INTRODUCTION

Strobilanthes belongs to Acanthaceae and the second largest genus of this family. It comprises of approximately 300 species in tropical Asia. The Indian subcontinent has nearly 150 species, out of which 59 are seen in peninsular India. The genus is not greatly explored for economic utility. Strobilanthes ciliatus is one of the endemic and potential medicinal plants. It is widely used in Ayurveda as a source of the drug 'Sahacharya' [1]. Western Ghats of India serves as a rich potential medicinal plants. It is widely used in Ayurveda as a source of the drug 'Sahacharya' [1]. Western Ghats of India serves as a rich repository of medicinal plants. Strobilanthes species are known for its several medicinal properties.

Extraction of phytochemicals using the standardized solvent based system provides the list of wide range of chemical constituents in medicinal plants. This can also help in the comparative analysis of compounds present in the different plant organ and also in the related species. The traditional utilization of medicines directly from the plant organ is not advisable because other than the bioactive compounds, it also contains a mixture of several other compounds. Understanding the purity and stability of the active compound is very essential in pharmacognostic studies [2]. Hence, the present study was undertaken to analyze the phytochemical constituents in ten Strobilanthes species from Northern Western Ghats of India.

MATERIALS AND METHODS

Plant materials

A total of 10 species of Strobilanthes were collected from different parts of Northern Western Ghats of India. The scientific name, common name, and place of the collection are provided table 1.

Preparation of extracts

Plant material collected from the field were washed under the tap water 2-3 times until the soil particles are removed. Fresh and healthy leaf and stem material were put for drying under the shade. After, two weeks when the samples are fully dried, they were powdered using a grinder. One gram of leaf and stem powder of each Strobilanthes species were weighed using an electronic balance. The sample was then extracted with 10 ml of methanol. The extracts were condensed to 1/10th of volume by heating at 50-60°C in a water bath and then it was filtered using Whatman filter paper no.1. The filtrate was centrifuged at 2500 rpm for 15 min and the supernatant was collected in sterile bottles [3].

Phytochemical tests

Phytochemical analysis of 10 species of Strobilanthes for various chemical constituents was carried out using standard methods, and detailed protocol is given below [3-4].

Test for alkaloids

Small aliquots of methanolic extract were stirred separately with few drops of dilute HCl and filtered. The presence of alkaloids was detected by treating the filtrate with Wagner’s reagent to confirm the presence of alkaloids in the sample with reddish-brown precipitate.

Test for carbohydrates

To 2 ml of filtrate, two drops of an alcoholic solution of alpha-naphthol are added, the mixture is shaken well, and 1 ml of concentrated sulphuric acid is added slowly along the sides of the test tube and allowed to stand. A violet ring indicates the presence of carbohydrates.

Test for glycosides

50 mg of the extract is hydrolyzed with concentrated hydrochloric acid for 2h on a water bath, filtered. 2 ml of filtered hydrolysate, 3 ml of chloroform is added and shaken, chloroform layer is separated and 10% ammonia solution is added to it. Pink colour indicates the presence of glycosides.

Test for saponins

2 ml of filtrate is diluted with 5 ml distilled water. The suspension is shaken in a graduated cylinder for 15 min. A two cm layer of foam indicates the presence of saponins.
Test for proteins

2 ml of filtrate is treated with one drop of 2% copper sulphate solution. To this, 1 ml of ethanol (95%) is added, followed by an excess of potassium hydroxide pellets. Pink color in the ethanolic layer indicates the presence of Proteins.

Test for phytoesters

The extract (50 mg) is dissolved in 2 ml of chloroform is added, and the content is carried out, and the results of the same is summarized in table 2, 3.

Test for terpenoids

1 ml of extract, to this few drops of neutral 5% ferric chloride solution is treated with one drop of 2% copper sulphate solution. S2 = + indicates presence of phytochemicals and (-) = indicates absence of phytochemicals.

Yellow fluorescence indicates the presence of flavonoids.

The extract is treated with 10% ammonium hydroxide solution.

The study revealed the substantial amount of phytochemicals like terpenoids, flavonoids, phytosterols, fixed oils, phenolics, carbohydrates and alkaloids.

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RESULTS AND DISCUSSION

The phytochemical analysis of Strobilanthes species has been carried out, and the results of the same is summarized in table 2, 3.

The study revealed the presence of phytochemicals, which are known to possess the active medicinal chemical constituents. The predominant medicinal phytochemical constituents are terpenoids, flavonoids, phytosterols, phenolic compounds, alkaloids, fixed oils and carbohydrates in Strobilanthes species.

Interestingly, terpenoids were present in all Strobilanthes species as a potent antioxidant and free radical scavenger, prevent oxidative cell damage, have strong osteoarthritis activity and analgesic activity [5-6]. In addition, terpenoids like ‘Lupeol’ are pharmacologically active and are having potential medicinal properties. It is having a complex pharmacology and has anti-protozoal, anti-microbial, anti-inflammatory, anti-tumour and chemopreventive properties [9] and lupeol is reported to be present in Strobilanthes ciliatus and Strobilanthes callus [10, 11].

Leaf and stem of all the 10 species of Strobilanthes possess terpenoids. The elements of terpenoids, like triterpenoids are involved in the healing of inflammatory disorders, treat arthritis, anti-tumour properties and antimicrobial activities. Traditionally over the ages, the tribal’s have used the plant for the treatment of inflammatory disorders. This confirms its use in folk medicine as a valid anti-inflammatory and antimicrobial herbal drug [7-8]. Flavonoids are also present in all Strobilanthes species as a potent antioxidant and free radical scavenger, prevent oxidative cell damage, have strong osteoarthritis activity and analgesic activity [5-6].

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Local species of *Strobilanthes* are used by the traditional people to cure different types of diseases. In North-east India, Manipur is abundant with the occurrence of *S. auriculata* and cook it in condiments or steam with indigenous small fish curry (*Gnatokapo thonoba*), to boost resistance towards the cardiovascular diseases. Hence, this species is a medicinally important plant for the people of Manipur [13]. Plant polyphenolic compounds long-term utilization is known to defend against the growth of cancers, diabetes, osteoporosis, cardiovascular and neurodegenerative diseases [14]. Similarly, potent dietary fibers such as cellulosics, hemicellulosics, non-digestible oligosaccharides protect human health from bowel disorders, decrease the risk of coronary heart disease and so on when occupied through diets [15]. In the present study, 10 *Strobilanthes* species screened for the secondary metabolites, phenolic compounds and carbohydrates were found in most of the species of *Strobilanthes*, owing its medicinal importance.

Furthermore, alkaloids, glycosides, saponins, proteins, fixed oils are found varied in the species of *Strobilanthes*. Among all species, *S. integrifolius* stem, *S. isoccephalus* stem, *S. reticulatus* var. *reticulatus* stem, *Strobilanthes* Blume sp leaf, *S. lupinus* leaf and *S. barbatus* leaf showed the absence of alkaloids. Plants containing glycosides are known to apply a beneficial action on the immune system by increasing body strength and therefore are valuable as dietary supplements. Glycosides were present only in *S. ciliatus* leaf, *S. callosus* var. *heyneanus* stem. Saponins were seen in *S. ciliatus* leaf, *S. isoccephalus* and *S. callosus*, leaf and both leaf and stem of *S. heyneanus*. They are known to promote dietary supplements and nutraceuticals. Proteins have significant alleviation against unfolding and degradation activity and also in cell functioning when activating on the targets of free radicals [16]. It was found only in the stem of *S. callosus* and *S. sessilis* var. *ritchei* stem. Fixed oils also known as carrier oils were moderately found in the *Strobilanthes* species; they carry traces of vitamins and minerals. They consecutively may be involved in the anti-microbial activity. Thus, the present study provides the phytochemical constituents present in ten species of *Strobilanthes*, the medicinal properties and the pharmacological activities further could be explored.

**CONCLUSION**

Phytochemical screening of 10 species of *Strobilanthes* of both leaf and stem revealed the presence of phytoconstituents i.e. terpenoids, flavonoids, phytosterols, phenolic compounds, fixed oils, carbohydrates. It is reported to possess an array of biological and pharmacological activities that include anti-inflammatory, anti-oxidant, anti-osteoarthritis, anti-diabetic, anti-microbial, etc. These activities are due to the presence of the above mentioned secondary metabolites. The traditional people uses these species without any knowledge. However, these traditional knowledge has been passed on to several generations. These plants are also mentioned in the ethnobotanical studies, ayurveda system of medicines, but it is very much important to survey and explore the potential of the genus. Further, with regard to the development of the quality herbal medicine isolation, characterization, standardization, mechanism of action as well as the clinical trials of the compounds are needed. Considering the above facts, it is concluded that the several species of the genus *Strobilanthes* can be of potential for development of pharmaceutically important drugs.

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**CONFLICT OF INTERESTS**

Declare none

**REFERENCES**


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**Table 3: Phytochemical analysis of leaf and stem of *Strobilanthes* species**

<table>
<thead>
<tr>
<th>Phytochemicals</th>
<th>Test</th>
<th>S6</th>
<th>S7</th>
<th>S8</th>
<th>S9</th>
<th>S10</th>
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</table>

L = Leaf, S = Stem, S6 = *Strobilanthes sessilis* var. *ritchei*, S7 = *Strobilanthes heyneanus*, S8 = *Strobilanthes Blume* sp. S9 = *Strobilanthes lupinus*, S10 = *Strobilanthes barbatus*. (+) = indicates presence of phytochemicals and (-) = indicates absence of phytochemicals.

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