetifolia*	-	-	+	-	+	-	-
23.	*Chichorium intybus*	-	-	-	-	+	+	-
24.	*Cissus quadrangularis*	-	-	-	+	-	-	-
25.	*Citrus limon*	-	-	-	+	-	-	-
26.	*Clitoria ternatea*	-	-	-	+	-	-	+
27.	*Coccinia grandis*	-	-	-	-	-	-	+

28.	*Commelina benghalensis*	-	+	+	-	-	-	-
29.	*Corchorus* sp.	-	-	-	-	-	-	+
30.	*Cordia obliqua*	-	-	-	-	-	-	+
31.	*Couroupita guianensis*	+	+	+	-	-	+	+
32.	*Croton sparsiflorus*	-	-	-	+	-	-	-
33.	*Cucurbita maxima*	-	-	+	-	-	+	-
34.	*Datura stramonium*	-	-	+	-	-	-	-
35.	*Delonix regia*	+	-	-	-	-	+	+
36.	*Dodonea viscosa*	+	+	-	-	+	+	-
37.	*Dracaena marginata*	+	+	+	+	+	-	-
38.	*Eclipta prostrata*	-	-	-	+	-	-	-
39.	*Erythrina indica*	-	-	-	-	-	-	+
40.	*Eucalyptus globulus*	+	+	-	+	+	+	-
41.	*Euphorbia hirta*	-	-	-	+	-	-	-
42.	*Ficus benghalensis*	-	+	-	-	-	+	-
43.	*Ficus religiosa*	+	-	-	-	-	-	-
44.	*Ficus ribes*	-	-	-	+	-	-	-
45.	*Guazuma ulmifolia*	-	-	+	-	-	-	-
46.	*Hyptis suaveolens*	+	+	-	-	-	+	+
47.	*Ipomea carnea*	-	-	-	-	+	-	-
48.	*Jasminum fluminense*	-	-	-	+	-	-	+
49.	*Jatropha curcas*	-	+	-	+	+	+	-
50.	*Kigelia africana*	+	-	+	+	-	-	+
51.	*Lantana camara*	+	-	+	-	-	-	-
52.	*Lawsonia inermis*	-	-	-	-	-	-	+
53.	*Leonotis nepetifolia*	+	-	+	+	-	+	+
54.	*Leucas aspera*	-	+	+	-	+	-	+
55.	*Mangifera indica*	+	-	+	-	+	+	-
56.	*Manilkara zapota*	-	+	-	-	-	+	+
57.	*Martynia annua*	-	-	-	-	+	-	+
58.	*Melia dubia*	-	-	-	+	-	-	-
59.	*Millingtonia hortensis*	-	-	+	+	+	-	-
60.	*Mimosa pudica*	-	-	-	-	-	-	+
61.	*Mirabilis jalapa*	-	-	-	-	-	+	+
62.	*Momordica charantia*	-	-	+	-	-	+	+
63.	*Morinda tinctoria*	-	-	-	+	+	-	-
64.	*Moringa oleifera*	-	-	-	+	-	-	-
65.	*Mukia maderaspatana*	-	-	-	-	-	-	+
66.	*Murraya koenigii*	+	+	-	+	-	+	+
67.	*Nerium oleander*	-	-	-	+	-	-	-
68.	*Nymphaea alba*	+	-	+	+	-	-	-
69.	*Ocimum americanum*	+	-	-	-	+	-	-
70.	*Oldenlandia umbellata*	-	-	-	+	-	-	+

71.	*Parthenium hysterophorus*	-	-	-	+	-	+	+
72.	*Pedilanthus tithymaloides*	+	-	-	-	-	+	-
73.	*Phyllanthus acidus*	-	-	-	+	-	-	-
74.	*Phyllanthus amarus*	+	-	-	-	-	-	-
75.	*Phyllanthus emblica*	-	-	-	-	-	-	+
76.	*Pithecellobium dulce*	-	-	-	-	-	-	+
77.	*Plumeria rubra*	+	-	-	-	-	+	-
78.	*Polyalthia longifolia*	-	+	-	+	-	+	-
79.	*Pongamia pinnata*	-	-	-	+	-	-	-
80.	*Prosopis juliflora*	-	-	-	-	+	-	-
81.	*Psidium guajava*	+	-	-	-	+	-	+
82.	*Ricinus communis*	+	-	-	+	-	-	+
83.	*Samanea saman*	-	+	-	+	-	-	+
84.	*Senna siamea*	+	-	-	+	-	-	-
85.	*Solanum nigrum*	-	-	-	-	-	-	+
86.	*Solanum torvum*	-	-	+	-	-	-	-
87.	*Solanum trilobatum*	-	-	-	+	-	-	-
88.	*Solanum xanthocarpum*	-	-	-	-	-	-	+
89.	*Stenolobium stans*	+	-	-	+	-	-	-
90.	*Sterculia foetida*	+	+	-	+	+	+	+
91.	*Syzigium cuminii*	-	+	-	+	-	-	-
92.	*Tamarindus indica*	-	-	-	+	-	-	+
93.	*Tabebuia rosea*	-	-	+	-	-	+	+
94.	*Tectona grandis*	-	+	-	+	-	-	-
95.	*Terminalia catappa*	+	-	-	+	-	-	-
96.	*Thespesia populnea*	-	+	-	-	-	+	-
97.	*Tinospora cordifolia*	-	-	-	-	+	-	-
98.	*Tridax procumbens*	-	-	-	+	-	-	+
99.	*Vitex negundo*	-	-	-	+	-	-	-
100.	*Xanthium strumarium*	+	-	+	+	-	-	-
Percent Occurrence of Phytochemicals		29%	20%	23%	48%	22%	30%	44%

It was interesting to note that only 5.8% of plants belonging to the creeper or climber as a habit showed their presence for the phytochemicals like Tannin and Terpenoids. Phlobatannin was recorded in 11.7%, Cardiac glycosides in 17.6%, Saponins in 23.5%, Flavonoids in 41.1% and Steroids in 53% of the plants studied.

With herbs and shrubs, there was no difference recorded with the presence of Tannin, Phlobatannin, Saponin and Flavonoids. They showed their presence in 30%, 10%, 20% and 40% respectively. However, the presence of Cardiac glycoside is 30% in herbs and it was only 15% in Shrubs. Similarly, the presence of Steroids is at higher side, i.e. 60% in herbs when compared with 35% in Shrubs.

Among 43 tree species studied for their presence of different phytoconstituents, Saponins and Terpenoids were recorded in 25-28% of plants, Phlobatannin in 32%, Tannins and Steroids in 37.2% of plants. The presence of Cardiac glycosides was recorded in nearly 42% of the plants among the total. Flavonoids showed their presence in more than 60% of the samples studied. The percent occurrence of different phytoconstituents present in different habits of the plant studied is presented in Fig. 2.

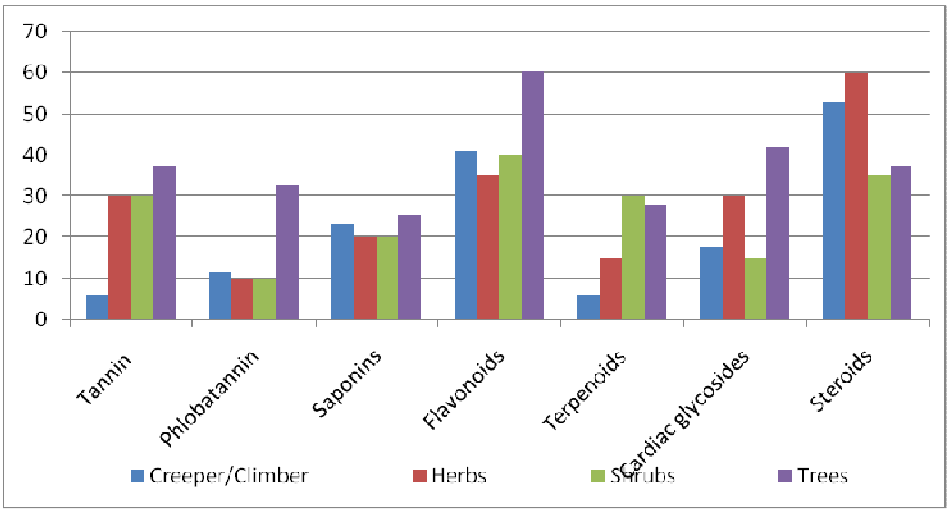

Fig. 2. Prevalence of Phytochemicals (In Percentage) in different plant habits

4. DISCUSSION

Plants have long been and continue to be the basis of many traditional medicines worldwide. Asian traditional medicinal systems such as traditional Chinese medicine (TCM), Korean Chinese medicine, Japanese Chinese medicine (kampo), Ayurveda from India and Jamu from Indonesia are well known [15]. Phytochemicals are compounds derived from the plants, among which most of them are found to possess several medicinal attributes, though they are non-nutritive. Further, detection of the presence of phytoconstituents from plants will help the pharmaceutical industry to save time and cost. Current study enlists the presence of different secondary metabolites present in 100 different plants commonly available in Chennai, Tamil Nadu, India.

Tannins are naturally occurring, water-soluble phenolic compounds, which precipitate proteins from aqueous media [16]. The present study reveals that nearly 29% of plants possess tannins. Through this study, it is evident that tannin is available more in trees than in creepers or climbers. The primary source of tannins used as an active pharmaceutical agent are from plants [17] implying that the pharmacologic effect of tannins depend up on the plant type. Thus, to isolate tannin, it is advised to look for tree species rather than creepers. Topical applications of tannins serve as an anti-inflammatory agent, treatment of wounds, burns, antihemorrhagic and antiseptic potential [18]. They are also used as anthelmintics [19], antimicrobials and antivirals [20], antioxidants [21], and to chelate dietary iron [22]. A review on tannins and human health has been carried by Chung et al. [23]. Condensed tannins of higher molecular weight are commonly described as Phlobatannins [24]. They are formed either due to aging of tissues [25] or due to enzymatic action on dead

cells [26]. It is evident by this study that, phlobatannins are present largely in trees (35%) when compared to other habits (10-12%) of the plants.

Providing bitter taste, saponins are chemicals that possess foaming characteristic. Though saponins possess several beneficiary effects such as reducing the risk of cancer, serving as antioxidants, providing immunity, etc., certain saponins are toxic. In this study, Saponins were recorded in more of Creepers or climbers than herbs and shrubs. The triterpenoid saponins are generally predominant in cultivated crops, while steroid saponins are common in herbs or for their health promoting properties [27]. A complete review on occurrence, isolation, characterization, its impact on animal cell, immune system, hypoglycaemic activity, molluscicidal effect, antifungal activity, antiviral activity, antioxidant activity of saponins as steroid based saponins and terpenoid based Saponins was carried by Francis et al. [28].

The modified or oxidized terpene is called as terpenoid. Terpenoids consists of around 55% of major group of plant secondary metabolite. The antimicrobial activities of terpenes are reported [29-31]. The application and future potency of terpenoids are reviewed by Swenger and Basu, [32]. Nearly 22% of the plant studied, showed the presence of terpenoid as their constituent.

Flavonoids and phenolics are the most important groups of secondary metabolites and bioactive compounds in plants [33]. In this study, nearly half of the plants showed the presence of flavonoids as their constituents. The habitual presence of flavonoids is seen in trees rather than herbs. Phenolics and flavonoids possess diverse biological activities, i.e. antiulcer and anti-inflammatory [34] and as an antioxidant [35]. Antidiabetic activity of flavonoids [36] and anticancer activity of flavonoids have been reviewed [37]. The biochemical role of flavonoids and phenolics in human and plants has been reviewed by Ghasemzadeh and Ghasemzadeh, [38].

The presence of steroids as phytoconstituent is reported next to flavanoids in this study. Nearly 44% of the plant studied showed their presence for steroids. Steroids are one of the most widely used groups of drugs in present day anaesthetic practice, sometimes with indication and sometimes without indications [39]. They are reported as controlling agent for topical diseases as eczema etc. Further, hormones and body building ability of steroids are widely reported.

In the present study, nearly 30% of the plants showed the presence of Cardiac glycosides. Cardiac glycosides are a class of natural products that are traditionally used to increase cardiac contractile force in patients with congestive heart failure and cardiac arrhythmias Evans [14]. Therapeutic effect of cardiac glycosides in breast cancer has been known since 1979 [40]. The role of cardiac glycosides in cancer research and cancer therapy is reviewed [41].

5. CONCLUSION

This study provides the detail on the phytoconstituents of commonly available plants from the city of Chennai, India which provides knowledge on the availability of secondary metabolites from different plants. The study provides data on the absence of Phlobatannin in the members of Solanaceae (5 plants) and Asteraceae (6 plants). Further, the presence of phytochemicals based on the habit of the plants is reported for the first time which reveals that creepers or climbers are not the good source for isolation of Tannins, Phlobatannins and

Terpenoids. Similarly, for isolation of Flavonoids, trees are the better source as herbs for Steroids. However, further research in this direction is needed to confirm the presence of phytochemicals at family level and their compositional change according to their habit and the studies on the quantitative determination of phytoconstituents are highly recommended.

CONSENT

Not applicable.

ETHICAL APPROVAL

Not applicable.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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