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PHYTOCHEMICAL SCREENING OF ACTIVE METABOLITES PRESENT IN EICHHORNIA CRASSIPES (MART.) SOLMS AND PISTIA STRATIOTES (L.): ROLE IN ETHANOMEDICINE

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Abstract
Natural products, such as plants extract, either as pure compounds or as standardized extracts, provide unlimited opportunities for new drug discoveries because of the unmatched availability of chemical diversity. In the last few decades there has been an increasing interest in the study of medicinal plants, as knowledge on ethnopharmacology, its holistic system approach, supported by the experiential base, can serve as an innovative and powerful discovery engine for newer, safer, and affordable medicines. This review is an attempt to assess the available scattered literatures and compile them under different categories in a systematic way, to provide the pharmaceutical prospective of genus *Nymphaea*. It is expected that many novelties will rapidly enlarge the current knowledge about genus *Nymphaea*, their constituents and corresponding pharmacological effects.

Keywords: Phytochemical screening, Steroid, neuroprotective, diuretic, Flavonoid, *Eichhornia crassipes and Pistia stratiotes*.

INTRODUCTION

Plants used for traditional medicine contain a wide range of substances that can be used to treat chronic as well as infectious diseases. A vast knowledge of how to use the plants against different illnesses may be expected to have accumulated in areas where the use of plants is still of great importance[1,2]. Plant synthesizes a wide variety of chemical compounds, which can be sorted by their chemical class, biosynthetic origin and functional groups into primary and secondary metabolites.

Primary metabolites are of prime importance and essentially required for growth of plants e.g. amino acids, ascorbic acid, carbohydrates, enzymes, lipids, nucleic acids and proteins etc. They are found universally in the plant kingdom because they are the components or products of fundamental metabolic pathways. The importance of primary pathway enabling a plant to synthesize, assimilates, and degrades organic compounds. They are obtained from higher plants for commercial uses and make up the physical integrity of the plant cell and are involved with the primary metabolite process of building and maintaining of living cells.

Secondary metabolites are naturally derived metabolites and by-products from microorganisms, plants, or animals[3]. These metabolites have been explored and exploited as a source of medicine. They are vital for the survival of the plant that produces them and are not an essential part of the process of building and maintaining living cells[4]. These secondary metabolites of plants serve as self defence mechanism against predation by many microorganisms, insects and herbivores[5]. The most important of these bioactive compounds of plants are alkaloids, flavonoids, tannins, phenolic compounds, steroids, saponins and glycosides[6,7]. A growing body indicates that secondary plant metabolites play critical roles in human health and may be nutritionally important[8]. Some biologically active plant compounds have found application as drug entities or as model compounds for drug synthesis and semi-synthesis.

Different chemical compounds isolated from the plants exhibit wide pharmacological activities and plays a role in treating the various disorders related to human health.

MATERIAL AND METHODS

Phytochemical Analysis

Extraction Procedure:

The plant materials (leaves, petiole, root) were washed with distilled water and dried under shadow then plant material was chopped into small pieces. Plant materials (leaves, petiole, root) extracts were prepared using soxhlet extraction unit, a quantity of 10gm plant materials (leaves, petiole, root) were weighed and suspended with 200 ml of solvent. The extraction for each plant material is carried out by using ethanol solvent. The extracts were dried by using rotor evaporator and stored in a refrigerator at 4ºC for further analysis. The test samples were processed further to be used to evaluate the presence of carbohydrates, proteins, lipids, amino acid, tannins, flavonoids, alkaloids and phenol.

Qualitative Detection of Phytochemical Constituents:

Various chemical tests were performed for the presence of bioactive constituents in each fraction of both plants by using standard procedures.

Detection for Tannins

1. **Braymer's Test:** 50 mg of each fraction was boiled in distilled water and was filtered. A few drops of 0.1% $FeCl_3$ was mixed and observed for colour change, the presence of brownish green coloration shows the occurrence of tannins[9].

Detection for phlobatannins

80 mg of each plant extract was boiled in 1% HCl, the deposition of a red precipitate indicated the presence of phlobatannins[10].

Detection for Saponins

1. **Foam Test**: In this method 20 mg fraction was boiled, filtered and combined with few ml of olive oil, formation of foam revealed saponin[11].

Detection for steroids

For the presence of steroid 5 drops of concentrated H_2SO_4 were added to 1 ml of the extract. Development of red colouration was indicative of a positive reaction.

Detection for Terpenoids

1. **Liebermann-Burchard test:** 1 ml of extract was treated with chloroform, acetic anhydride and drops of H_2SO_4 was added and observed for the formation of dark green colour.
2. **Salkowski Test:** 5 ml (1 mg/ml) of fraction was combined with few drops chloroform, and then 3 ml of concentrated H_2SO_4. Change of reddish brown colour revealed terpenoids[11].

Detection for alkaloids: 0.4 gm of every fraction was combined with 8 ml of 1%HCl, warmed and filtered[11].

1. **Mayer's Test:** A fraction of extract was treated with Mayer's reagent (1.36 gm of $HgCl_2$+5g KI in 100 ml of water). Formation of cream coloured precipitate confirms the presence of alkaloids.
2. **Wagner's test:** A fraction of extract was treated with Wagner's test reagent (1.27 gm of iodine and 2 gm of potassium iodide in 100 ml of water). Formation of brown/reddish precipitate indicates the presence of alkaloids.
3. **Hager's Test:** A fraction of extract was treated with Hager's reagent (saturated picric acid solution). Formation of yellow coloured precipitate confirms the presence of alkaloids.
4. **Dragendroff's Reagent:** A fraction of extract was treated with 1ml Dragendroff's Reagent (0.17gm Bismuth nitrate in 2ml alcohol in 8ml of water add 4 gm of potassium iodide into another beaker, in 10 ml alcohol and 20 ml water and stirred until KI is completely dissolved). On mixing of the two solutions, formation of orange or Red coloured precipitate confirms the presence of alkaloids.

Detection for Flavonoids

1. **NaOH Tests**: Take 2-3 ml of extract, add few drops of sodium hydroxide (NaOH) solution into a test tube. Formation of intense yellow colour that became colourless on addition of few drops of dilute HCl indicates the presence of flavonoids[12].
2. **H_2SO_4 test:** A fraction of extract was treated with concentrated H_2SO_4 and observed for the formation of orange colour.
3. **Lead acetate test:** A small amount of extract was treated with lead acetate and observed for the formation of white precipitate.

Detection for Quinones: The extracts was treated with concentrated HCl, appearance of green colouration indicates presence of Quinones.

Detection for Anthraquinones

1. **Borntrager's test:** About 50 mg of powdered extract was heated with 10% ferric chloride solution and 1ml concentrated HCl. The extract was cooled, filtered and the filtrate was shaken with diethyl ether. The ether extract was further extracted with strong ammonia, pink or deep red colourations of aqueous layer indicate the presence of anthraquinone.

Detection for Cardiac glycosides

1. **Keller-Killani Test**: 0.5 gm of extract was dissolved in 5 ml water. 2 ml of glacial acetic acid containing one drop of 5% ferric chloride solution was added. This was under layed with 1 ml of concentrated sulphuric acid. A reddish brown ring at the interface indicated the presence of a deoxy-sugar characteristic of cardenolides[13].

Detection for Sterols

1. **Liebermann-Burchard Test**: Extract was added with 2 ml chloroform. 1-2 ml acetic anhydride and 2 drops of concentrated H_2SO_4 were dropped into the test tube. First red, then blue and finally green colour indicated the presence of sterols[14].
2. **Salkowski Test:** The fraction of extract was treated with ethanol and H_2SO_4 and observed for the formation of violet blue or green colour.

Detection for Anthraquinone: 0.5 gm of the extract was boiled with 10 ml of sulphuric acid and filtered while hot. The filtrate was shaken with 5 ml of chloroform. The chloroform layer was pipetted into another test tube followed by addition of 1 ml of 10% ammonia. The resulting solution was observed for color changes to violet indicating presence of anthraquinones[13].

1. **NaOH test:** A small amount of extract was treated with 2M NaOH and observed for the formation of blue green colour.

Detection for Phenols

1. **Ferric Chloride Test**: Extracts were treated with 3-4 drops of ferric chloride solution. Formation of bluish black colour indicates the presence of phenols.
2. **Test for Cartenoids:** 1gm filtrate was extracted with 10 ml chloroform in at test tube with vigorous shaking. The mixture was filtered and 85% sulphuric acid was added. A blue colour at the interface showed the presence of cartenoids.
3. **Test for Polyphenols:** To 2 ml of extract with alcohol and few drops of neutral ferric chloride solution were added. Formation of greenish blue colour indicates the presence of polyphenol.

Detection for Carbohydrates

1. **Molisch's test:** Few drops of Molisch's reagent were added to each of the portion dissolved in distilled water, followed by addition of 1 ml of conc. H_2SO_4 by the side of the test tube. The mixture was then allowed to stand for two minutes and then diluted with 5 ml of distilled water. Formation of a red or dull violet colour at the interphase of the two layers was a positive test.
2. **Fehling's Test**- 2 ml of the extract, equal volume of freshly prepared Fehling's solution (prepared by mixing solution A: 7.0 gm $CuSO_4$. 7 H_2O in 100 ml distilled water and B: 24.0 gm KOH and 34.6 sodium potassium tartarate in 100 ml distilled water) was added and the mixture was boiled on a water bath. The development of a rusty brown colour or red precipitate indicated the presence of the carbohydrates.
3. **Benedict's Test**- To 2 ml of the aliquot, a few drops of Benedict's solution (prepared by dissolving 17.3 gm of sodium citrate, 10.0 gm of Na_2CO_3 in 75 ml of distilled water, which was filtered and to this 17.3 gm of $CuSO_4.7H_2O$ dissolved in 20 ml of distilled water was added with agitation and the volume was raised to 100 ml with distilled water) was added followed by boiling the mixture on a water bath. A sequential change in the colour (blue-green-orange) indicated the presence of carbohydrates.

Detection for Proteins

1. **Biuret Test**- To the 2 ml of the aliquot, 2 ml of 20% KOH solution was added and mixed thoroughly. To this mixture, 1 ml of 0.5 % $CuSO_4$ solution was slowly added, which resulted in the development of pale purple colour indicating the presence of proteins.
2. **Ninhydrin Test(acetone):** Ninhydrin was dissolved in acetone, the extract was treated with ninhydrin and observed for the formation of Blue colour.

Detection for Volatile Oils & Resins:

Test solution was applied on filter paper. It develops a transparent appearance on the filter paper, which indicates the presence of volatile oils and resins.

RESULTS AND DISCUSSION

The plant has medicinal property due to presence of these phytochemicals[15]. The concentration of extraction yield differed among the solvents depending on their polarity. The quantity of extraction yielded was high from high polarity solvents like methanol, ethanol and water and low from the low polarity solvents like chloroform and acetone.

In the present study, various plant parts (leaves, petiole and roots) of *Eichhornia crassipes* and (leaves and roots) of *Pistia stratiotes* were investigated. Physicochemical tests of all the plant parts of both the plants were carried out. Leaves and Petiole of *Eichhornia crassipes* show presence of various metabolites in extract. Leaves of *Pistia stratiotes* show presence of maximum metabolite in extract and roots show minimum metabolite.

Secondary metabolites like alkaloids, reducing compounds, polyphenols, alkaloids, glycosides, tannins etc. are reported in *E. crassipes* by phytochemical screening[16-19].

Preliminary phytochemical screening of the crude extracts of *E. crassipes* and revealed the presence of different kind of chemical groups (Summarized in **Table 1- Table3**).

TABLE 1: Physico-chemical tests of leaves of *Eichhornia crassipes*

	Procedure	Observation	EXTRACTIVES				
			Ethanol (ET)	Methanol (ME)	Chloroform (CF)	Acetone (Ac)	Aqueous (AQ)
TANNIN	Braymer's Test	Brownish green colour	+	+	+	-	+
PHLOBATANNIN		Red ppt	-	-	-	-	+
SAPONIN	Form Test	Foam formation	-	-	-	-	-
STEROIDS	Liebermann-Burchard Test	Red colour	+	+	+	+	-
		Green color	+	+	+	+	-
TERPENOIDS	Salkowaski Test	Reddish brown color	+	+	-	-	-
	Mayer's Test	Cream colour ppt	+	-	-	-	-
ALKALOIDS	Wager's Test	Reddish brown colour ppt	+	+	+	+	-
	Hager's Test	Yellow ppt	+	+	+	-	-
	Dragendroff's Test	Orange/ Red ppt	+	+	+	-	-
	NaOH Test	Colourless	+	+	-	-	-
	H_2SO_4 Test	Orange colour	-	-	-	-	-
FLAVONOIDS	Lead acetate	White colour ppt	+	+	+	+	+
QUINONES		Green colour	+	+	+	+	-
ANTHRAQUINONES	Borntrager's Test	Deep red colour layer	+	-	+	+	+
CARDIAC GLYCOSIDES	Keller-Killani Test	Reddish brown ring	-	+	-	+	-
	Liebermann-Burchard Test	Green colour	+	-	-	+	-
STEROLS	Salkowaski Test	Violet colour	+	+	-	+	-
ANTHOCYANIN	NaOH Test	Blue green colour	-	+	-	-	-
PHENOLS	$FeCl_3$ Test	Deep Blue colour	-	-	-	-	-
CARTENOIDS		Blue colour	+	+	-	-	+
		Greenish blue colour	-	+	-	-	+
POLYPHENOLS	Molish's Test	Red/violet colour	+	+	+	+	+
	Fehling's Test	Rusty brown color or red ppt/	-	-	+	-	+
CARBOHYDRATES	Benedict Test	Blue-Green-Orange	+	+	+	-	+
	Biuret Test	Pale purple color	+	+	+	-	+
PROTEINS	Ninhydrin	Blue colour	-	-	-	-	-
VOLTILE OILS & RESINS		Transparent appearence	+	+	+	-	-

+ indicates presence; – indicates absence

TABLE 2: Physico-chemical tests of Petiole of *Eichhornia crassipes*

			EXTRACTIVES				
	Procedure	**Observation**	**Ethanol (ET)**	**Methanol (ME)**	**Chloroform (CF)**	**Acetone (Ac)**	**Aqueous (AQ)**
TANNIN	Braymer's Test	Brownish green colour	-	-	-	-	-
PHLOBATANNIN		Red ppt	-	-	-	-	+
SAPONIN	Form Test	Foam formation	-	-	-	-	-
STEROIDS	Liebermann-Burchard Test	Red colour	+	+	-	+	-
		Green color	+	+	-	+	-
TERPENOIDS	Salkowaski Test	Reddish brown color	+	+	-	-	-
ALKALOIDS	Mayer's Test	Cream colour ppt	+	+	-	-	+
	Wager's Test	Reddish brown colour ppt	+	+	+	+	-
	Hager's Test	Yellow ppt	+	+	+	-	-
	Dragendroff's Test	Orange/ Red ppt	+	+	+	-	-
	NaOH Test	Colourless	-	+	-	-	-
	H_2SO_4 Test	Orange colour	-	+	-	-	-
FLAVONOIDS	Lead acetate	White colour ppt	+	+	+	+	+
QUINONES		Green colour	+	+	+	+	-
ANTHRAQUINONES	Borntrager's Test	Deep red colour layer	+	+	+	+	+
CARDIAC GLYCOSIDES	Keller-Killani Test	Reddish brown ring	-	+	-	+	-
	Liebermann-Burchard Test	Green colour	-	+	-	-	-
STEROLS	Salkowaski Test	Violet colour	-	-	-	+	-
ANTHOCYANIN	NaOH Test	Blue green colour	-	-	-	-	-
PHENOLS	$FeCl_3$ Test	Deep Blue colour	-	-	-	-	-
CARTENOIDS		Blue colour	+	+	-	-	-
POLYPHENOLS		Greenish blue colour	-	-	-	-	-
CARBOHYDRATES	Molish's Test	Red/violet colour	+	+	+	+	+
	Fehling's Test	Rusty brown color or red ppt/	-	-	+	+	-
	Benedict Test	Blue-Green-Orange	+	-	+	-	-
	Biuret Test	Pale purple color	+	-	+	-	+
PROTEINS	Ninhydrin	Blue colour	+	-	-	-	-
VOLTILE OILS & RESINS		Transparent appearence	-	-	-	-	-

+ indicates presence; – indicates absence

TABLE 3: Physico-chemical tests of root of *Eichhornia crassipes*

	Procedure	Observation	EXTRACTIVES				
			Ethanol (ET)	Methanol (ME)	Chloroform (CF)	Acetone (Ac)	Aqueous (AQ)
TANNIN	Braymer's Test	Brownish green colour	-	-	-	-	-
PHLOBATANNIN		Red ppt	-	-	-	-	-
SAPONIN	Form Test	Foam formation	-	-	-	-	-
STEROIDS	Liebermann-Burchard Test	Red colour	-	+	-	-	-
		Green color	-	-	-	-	-
TERPENOIDS	Salkowaski Test	Reddish brown color	-	-	-	-	-
	Mayer's Test	Cream colour ppt	-	-	-	+	-
	Wager's Test	Reddish brown colour ppt	-	-	+	+	-
	Hager's Test	Yellow ppt	-	-	+	-	-
ALKALOIDS	Dragendroff's Test	Orange/ Red ppt	-	-	+	+	-
	NaOH Test	Colourless	-	-	-	-	-
	H_2SO_4 Test	Orange colour	+	-	-	-	-
FLAVONOIDS	Lead acetate	White colour ppt	+	+	+	+	+
QUINONES		Green colour	+	+	+	-	+
ANTHRAQUINONES	Borntrager's Test	Deep red colour layer	-	+	+	+	+
CARDIAC GLYCOSIDES	Keller-Killani Test	Reddish brown ring	-	-	-	+	+
	Liebermann-Burchard Test	Green colour	-	-	-	-	-
STEROLS	Salkowaski Test	Violet colour	-	-	-	-	-
ANTHOCYANIN	NaOH Test	Blue green colour	-	-	-	-	-
PHENOLS	$FeCl_3$ Test	Deep Blue colour	-	-	-	-	-
CARTENOIDS		Blue colour	-	+	-	-	-
POLYPHENOLS		Greenish blue colour	-	-	-	-	-
	Molish's Test	Red/violet colour	-	+	+	+	+
	Fehling's Test	Rusty brown color or red ppt	-	-	+	+	-
CARBOHYDRATES	Benedict Test	Blue-Green-Orange	-	-	-	-	+
	Biuret Test	Pale purple color	-	-	+	-	-
PROTEINS	Ninhydrin	Blue colour	-	-	-	-	-
VOLTILE OILS & RESINS		Transparent appearence	-	-	-	-	-

+ indicates presence; – indicates absence

Preliminary phytochemical screening of the crude extracts of *P. stratiotes* and revealed the presence of different kind of chemical groups (Summarized in **Table 4- Table5**).

TABLE 4: Physico-chemical tests of leaves of *Pistia stratiotes*

	Procedure	Observation	EXTRACTIVES				
			Ethanol (ET)	Methanol (ME)	Chloroform (CF)	Acetone (Ac)	Aquous (AQ)
TANNIN	Braymer's Test	Brownish green colour	+	-	-	-	+
PHLOBATANNIN		Red ppt	-	-	-	-	-
SAPONIN	Form Test	Foam formation	-	-	-	-	-
STEROIDS	Liebermann-Burchard Test	Red colour	+	+	+	-	-
		Green color	+	+	+	-	-
TERPENOIDS	Salkowaski Test	Reddish brown color	-	-	-	-	-
ALKALOIDS	Mayer's Test	Cream colour ppt	-	-	-	-	-
	Wager's Test	Reddish brown colour ppt	-	+	-	-	-
	Hager's Test	Yellow ppt	-	+	-	-	-
	Dragendroff's Test	Orange/ Red ppt	-	-	-	-	-
	NaOH Test	Colourless	-	-	-	-	-
	H_2SO_4 Test	Orange colour	+	-	-	-	-
FLAVONOIDS	Lead acetate	White colour ppt	+	+	+	-	-
QUINONES		Green colour	+	+	+	-	-
ANTHRAQUINONES	Borntrager's Test	Deep red colour layer	+	+	+	+	+
CARDIAC GLYCOSIDES	Keller-Killani Test	Reddish brown ring	+	+	-	+	+
	Liebermann-Burchard Test	Green colour	-	-	+	-	-
STEROLS	Salkowaski Test	Violet colour	-	-	+	-	-
ANTHOCYANIN	NaOH Test	Blue green colour	-	-	-	-	+
PHENOLS	$FeCl_3$ Test	Deep Blue colour	-	-	-	-	+
CARTENOIDS		Blue colour	-	-	-	-	+
POLYPHENOLS	Molish's Test	Greenish blue colour	-	-	-	-	+
		Red/violet colour	-	-	-	-	-
	Fehling's Test	Rusty brown color or red ppt/	-	-	+	-	-
CARBOHYDRATES	Benedict Test	Blue-Green-Orange	-	-	-	-	-
	Biuret Test	Pale purple color	-	-	-	-	-
PROTEINS	Ninhydrin	Blue colour	-	-	-	-	-
VOLTILE OILS & RESINS		Transparent appearence	+	+	+	-	-

+ indicates presence; – indicates absence

TABLE 5: Physico-chemical tests of roots of *Pistia stratiotes*

			EXTRACTIVES				
	Procedure	**Observation**	**Ethanol (ET)**	**Methanol (ME)**	**Chloroform (CF)**	**Acetone (Ac)**	**Aquous (AQ)**
TANNIN	Braymer's Test	Brownish green colour	-	-	-	-	+
PHLOBATANNIN		Red ppt	-	-	-	-	-
SAPONIN	Form Test	Foam formation	-	-	-	-	-
STEROIDS	Liebermann-Burchard Test	Red colour	-	-	+	-	-
		Green color	-	-	+	-	-
TERPENOIDS	Salkowaski Test	Reddish brown color	-	-	-	-	-
	Mayer's Test	Cream colour ppt	-	-	-	-	-
	Wager's Test	Reddish brown colour ppt	-	-	-	-	-
	Hager's Test	Yellow ppt	-	-	-	-	-
ALKALOIDS	Dragendroff's Test	Orange/ Red ppt	-	-	-	-	-
	NaOH Test	Colourless	-	-	-	-	-
	H_2SO_4 Test	Orange colour	-	-	-	-	-
FLAVONOIDS	Lead acetate	White colour ppt	+	+	+	-	+
QUINONES		Green colour	+	+	+	-	+
ANTHRAQUINONES	Borntrager's Test	Deep red colour layer	+	+	+	+	+
CARDIAC GLYCOSIDES	Keller-Killani Test	Reddish brown ring	+	+	+	+	+
	Liebermann-Burchard Test	Green colour	-	-	+	-	-
STEROLS	Salkowaski Test	Violet colour	-	-	+	-	-
ANTHOCYANIN	NaOH Test	Blue green colour	-	-	-	-	+
PHENOLS	$FeCl_3$ Test	Deep Blue colour	-	-	-	-	-
CARTENOIDS		Blue colour	-	-	-	-	-
POLYPHENOLS	Molish's Test	Greenish blue colour	-	-	-	-	-
		Red/violet colour	-	-	-	-	-
	Fehling's Test	Rusty brown color or red ppt	-	-	+	-	-
CARBOHYDRATES	Benedict Test	Blue-Green-Orange	-	-	+	-	-
	Biuret Test	Pale purple color	-	-	-	-	-
PROTEINS	Ninhydrin	Blue colour	-	-	-	-	-
VOLTILE OILS & RESINS		Transparent appearence	-	-	+	-	+

+ indicates presence; – indicates absence

Active chemical constituents and their medicinal values: The active chemical metabolites present in the *Eichhornia crassipes* and *Pistia stratiotes* are believed to account for its extraordinary medicinal properties as shown in the **Table 6**.

Alkaloids are heterocyclic indole compounds which have established pharmacological properties[20-23]. The presence of flavonoids and tannins in all the plants is likely to be responsible for the free radical scavenging effects.

Flavonoids and tannins are phenolic compounds and plant phenolics are a major group of compounds that act as primary antioxidants or free radical scavengers[24]. Flavonoids exhibit pharmaceutical activities[25-27] like anti-allergic, anti-inflammatory, antimicrobial and anticancer activity[28].

Steroids have been observed to promote nitrogen retention in osteoporosis and in animals with wasting illness[29]. **Triterpenoids** are a large class of natural isoprenoids present in higher plants, which exhibit a wide range of biological activities[30-36].

Anthraquinones are a main source of natural dye, which are gaining importance due to the environmental pollution caused by synthetic dyes[37]. Anthocyanins exhibit important antioxidant and anti-inflammatory actions as well as chemotherapeutic effects[38].

Tannin found to possess astringent properties for the healing of wounds and inflamed mucous membranes. Tannin and flavonoid are responsible for antidiarrheal activity. Tannin has been widely used to sprains, bruises and superficial wounds and has antibacterial property.

Carbohydrate is reported to have numerous roles in living things, such as the storage and transport of energy (starch, glycogen) and structural components (cellulose in plants, chitin in animals). Additionally carbohydrates and their derivatives play major role in the working process of the immune system, fertilization, pathogenesis, blood clotting and development[39].

Proteins work together to achieve a particular function, and form stable complexes. Many proteins are enzymes that catalyze biochemical reactions and are vital to metabolism. Proteins also have structural or mechanical functions. Other proteins are important in cell signalling, immune responses, cell adhesion, and the cell cycle. Proteins are also necessary as fodder; since animals cannot synthesize all the amino acids. The most important industrial uses of proteins are for the production of plastics and adhesives, in coatings for the paper products, and in bonding ply wood veneers. Artificial textile fibres can be prepared from vegetable proteins[40,41].

TABLE 6: Active Constituents and their Medicinal Value of different Extracts of *Eichhornia crassipes* and *Pistia stratiotes*

Active Constituent	Medicinal Value
Alkaloids	Anti-microbial, sedative, relaxant, anti-spasmodic; used to treat tumors, nocturnal leg cramps, diarrhoea, psychiatric and palpitation
Flavonoids	Anti-oxidant, strengthens capillary walls, antidiarrheal activity, reduces osteoporosis, improves blood cholesterol levels, and lowers risk of cancer and coronary heart diseases.
Steroids	Aphrodisiac, reduces cholesterol levels, affects immune system and tumor cells
Terpenoids	Anti-viral, anti-bacterial, anti-malarial, anti-inflammatory, anti-cancer; inhibits cholesterol synthesis
Saponins	Anti-inflammatory, anti-hepatotonic, hypoglycemic, anti-microbial and anti-viral; used in detergents and molluscicides
Tannins	Anti-fungal, anti-biotic, anti-inflammatory, analgesic, astringent and wound healing, antidiarrheal activity.
Phenols	Antiinflammatory, antioxidants, anticancer, antiseptic
Glycosides	Sedative, muscle relaxant, diuretic

The presence of alkaloids, flavonoids, sterols, terpenoids, anthraquinones, proteins, phenols and quinones in ethanol extracts of fresh *E. crassipes*[42]. A preliminary phytochemical analysis of *P. stratiotes* in methanol and n-hexane extracts confirmed the presence of flavonoids, tannins, alkaloids, steroids, reducing sugars, deoxy sugars, glycosides, resins and saponins. However, anthraquinones and volatile oils were not detected in both extracts while the detection of phenolic compounds in both extracts was confirmed by the positive test for flavonoids[43]. Phenolic compounds possess biological properties such as antiapoptosis, antiaging, anticarcinogen, antiinflammation, as well as inhibition of angiogenesis and cell proliferation activities[44]. The phytochemical studies of plant extract with methanol shows that alkaloids, phytosterols, phenols, flavonids and tannins are present in *P. stratiotes* leaves. However, Fehling's and Molish test for carbohydrate and Salkowski test for terpenoids showed negative response[45]. The preliminary phytochemical screening of *P. stratiotes* revealed presence of alkaloids, carbohydrates,

tannins and phenolic substances, steroids and sterols, triterpenoids, flavonoids, saponins and gummy materials[46].

CONCLUSION

Plants are rich in primary and secondary metabolites are widely used in traditional medicine to combat and cure various ailments. *Eichhornia crassipes* and *Pistia stratiotes* are the plants used in medicine from the time of Ayurveda, the ancient system of Indian medicine. The different extracts of both the plant contain many bioactive chemical constituents including, alkaloids, glycosides, steroids, terpenoids, saponins, tannins and reducing sugars. The anti-inflammatory, antispasmodic, antianalgesic and diuretic effects can be attributed to the high steroids, tannins, terpenoids, saponins and glycosides present in these plants. These plants has been used successfully in Ayurvedic medicine for centuries, more clinical trials should be conducted to support its therapeutic use.

The present study can be used in future for the economical formulation of the active chemical ingredients in natural drugs against a variety of neurological and inflammatory diseases.

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