Research Article

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Quantification and identification of alkaloids of *Eichhornia crassipes*: the world’s worst aquatic plant

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ABSTRACT

The recent revival of interest in plant medicines across the globe and consequent pressure on precious herbal resources, calls for the use of plants through scientific screening and validation. The world’s worst aquatic weed water hyacinth usually ranges from tropical desert to subtropical or warm temperate desert to rainforest zones. The present investigation was planned to detect the presence of secondary metabolite alkaloids in the shoot and rhizome part of the plant by preliminary screening. Thin Layer Chromatography (TLC) technique trailed by quantitative estimation. Alkaloids are bio-active compounds having therapeutic importance. Plant species examined contained six alkaloids isolated by TLC. Because of the rich diversity of this aquatic plant it is expected that screening and scientific evaluation of plant extracts may prove beneficial for the mankind along with the management of the weed. The result obtained indicates that though the plant is an aquatic weed is good services of phytochemical needed for maintenance of good health and can also be exploited in the manufacture of drugs.

Keywords: Alkaloids, *Eichhornia crassipes*, Water hyacinth.

INTRODUCTION

The roles of plants in maintaining human health is well documented [31]. Plants are used medicinally in different countries and are a source of many potent and powerful drugs [40]. The active principles of many drugs found in plants are secondary metabolites [14, 9]. Therefore, basic phytochemical investigation of these plant extracts for their major phytoconstituents is also vital. Most of the molecules in plants are secondary metabolites, of which at least 12,000 have been isolated and the number estimated to be less than 10% of the total [32]. The medicinally useful bioactive constituents can be divided into several categories of alkaloids, flavonoids, phenolics, essential oils and polyphenols [37, 26, 1, 6, 15]. Alkaloids play a metabolic role and control development in living systems [12]. These chemical substances are known to carry out important medicinal roles, in human body. They are also involved in protective function in animals and are used as medicine especially the steroidal alkaloids [41].

Aquatic plants have economic & environmental uses, depending on their natural characteristics. Some are consumed in human diet, while other species have medicinal values and still other species are good resources of minerals and vitamins. Since aquatic weeds are known to differ widely in their chemical composition depending upon species, season and location [5], an insight into their chemical composition is essential if utilization prospects are to be considered.

*Eichhornia crassipes* (Mart) Solms commonly known as water hyacinth is warm water aquatic plant belonging to the family Pontederaceae. Water hyacinth is listed as one of the most productive plant on earth and is considered the world’s worst aquatic plant [21, 44, 16]. Its habitat ranges from tropical desert to subtropical or warm temperate desert to rainforest zones. It tolerates annual temperatures ranging from 21.1°C to 27.2°C and its pH tolerance is estimated at 5.0 to 7.5. The “beautiful blue devil” water hyacinth, recognized by its lavender flowers and shining bright leaves which spreads at an alarming rate. The plant is euryhaline, tolerating both fresh and marine water; hence its spread knows no boundaries. Recently, screening and validation have been given to harvesting this aquatic plant for practical uses to partially defray the cost of removing plants from waterways and use as economical sources in many parts of the world. Though very less pharmacological study on *Eichhornia crassipes* has been reported in literature; this study was designed to evaluate the pharmacological active substance of water hyacinth in order to establish the molecular basis for some of its therapeutic properties in folkloric use.

Thus, the present study have been concentrated on the preliminary screening, qualitative separation carried out by thin layer chromatography and followed by the quantitative estimation of the secondary metabolite i.e. alkaloids from *Eichhornia crassipes*. Hence, the study deals with the screening and scientific evaluation of bio-active compound that may prove beneficial for the mankind along with the management of the aquatic weed.

MATERIALS AND METHODS:

Water hyacinth (*Eichhornia crassipes*) plants were collected from the water bodies in Bilaspur district of Chhattisgarh (21°37′-25°7′ N latitude and 81°12′-83°40′ E longitude). Fresh shoots and rhizomes were washed several times under running tap water followed by surface sterilization by Mercuric Chloride (0.01%). The shoot and rhizome parts were separated and shade dried followed by oven-drying at 50°C for 24 hours. These plant materials were grinded to powder and used for further phytochemical analysis as follows:

a) Preliminary screening for alkaloid:

The aqueous extract of each sample (shoot and rhizome) was prepared by soaking 100g of dried powdered samples in 200ml of distilled water for 12 hours. The extracts were filtered using Whatman filter paper No. 42 (125mm) and used for test using the standard method of Harborne (1998) [18].

Test for alkaloid:

5ml of extract was added to 2ml of hydrochloric acid. To this acidic medium, 1ml of Dragendorff’s reagent was added. An orange or red precipitate appears immediately which indicates the presence of alkaloids.

b) Qualitative screening of alkaloid by TLC study:

Thin layer chromatography (TLC) technique of crude extracts was applied for the detection of alkaloid using the standard method of Harborne (1973) [17]. The powdered shoot and rhizome of water hyacinth with 10%
acetic acid in ethanol were extracted separately and kept for 4 hours to settle down. The extracts were concentrated to one quarter of the original volumes and then the alkaloids were precipitated by drop wise addition of concentrated ammonium hydroxide (NH₄OH). Extracts were centrifuged at 10,000 rpm for 10 minutes. Each residue was washed with 1% NH₄OH while discarding the supernatant. Then the residue was dissolved in a few drops of chloroform. The final extracts obtained (shoot extract SE and rhizome extract RE) were spotted on the TLC plate (plate of silica gel G) and the chromatograms developed using developing system (Methanol-Ammonium hydroxide in 200:3 proportion). Later, the spots for alkaloid were detected by their colour in UV light and R<sub>f</sub> (x100) values.

c) Quantitative estimation of alkaloid:

Quantitative estimation of alkaloid in water hyacinth (shoot and rhizome) was done by using standard procedures as described by Harborne (1973) [17].

RESULTS:

Preliminary screening of Eichhornia crassipes reveals the presence of alkaloids in both, shoot and rhizome part. The data obtained by the qualitative analysis of alkaloids from the shoot and rhizome parts of water hyacinth using TLC is summarized in Table 1. Distribution of alkaloids in the shoot and Table 1. Qualitative separation of alkaloid contents from Eichhornia crassipes by thin layer chromatography (TLC).

<table>
<thead>
<tr>
<th>Different Extracts</th>
<th>Solvent System : Methanol – Ammonium hydroxide, (200:3)</th>
<th>Colour of the Spots/Behaviour in UV light</th>
<th>Alkaloids</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R&lt;sub&gt;f&lt;/sub&gt;(X100) Observed values</td>
<td>R&lt;sub&gt;f&lt;/sub&gt;(X100) Standard values</td>
<td></td>
</tr>
<tr>
<td>SE</td>
<td>31.8 32</td>
<td>Blue</td>
<td>Cytisine</td>
</tr>
<tr>
<td></td>
<td>34.8 35</td>
<td>Ochre green</td>
<td>Codeine</td>
</tr>
<tr>
<td></td>
<td>41.6 41</td>
<td>Dark green</td>
<td>Thebaine</td>
</tr>
<tr>
<td></td>
<td>52.2 52</td>
<td>Bright blue</td>
<td>Quinine</td>
</tr>
<tr>
<td></td>
<td>62.1 62</td>
<td>Light brown</td>
<td>Tornatine</td>
</tr>
<tr>
<td>RE</td>
<td>32 32</td>
<td>Blue</td>
<td>Cytisine</td>
</tr>
<tr>
<td></td>
<td>56.8 57</td>
<td>Light blue to greenish</td>
<td>Nicotine</td>
</tr>
<tr>
<td></td>
<td>63.2 62</td>
<td>Light brown</td>
<td>Tornatine</td>
</tr>
</tbody>
</table>

Key: SE = water hyacinth shoot extract, RE = water hyacinth rhizome extract

Table 2. Distribution of Alkaloid constituents in the shoot and rhizome parts of Eichhornia crassipes.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Phytochemicals</th>
<th>Shoot</th>
<th>Rhizome</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cytisine</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>2</td>
<td>Nicotine</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>3</td>
<td>Tornatine</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>4</td>
<td>Codeine</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>5</td>
<td>Thebaine</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>6</td>
<td>Quinine</td>
<td>+</td>
<td>–</td>
</tr>
</tbody>
</table>

Key: + is presence of constituents, – is absence of constituents

Table 3. Quantitative estimation of alkaloid from Eichhornia crassipes (values in percentage).

<table>
<thead>
<tr>
<th>Plant part</th>
<th>Alkaloid (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shoot</td>
<td>0.36 ± 0.077</td>
</tr>
<tr>
<td>Rhizome</td>
<td>0.66 ± 0.630</td>
</tr>
</tbody>
</table>

Mean ± SD (n = 4) rhizome of water hyacinth were shown in Table 2. A total of six alkaloids detected from the plant include cytisine, nicotine, tomatine, codeine, thebaine and quinine. Five alkaloids except nicotine are present in shoot of water hyacinth. While as rhizome consist of only three alkaloids namely cytisine, nicotine and tomatine. Hence, the total alkaloids in shoot were found to be greater than the rhizome of Eichhornia crassipes. However, quantitative estimation of alkaloid contents reveals the high percentage in rhizome (0.66%) compared to shoot (0.36%) of Eichhornia crassipes (table 3).

DISCUSSION:

The phytochemicals are known to have antimicrobial activity [11, 20, 43]. According to Lewis and Elvin-Lewis [28], alkaloids functions with the aid of their defense mechanism act as phytoprotective agent against invading microorganism. Alkaloids have anti-inflammatory effects [30, 27, 29, 3, 23], hypoglycemic activities [35, 8]. Reports by Stray [42], Okwu and Okwu [34] indicate that naturally occurring alkaloids and their synthetic derivatives have antispasmodic and bactericidal activities. Similarly, according to Doughari [10] alkaloids are formed as metabolic by-products and have been reported to be responsible for the antibacterial activity. These are heterocyclic indole compounds which have proved to have pharmacological properties such as hypotensive activity [2], anticonvulsant activity [39], antitrypanosoma, antimicrobial and antimalarial activities [36, 13]. Alkaloids are also reported to be most effective for managing hypertension and also providing protection for the heart. Some alkaloids are known to be useful in correcting renal disorders [25]. According to Okwu [33] alkaloids are known to exhibit marked physiological activity when administered to animals.

Kandukuri et al. [24] reported the presence of alkaloids in Eichhornia crassipes whereas its absence was reported by Anjana and Matai [4], Ndubuisi et al. [32]. Haroon [19] recorded the antimicrobial activity in Eichhornia crassipes. In addition in recent findings [22] water hyacinth was reported as a safe cancer medicine and revealed its tumor inhibition potential. The results obtained in the present investigation show the presence of good amount of alkaloid, a secondary metabolite that take part in defense mechanism and also take part in the therapeutic activities. Hence, the water hyacinth can be exploited for use in pharmaceutical and cosmetic industries. A complete study conducted with the purpose of finding this chemical in water hyacinth is worthwhile as the output is “Best out of the waste”. Therefore it can be suggested that Eichhornia crassipes are not only interesting source of therapeutic activities but also potential source of alkaloids.

REFERENCES:

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