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Research Paper

Comparative Studies of the Phytochemical and Nutritional Analysis of Water Hyacinths *[Eichhornia crassipes]* Stem and Leaf

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The use of Herbal plant formulations and culinary as an excellent source of several nutrients and ethno-medicine has been the major subject of study in human history. This conventional usage prompted the researchers to formulate these herbal drugs in the treatment of diseases. This study is predominantly on the comparative, characterization and nutritional assay of the stem and leaf of water hyacinth extracts through phytochemical screening, elemental and proximate analysis to elucidate the potential applications. From the results, the ethanol extract of the leaves (EL) revealed the presence of phenol, steroids and saponin owing to the affinity of the solvent for hydrophilicity, while the hexane extract of the leaves (HL) shows the presence of flavonoids and steroids. Also the ethanolic extract of the stems (ES) shows the presence of phenol, steroids and saponin for the same reason, while the hexane extract of stems (HS) shows the presence of flavonoids and steroids. The proximate analysis of the leaf reveals appreciable percentages of protein, fibre and moisture content while that of stem shows higher percentages for carbohydrates and crude lipids. The leaf and stem show equal percentages for the ash content. The Elemental analysis shows that heavy metal concentrations of the leaf and stem are within threshold limits. This evident research substantiates the potential application of water hyacinth for consumption. The presence of secondary metabolites for pharmacological and therapeutic utilization such as anticancer, antimicrobial, antioxidant, antidandruff, antiproliferative activities and provides a potential source of animal feed due to the higher percentage of carbohydrates, crude protein and crude fibre.

Keywords: Stem and leaf, phytochemical, nutritional analysis, water hyacinth

INTRODUCTION

Eichhornia crassipes (Mart) Solms commonly known as water hyacinth is native to South America that is Brazil. It is one of the most prolific free floating monocotyledonous and stoloniferous plants on earth and is considered the world's worst aquatic weed or macrophyte, belonging to the family Pontederiaceae (Musa, 2005). Water hyacinth possesses serious environmental treats in many regions of the world by disturbing human activities such as fishing, clogging of irrigation and blockage of water channels. It also serves as micro habitat for some aquatic animals, birds and disease vectors. This plant in recent years has been exploited for its phytochemical constituents and phytoremediation owing to its much higher nutrient removal efficiency with their high nutrient uptake capacity, pharmaceutical properties and adsorption characteristics show the presence of significant secondary metabolites in the world's worst weed (Lindsey *et al.,* 1999). The plant has high oxygen absorption when decomposition of a large biomass of the plants occurs (Gopal, 1987). In spite of all these multi-

faceted problems that are constantly getting ravaged and escalated by water hyacinth, it has some usability in the production of fertilizer, animal feeds, paper production, water purification, biogas generation because of its 64% methane content. Once looked upon nonchalantly and has received supreme interest in recent years owing to its constructiveness in various fields.This plant in recent years has been exploited for its phytochemical constituents and phytoremediation owing to its much higher nutrient removal efficiency with their high nutrient uptake capacity, pharmaceutical properties and adsorption characteristics show the presence of significant secondary metabolites in the world's worst weed (Lindsey and Hirt, 1999). Because, when compared to other plants, water hyacinths posses fast growth rate in the active growth season, for instance, twice the quantity of water hyacinth plants and biomass can occur within a short range of days. Due to its high scathel nature, it has been enlisted as among 100 of the world's worst invasive alien species (Lowe *et al*., 2000; Hill *et al.,* 2011) as shown in (Figure 1).

Figure 1. Water hyacinth.

Antimicrobials have long been synthesized with the advent of the first synthetic antibiotic as these were single molecules which are competent against countless organisms. Development of antibiotic resistance has led to the structural alteration of the existing drugs which in many case has been proved to be effective thus extending the life span of the drugs (Villamagna and Murphy, 2010). These synthetic drugs again warrant modification when the organisms start resisting them. Rational drug design does not always give way to effectual antimicrobials (Cushnie and Lamb, 2005). In the past, owing to the complex matter of drug uptake by cells, synthesis of potent enzyme inhibitors with diffident antibacterial activity was only carried out. An alternative approach for the development of novel drugs is represented by the wide empirical screening of chemical entities for antimicrobial activity (Mungole and Chaturvedi, 2011). Renewal in the plant derived phytochemicals has again bloomed as the structural modification cannot be continuously made to produce an effective drug targeting other sites than that already targeted. Curative nature of plants has been exploited with scientific significance in past few decades. Perhaps many researchers have started exploiting the plant sources for the lead compounds which can be active against such organisms. Natural products have been a largely rich source of anti-infective agents (Rahmoun *et al.,* 2010; Dubey *et al.,* 2012) in past few years indicating the surge of the researchers to identify a plant with good antimicrobial activity (Selvamohan *et al.,* 2010; Jayanthi *et al.,* 2012). Researchers mainly focus on the medicinal plants rather than on the common weeds which are also the source of many phytochemicals. Attention has been drawn more recently to the potentials and severe restriction to the scope of using freshwater biomass for variety of applications such as animal fodder and means of metal remediation has been reported (Sharma and Kumar, 2012). The prospect of converting aquatic weeds to biogas and bioethanol is ongoing in some developing countries such as India (Arulpriya *et al.,* 2010). Water hyacinth contains many phytochemicals (Harborne, 1973). Systematic investigation has evaluated that these aquatic weeds constitute some considerable importance such as proteins and minerals but failed to gain utilization and attention. This resulted in aquatic bodies being inhabitable for fish culture, though it can be incorporated into fish diets for conversion into valuable fish flesh (Harborne, 1973). However, it posed several limitations, such as low protein contents, amino acid imbalance, anti nutritional factors, excess amount of crude fibres in some plants and presence of large percentage of ash owing to the composition of some elemental component (Harborne, 1973). Therefore some processing means has been adopted to enhance the nutrient value of these plants' ingredients. Trials have also been made in order to increase the bioavailability of these nutrients, to reduce or remove anti-nutritional factors and crude fibres and also to add certain known deficient additives required. Hence the present paper tends to reports the comparative study for the phytochemical and nutritional bioassay of water hyacinths *(Eichhornia crassipes)* stem and leaf using ethanol and hexane solvents.

MATERIALS AND METHODS

Sample collection

Fresh water hyacinth was collected randomly and aseptically from a swampy area of a fish pond in Gwagwalada, Pasol road. The leave and the stem portion were cut off and washed thoroughly to free from debris. The leaf and stem portion were blended separately and kept in a plastic bucket prior to preservation in refrigerator for some days to prevent the decomposition of the sample.

Preparation of extracts

The extraction was carried out on the leaves and stems

by a method of successive maceration, a quantity of plant materials (leaves and stems) are weighed and suspended with 550 ml of ethanol and hexane solvent separately. The extracts were concentrated using rotary evaporator, which is now stored in a refrigerator at 4°C prior to further analysis (Chukwuka *et al*., 2011). The various solvent extracts and fractionates of the extract was then screened for the presence of different phytochemicals (Trease and Evans,1989).

Phytochemical test

Ethanolic and hexane extract of fresh leaves and stems of *Eichhornia crassipes* were subjected to preliminary phytochemical screening for the detection of various plant constituents.

Proximate analysis

The aquatic plant was analyzed for, moisture, carbohydrates, crude proteins, crude lipids, ash, and crude fibre.

Ash contents

This is the measure of the residual left over after the complete incineration of the dried sample. 3.0 g of the dried plant samples were incinerated in a muffle furnace at 550°C for 5 h. The initial temperature was 300°C and temperature was increased slowly by 50°C for every 30 min. The ashes produced were then cooled down to room temperature in desiccators and then reweighed. The ash content was then calculated as:

Ash % = Ash weight (g) / Weight of dry sample x 100

(Prince and Prabakara, 2011; Onwuka, 2005)

Crude protein

These were determined by digesting the sample at high temperature (105°C) in 25 ml concentrated sulphuric acid in the presence of potassium sulphate and copper sulphate catalyst. Then sodium hydroxide was added to the sulphate of ammonia produced by digestion in order to release ammonia. Collection was done after distillation in boric acid solution with bromocresol green and methyl red indicator and a 0.1 HCl titrant. The percentage of crude protein was obtained by multiplying by a factor, the percentage of nitrogen determined by titration.

$$\% \text{ of Crude Protein} = \frac{(\text{Volume} \times 0.875)}{\text{Sample weight}}$$

Were
Volume = Volume for titration of sample
0.875 = factor for protein
Sample weight = weight of sample used for digestion (James, 1995)

Crude lipids

Soxhlet fat extraction method was used for the lipid content determination by placing 5g of the dried samples in the extraction thimble plugged lightly with cotton wool. The soxhlet apparatus was allowed to reflux at 50^{o}C using 50 ml of petroleum ether till extraction was complete. The extracted solvent in the flask were transferred into an already weighed oven dried beakers, then evaporated to dryness using water bath at 60^{o}C. The dried fat was then cooled in a desiccator prior to weighing (AOAC, 2000)

Crude fibre

The crude fibre content was evaluated by a method of acid and alkaline digestion methods using 4g of each sample with 20% H_2SO_4 and NaOH solution and then boiled (Udo *and* Oguwele, 1986).

Crude carbohydrate content

The carbohydrate content of the test samples were determined by estimation using the arithmetic difference method. %CHO = 100 - (%fat + %ash + % fibre + % protein) (Kar and Ghosh, 2008).

Moisture content

2 g of the aquatic plant samples were oven-dried in crucibles at 105°C overnight and then cooled in a desiccator for 1 h prior to weighing. The percentage losses in weight were expressed as percentage moisture content (Tsuchiya, 2010).

Mineral analysis

The assay of the heavy composition of the aquatic plant samples (stem and leaf) were carried out by analyzing the mineral composition, the evaluations were done by digesting 3 g on a hot plate using acid digestion (HNO_3) and then subjected to heating in a fume cupboard. After digestion, the solutions were filtered into 100 ml volumetric flask and the volume made up to the mark using deionized water. The element determined were Cr, Cd and Pb using the various standards for calibration. The equipment used was Atomic Absorption spectrometer.

RESULTS AND DISCUSSION

The phytochemical, elemental and proximate composition of *E. crassipes* (leaf and stem) determined were

Table 1. Phytochemical screening of the extracts of water hyacinth leaf and stem

S/N	Phytochemicals	EL	ES	HL	HS
1	Alkaloids				
A	Mayers test	-	-	-	-
B	Wagner's test	-	-	-	-
C	Hager's test	-	-	-	-
2	Flavonoids				
A	NaOH Test	-	-	+	+
B	H_2SO_4 test	-	-	+	+
3	Steroids				
A	Liebermann-Burchard test	-	-	-	-
4	Terpenoids				
A	Liebermann-Burchard test	+	+	+	+
5	Tanins				
A	Lead acetate test	-	-	-	-
B	gelatin test	-	-	-	-
6	Saponins				
A	Foam test	+	+	-	-
7	Phenolics				
A	Ferric chloride test	+	+	-	-
B	Libermann's test	+	+	-	-

Key notes: EL=Ethanolic Leaf, ES=Ethanolic Stem, HL=Hexane Leaf, HS= Hexane Stem.

Table 2. Proximate analysis result of water hyacinth stem and leaf.

Parameters	% Concentration	
	Stem	Leaf
Crude protein	9.68 ± 0.02	20.66±0.77
Crude fibre	28.50 ± 0.12	34.89±0.01
Crude lipid	1.60 ± 0.09	0.63±0.08
Ash	15.46±0.20	15.46±0.13
Moisture	9.29 ± 0.39	10.22±0.32
Carbohydrates	35.47	18.14±0.18

Key: Data are mean triplicates determinations ± standard deviation.

summarized in the (Tables 1-3), the ethanol extract of leaves (EL) revealed the presence of phenol, steroids and saponin owing to the affinity of the solvent for hydroxyl radical while the hexane extract of the leaves (HL) shows the presence of flavonoids and steroids as shown in (Table 1). Also the ethanolic extract of the stems (ES) shows the presence of phenol, steroids and saponin while the the hexane extract of stems (HS) shows the presence of flavonoids and steroids as shown in (Table 1). This result corresponds with that reported by Jayanthi *et al*. (2012) and Lalitha *et al.* (2013). Phytochemical studies have shown that plants with antimicrobial activity contain bioactive constituents such as tannins, flavonoids, alkaloids and saponins. Alkaloids and flavinoids have been used as antiviral, antibacterial, antiamoebial and anticancer agents. Phenolic and polyphenolic are the other group of secondary metabolites. The uses of plant-derived products as disease control agents have been studied, since they tend to have low mammalian toxicity, less environmental effects and wide public acceptance (Tsuchiya, 2010). This evident result indicated that the anti-nutritive bioactive components are widely distributed within the stems and the roots although other bioactive substances

Table 3. Elemental analysis of the water hyacinth leaf and stem.

Elements	Concentrations (mg/dm^3)	
	Stem	Leaf
Lead	0.0728	0.0304
Cadmium	0.006	0.0075
Chromium	0.062	0.0028

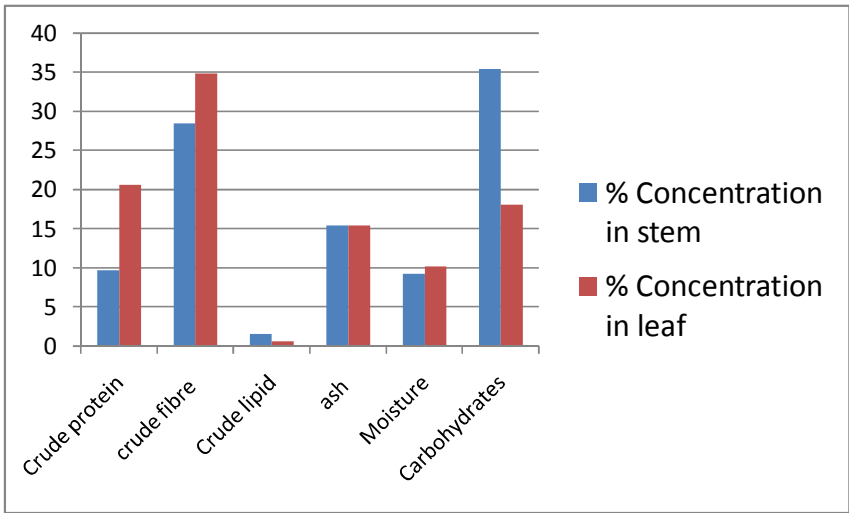

Figure 2. Graph of proximate analysis of water hyacinth stem and leaf.

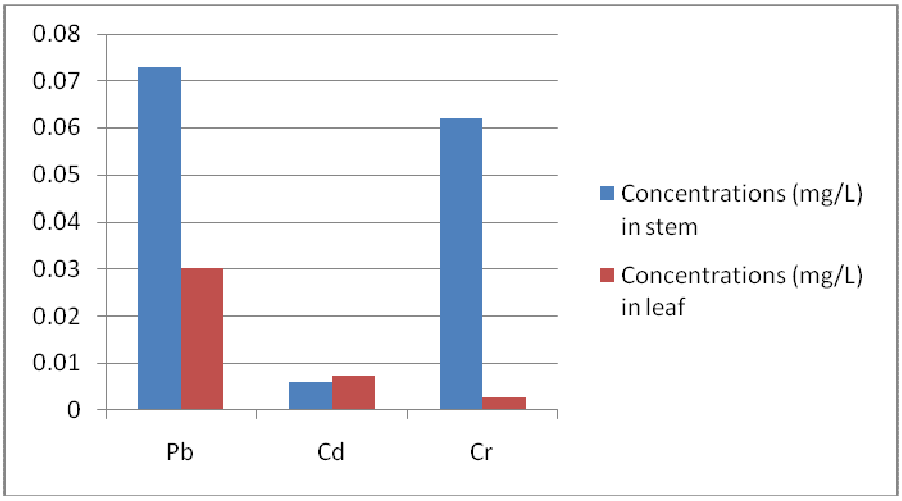

Figure 3. Graph of elemental analysis of water hyacinth stem and leaf.

such as tannins, and terpenoids were not present. This may be due to the method of extraction. The crude lipid value varies in the range of 1.60% for the stem and 0.63% for the leaf as shown in (Figure 2). This may be due to micro-habitat variation in the study area. Crude protein values were higher in the leaf with 20.6% and 9.68% in stem as shown in (Figure 2). This may also be due to micro-habitat variation in the study area. The protein content value for the stem was 20.66% and 9.68% for the leaf in our study. This value was higher than that of Muhammed *et al. (*2012) and Okoye *et al.* (2000) while close enough to that of Mbagwu and Adeniji, (1988). Akmal *et al.* (2014) evaluated the mean protein content in Vallisneria to be 31.25±0.35, water hyacinth

was 12.12±0.02, water lilly was 25.60±0.28, and in phragmites 19.67±0.03. The ash content in our study was 15.46% for the stem and leaf as shown in (Figure 2). Muhammed *et al.* (2012) reported 27.36±1.261% for petiole, 22.55±1.030 for roots, and 14.48±0.340 for leaves and 9.68±0.193 for rhizome. Crude fibre values ranged from 28.50 to 34.89% for the stem and leaf. Akmal *et al*. (2014) reported a mean crude fibre in Vallisneria as 3.80±0.02, in water primrose was 11.38±0.05, in water lilly was 10.60±0.02, in phragmites was 13.74±0.02, in cuttail was 13.29±0.03, in cod grass was 9.75±0.021 and in water hyacinth was 11.14±0.02. The results of our study were somewhat higher than that of Anjana and Matai, (1990). The moisture content of our study ranged from 9.29 to 10.22% for the stem and leaf as shown in (Figure 2). Several aquatic plants are characterized with high amounts of moisture. Even though different methods have been exploited for air drying but high moisture content for protein extraction is required because extraction is facilitated generally by addition of water (Chebil *et al*., 2006).The carbohydrate contents were 35.47% and 18.14% for the stem and leaf as shown in (Figure 2). This is lower in leaf and higher in stem as compared to 26% reported for sunflower. Other reports of carbohydrate content ranged from 7.08-14.15% (Boyd *et al*., 1968). The Pb, Cd and Cr levels were 0.0728 mg/dm^3, 0.006 mg/dm^3, 0.062 mg/dm^3 for the stem and 0.0304 mg/dm^3, 0.0075 mg/dm^3, 0.0028 mg/dm^3 for the leaf as shown in (Figure 3). Wolverton and Mcdonald, (1975) found that water hyacinth absorbs and accumulates heavy metals such as Cu, Cd, Pb, Cr, Fe, Mn and As. Much literature has not been reported on the Cr levels in plants but common levels of Cr found in plant material are in the order of 0.02 to 2.0 mg/kg (Chisholm *et al.,* 1978).

Conclusion

From the results of the comparative study of the stem and leaf, the proximate and elemental analyses of the aquatic biomass, the plant studied (leaf) has an appreciable source of crude fibre and crude protein than the stem while the stem has carbohydrates and lipids higher than that of the leaf. Although, there are little variations in the leaf and stem of water hyacinth in relation to their distribution of the phytochemicals, yet there is an element of similarity in the steroids. This result clearly substantiates the fact that this aquatic plant has high nutritive value incorporated in it. This aquatic plant is of immense economic importance and also a step toward better utilization of these plants for feed formulation. This in turns helps in eradicating the weed.

Recommendation

This aquatic plant can be utilized as food for appreciation and alleviation of carbohydrates, fibre and protein shortage that is prevalent in many developing countries but element of skeptism occurs in the degree of contribution. Also, the level of heavy metal tested was lower compared to their acceptable limits.

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