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# Pharmacognostic and Elemental Comparative Studies of the Leaf of *Hygrophila auriculata* (K. Schum) *Heine* (Acanthaceae) Grown in Industrial and Non-Industrial Areas of Jos-South Local Government Area of Plateau State, Nigeria

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**ABSTRACT**

*Exposure to Industrial wastes and leakages can cause prolong damage to humans and plants due to the presence of chemical wastes and heavy metals. This study was conducted to compare the pharmacognostic profile, presence and effects of heavy metals and determine the adverse effects of using medicinal plants from the industrial area to manage diseases in humans with that of the plant grown in the Non-Industrial Area. Standard methods for pharmacognostic and elemental analysis such as macro- and microscopical evaluation, Physico-chemical, phytochemical and elemental analysis were used. Statistical analyses were done using student t-test and Analysis of Variance (ANOVA). Hygrophila auriculata leaf grown in Industrial Area was found to be slightly sour in taste, light green in color with yellowish patches and musty odor as compared to the tasteless, deep green coloration and characteristic odor in Non-Industrial Area. Results of the physicochemical analysis showed that moisture content, total ash, acid insoluble and water-soluble ash, alcohol and water-soluble extractive values showed the accumulation of extraneous organic matters, impurities and retained much water in Hygrophila auriculata leaf grown in Industrial Area than the one grown in Non-Industrial Area. Hygrophila auriculata leaf grown in Industrial Area was screened positive for steroids/terpenes, cardiac glycosides, and saponins while that grown in Non-Industrial Area was positive for steroids/terpenes, cardiac glycosides, saponins, tannins, flavonoids and alkaloids. Hygrophila auriculata leaf grown in Industrial Area was found to contain a significant amount of Cobalt, Lead and Zinc at ($p<0.05$) as compared to the values obtained from those grown in Non-Industrial Area. Plants from industrial areas should not be used as a drug.*

**Keywords:** Acanthaceae, Comparative, Industrial and non-industrial area, *Hygrophila auriculata*.

## INTRODUCTION

An industry is a place where raw materials are transformed into intermediate products for the processing of other materials or finished products for consumption. These materials include crude drugs, cocoa, rubber, etc. Besides the

industry causing environmental damage, the contamination resulting from the leakages of chemicals also affect the health of plants, people and water around it. The industry also increases the number of heavy metals such as lead, cobalt, etc that are harmful to both plants and humans [1-3]. In recent years, there has been an increasing ecological and global public health concern associated with environmental contamination by heavy metals. Also, human exposure has risen dramatically and as a result of the exponential increase of their use in several industrial, agricultural, domestic and technological applications [4]. Reported source of heavy metals in the environment includes geogenic, industrial, agricultural, pharmaceutical, domestic effluents and atmospheric sources [5].

*Hygrophila auriculata* (K. Schum) *Heine* (Acanthaceae) is a wide shrub usually growing in marshy places along with riverine areas. It is described in the Ayurvedic literature as Ikshura, Ikshagandha, and Kokilasha; having eyes like Kokila or Indian cuckoo and classified as Seethaveryam, Mathuravipaka and used for the treatment of edema, diabetes, jaundice, rheumatism, urinary tract infections, pain and inflammation [6,7].

Some tribes in Jos-South Local Government Area of Plateau State, Nigeria use *Hygrophila auriculata* leaf for the management of Urinary Tract Infections, Inflammation, and gout from both Industrial and Non-Industrial Areas. The present study is aimed at comparing the pharmacognostic and elemental analysis of the Leaf of *Hygrophila auriculata* (K. Schum) *Heine* (Acanthaceae) grown in Industrial and Non-Industrial Areas of Jos-South Local Government Area of Plateau State, Nigeria.

## MATERIALS AND METHODS

### *Plant collection, identification, and preparation*

*Hygrophila auriculata* (K. Schum) *Heine* (Acanthaceae) leaf from non-industrial area was collected from Dadinkowa forest in Jos-South Local Government Area of Plateau State, Nigeria while *Hygrophila auriculata* from industrial area was collected from Jos Steel Rolling Company Ltd of Azi Nyako industrial area in Jos-South Local Government Area of Plateau State, Nigeria on September 14th, 2017. The plant was identified in the field using the pharmacognostic descriptions and keys in official books. The identity of the plant was authenticated at the Department of Horticulture and Landscape Technology, Federal College of Forestry, Jos, Nigeria, and assigned Voucher specimen Number (FHJ 247A) for the non-industrial area and (FHJ 247B) for the industrial area by Mr. J. J. Azila. The plant was air-dried at room temperature under shade until a constant weight was obtained for a period of three weeks for each sample. The plant was then pounded to powder using local pestle and mortar, sieved with a mesh of size-20 and stored in an air-tight container-A (FHJ 247A) and container-B (FHJ 247B) until when needed for use.

### *Chemicals and reagents*

Analytical graded chemicals purchased from Sigma-Aldrich Company used include: 65% Nitric acid ($HNO_3$), 30% Hydrogen peroxide ($H_2O_2$), 70% Perchloric acid ($HClO_4$) and multi-element standard solution (reference material).

### *Macroscopy of the leaf*

The leaves from non-industrial and industrial areas were observed separately for features like the taste, color, and odor [8].

### *Pharmacopeia standards*

Methods for the determination of pharmacopeia standards such as the moisture content, total ash values, water-soluble ash values, acid insoluble ash values and extractive values of the leaf of *Hygrophila auriculata* were carried out as described for samples from the non-industrial and industrial area each [9].

### *Elemental analysis*

#### Acid digest and atomic absorption spectrophotometer analysis

The method described by Achikanu et al. [10] was adopted with modifications. Acid digest of each plant sample was prepared by oxidizing 0.2 g of the powdered ash-leaf from the industrial and non-industrial site by adding 10 ml nitric and 5 ml perchloric acid (2:1). About 1 ml of the acid digest was then further diluted with distilled water to make it up to 20 ml due to the corrosive nature of the acid used. Aliquots of the mixture were used to estimate for the

presence of Lead, Zinc, and Cobalt using atomic absorption spectrophotometer (AA240FS). Blanks were prepared to check for background contamination by the reagents used. The results reported in parts per million (ppm).

### *Statistical analysis*

Statistical analyses were done using student t-test and Analysis of Variance (ANOVA).

## RESULTS

**Table 1:** Result of the macroscopic characters of the leaf of *Hygrophila auriculata*

| Characters | Industrial area | Non-industrial area |
|---|---|---|
| Taste | Slightly sour | Tasteless |
| Color | Light green with yellowish patches | Deep green |
| Odor | Musty | Characteristic |

**Table 2:** Result of the pharmacopeia standards of the leaf of *Hygrophila auriculata*

| Test | Leaf powder (%w/w) from industrial area | Leaf powder (%w/w) from non-industrial area |
|---|---|---|
| Moisture content | 17.83 ± 0.01 | 7.40 ± 0.02 |
| Total ash value | 16.07 ± 0.02 | 13.41 ± 0.01 |
| Acid insoluble ash value | 2.27 ± 0.04 | 1.44 ± 0.03 |
| Water soluble ash value | 15.44 ± 0.01 | 12.74 ± 0.04 |
| Alcohol soluble extractive value | 4.15 ± 0.03 | 36.76 ± 0.01 |
| Water soluble extractive value | 6.23 ± 0.04 | 47.40 ± 0.032 |

**Table 3:** Result of the phytochemical screening of the leaf of *Hygrophila auriculata*

| Constituents | Industrial area | Non-industrial area |
|---|---|---|
| Steroids/Terpenes | + | + |
| Cardiac glycosides | + | + |
| Saponins | + | + |
| Tannins | - | + |
| Flavonoids | - | + |
| Alkaloids | - | + |

**Table 4:** Result of the elemental analysis of the leaf of *Hygrophila auriculata*

| Analysis | Industrial area (ppm) | Non-industrial area (ppm) |
|---|---|---|
| Cobalt | a10.21 | 0 |
| Lead | a20.32 | 3.01 |
| Zinc | a70.25 | 30.65 |
| A=Significant different at ($p<0.05$) | | |

## DISCUSSION

High doses of cobalt, lead, zinc and other heavy metals absorbed by *Hygrophila auriculata* leaf from the industrial area as compared to the non-industrial area were responsible for the sour taste, musty odor and light green coloration

with yellowish patches described in (Table 1) as these impair chloroplast [11], thereby resulting in the reduced chloroplast content that gradually changed bright green colors of leaves to light green, yellow and/or brown.

The value of the moisture content of the leaf from non-industrial area falls within the acceptable limit for moisture content of crude drugs which should not be more than 14% whereas, the value of the moisture content from the industrial area is high and did not fall within the acceptable limit specified by the official book [12]. Heavy metals interfere negatively with the biological activities of plants such as water retention mechanism, photosynthesis, chlorosis, gaseous exchange, and nutrient absorption. They also cause a reduction in plant growth, dry matter accumulation and yield disorder [13]. This may be responsible for the increased activity of hydrolytic enzymes that impaired the normal water regulatory mechanism which caused the moisture content of the leaf of *Hygrophila auriculata* to increase (Table 2).

The results of the total ash, acid insoluble and water-soluble ash values of the leaf of *Hygrophila auriculata* from the non-industrial area can be inferred based on the quantitative values of the ash that all traces of extraneous organic matter and/or heavy metals; physiologically and environmentally were appreciably absent giving the drug a high extent of purity. The results of the total ash, acid insoluble and water-soluble ash values from the industrial area were appreciably high due to the absorption and accumulation of dry matter, heavy metals and extraneous organic matter both from the soil and from the environment [14]. This may be responsible for the impurities (Table 2).

Alcohol and water-soluble extractive values of the Leaf of *Hygrophila auriculata* from non-industrial areas were higher than that of the industrial area and this may explain why more phytochemical constituents were present in the sample from non-industrial area as compared to the industrial area. Extractive values are useful for the evaluation of crude drugs and give an idea about the nature of chemical constituents present in them [11,12]. The amount of extractive, a drug yields to a given solvent is often an approximate measure of a certain constituent or group of related constituents a drug contains [11-13]. The less extractive value may also indicate the addition of exhausted materials, presence of heavy metals, adulteration or incorrect processing during drying or storage [13,14] (Table 3).

Results of the Elemental Analysis of the Leaf of *Hygrophila auriculata* (Table 4) from non-industrial area did not show any appreciable toxicity amount of cobalt, lead and zinc whereas results from the industrial area showed a potential toxicity amount of cobalt, lead and zinc as compared with the quantitative WHO/FDA requirement standard for the maximum permissible amount of cobalt, lead and zinc in leafy plant which should not be more than 5 ppm, 10 ppm and 50 ppm respectively [15-19]. The toxicity of cobalt in plants leads to leaf fall and discoloration and affect the growth and metabolism of plants. Toxicity on humans leads to neurologic dysfunction such as hearing loss, tinnitus, optic nerve atrophy, visual impairment, convulsion, vertigo, headache, tremors, polyneuropathy, incoordination, cognitive decline and depression [20].

The toxicity of lead causes stunted growth, chlorosis, and blackening of the root system in plants [21]. It also inhibits photosynthesis, upsets mineral and nutrients uptake and water balance, changes hormonal status and affects membrane structure and permeability. In humans, high accumulation in the blood leads to anemia, weakness of the body, kidney and brain damage and death. It also has the tendency to cross the placenta in a pregnant woman and can cause damage to the developing baby's nervous system [21,22]. High accumulation of zinc in plants causes phytotoxicity by changing the permeability of the cell membrane and cell death may occur eventually whereas in humans, it causes the inhibition of copper uptake, low body immunity, low level of HDL cholesterol (the good cholesterol), cytotoxicity, cell death in the brain, ischemia and trauma [23-25].

## CONCLUSION

*Hygrophila auriculata* leaf grown in Industrial Area was found to be sour in taste, light green in color with yellowish patches and musty odor. There was a high accumulation of extraneous organic matters and impurities and retention of water in the leaf. The leaf was also found to contain fewer secondary metabolites and a significant toxic amount of Cobalt, Lead and Zinc than that grown in the non-industrial area. Plants from industrial areas should not be used as a drug.

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