Indian Journal of Fundamental and Applied Life Sciences ISSN: 2231-6345 (Online)
An Online International Journal Available at http://www.cibtech.org/jls.htm
2012 Vol. 2 (2) April-June, pp.234 -238/Kumar and Sheel

Review Article

SUITABILITY AND UTILITY VALUE OF *TYPHA ANGUSTIFOLIA* LINN. FOR CULTIVATION IN NORTH BIHAR COUNTRYSIDE WETLANDS

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ABSTRACT
Typha angustifolia Linn., a common plant of wetlands, is an unexploited taxon which can be used as a good source of food, medicines, and, fibres. At the same time, it can be used as a sewage or industrial waste disposal agent as it exhibits a high degree of tolerance to heavy metals and other contaminants, and, can efficiently accumulate them in its root, shoot and leaves for their ultimate removal from the system. Its phytoremediation potential can be enhanced by arming it with some bacterial genes coupled with suitable promoter sequences. The plant can be made to import mercury reductase and organo-mercurial lyase genes from mercury resistant bacteria.

Key Words: *Typha angustifolia, Typha angustata, Typha gracilis, Typha salgirica, Typha javanica, Puhuang, Cattail, Small Reed-Mace, Edibility, Medicinal Value, Fibrous Leaf, Mattress, Heavy Metal Tolerance, Waste Disposal, Gene Transfer, Mercury Resistance Genes*

INTRODUCTION
Typha (meaning "marsh" in Greek) is a monocot genus of the monotypic family Typhaceae with about 12 species distributed in the tropical and temperate regions of the world in marshes and wetlands of varied depth (Rendle, 1938). They are able to occupy pond and lake margins, fresh and brackish marshes, ditches and reservoirs contaminated with industrial wastes (Sharitz *et al*., 1980). Some of the taxonomically identified species of the genus are supposedly the hybrid of two different species growing side by side in the same stand, adapting to shallow and deep water logged areas respectively (McManus *et al*,. 2002). *Typha angustifolia* Linn., with several synonyms such as *Typha angustata* Bory & Chaub., *Typha angustifolia* Linn. var. *angustata* (Bory & Chaub.) Jord., *Typha angustifolia* Sibth. & Sm., *Typha gracilis* Schur., *Typha salgirica* A. Krasnova, and, *Typha javanica* Schnizlein ex Rohrbach. (Wiersema, 1999; IPNI, 2003), is a common wetland rhizomatous plant with long, tapering and sessile leaves and small unisexual flowers borne in a spike on a cylindrical axis (Haines, 1925) found throughout India (Fig. 1). Known as "long-bracted cattail" or "small reed-mace"in English, "Kab" in Bengal, and, as "Pater" in North Bihar of India and Nepal Terai region, it is found as a prevalent and dominating plant in the shallow wetlands in the country-sides of North Bihar in the months of July-October
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Use of Leaf and Shoot Fibres of Typha Angustifolia
Folk people of the Mithila region have been using the long fibrous leaves of the plant to weave 2-2.5 inch-thick strong mattresses ("Shitalpati") for use as a course kind of bed-sheet since olden times. Fibrous leaves and stems are used for thatching, screens, wickerwork, ropes, stuffing, insulation for jacket, chair making and hats etc. also in other parts of this country (Singh and Kachroo, 1976) and many countries of the world (Moerman, 1998). Gupta (1994) listed these products from *Typha* species as important non-wood forest products in Asia in his report to FAO (UN). The fibrous strength of the leaf of *T. angustifolia* is due to the fact that the leaf lamina has a thick zone of fibres at the margin and contains one to four vascular bundles embedded at the proximal edge of the zone with the subepidermal vascular bundles along the abaxial and adaxial margins of the leaf interspersed with fibre bundles in the chlorophyllous mesophyll (McManus *et al.*, 2002) (Fig. 2).Plant leaves of *T. angustifolia* may probably

be used with memory foam and high resiliency base foam to create an innovative and modern bed mattress with help from modern technology.

Figure 1: Plant of *Typha angustifolia* Linn.

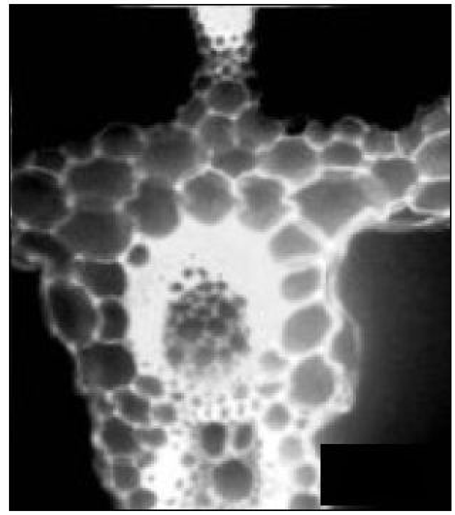

Figure 2: C.S. of leaf showing of arrangement fibre cells (*Source: McManus et. al., 2002***).**

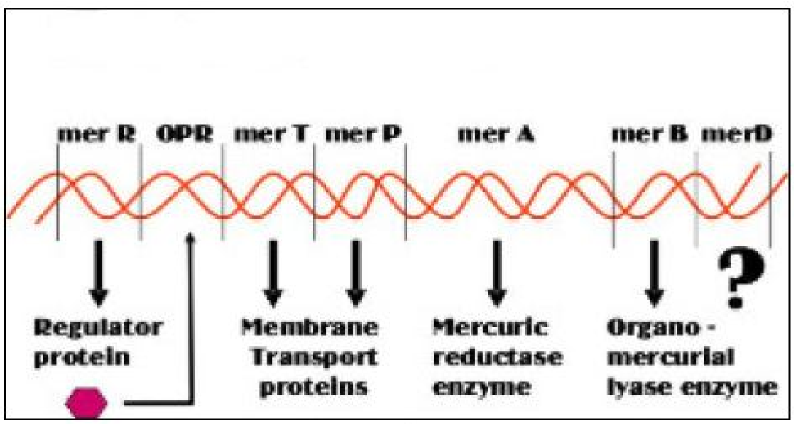

Figure 3: Diagrammatic representation of *mer* operon of bacteria

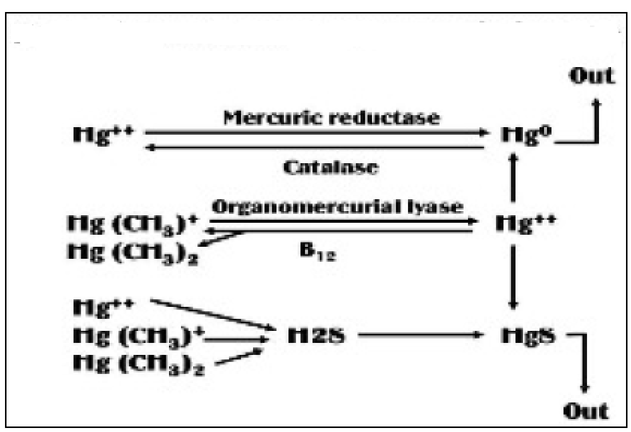

Figure 4: Process of mercury elimination in mercury resistant bacteria

Edibility

In many parts of the world, starch-rich roots of *T. angustifolia* (Tanaka, 1976) are eaten raw or boiled or dried roots are pulverized into a powder, and then, used as a thickener in soups or added to cereal flours to make biscuits, bread, cakes etc. (Facciola, 1990). Shoots (rhizome) and flowering stems are likewise used elsewhere (Low, 1989). Pollens are yet another source of protein used as additive in making bread, porridge etc. (Facciola, 1990).

Medicinal Uses

The leaves are diuretic (Duke and Ayensu, 1985). The pollen is astringent, desiccant, diuretic, haemostatic and vulnerary (Him-Che, 1985), and, used in the treatment of nose bleeds, haematemesis, haematuria, uterine bleeding, dysmenorrhoea, postpartum abdominal pain and gastralgia, scrofula and abscesses. The seeds are haemostatic. The rootstock is supposedly astringent and diuretic (Chopra *et al.,* 1986).

In China, "Puhuang" is the traditional drug obtained from *Typha* plants (Gao and Liao, 1998). Plant parts of both *T. angustifolia* and *T. latifolia* are used for medicinal applications even in angina,cystitis, diarrhea, urethritis, menstrual cramps, burns, insect bites, rash and wounds. Pollens are dustedon bleeding wounds to prevent the flow of blood. Poultice from powdered roots is used to treat poison oak, ivy, rashes, insect bites and burns. In China, the plant parts have been traditionally used for promoting circulation of the blood and relief of cardiac pain (Wu, 2005). Edibility of plant parts of Chinese medicinal plants has normally been linked to purification and regulation of blood in China's traditional medicine system. In regards to its anti-oxidant activity, ORAC (Oxygen Radical Absorbance Capacity) of *Typha angustifolia* was found to be quite high as 120 µmole TE (Trolox equivalent)/gm of dried herb by Liao *et al.*(2007). Extracts of *Typha angustifolia* were also found to lower serum cholesterol levels in artherosclerotic rabbits (Tao *et al.,* 2004).

Chemical Constituents

Xu *et al. (*1986) isolated seven crystalline compounds from the inflorescence of *Typha angustifolia.* These compounds were vanillic acid, E-p-hydroxy-cinnamic acid, protocatechuic acid, E-Pro-penoic acid-3-(hydroxyphenyl)-2,3-dihydropropyl ester, succinic acid, p-hydroxybenzaldehyde and Dmannitol. Plant contains three steroids [b-sitosterol, (20S) 24-methylenlophenol, and stigmast-4-ene-3, 6-dione] and three fatty acids [α– linolenic, linoleic, and an unidentified $C_{8\ 2}$]. Roots are rich in polysaccharides. Flavonoids are present in shoots and flowering heads. An allelopathic sterol -(20S)-4 alpha-methyl-24-methylenecholest-7-en-3 beta-ol has been reported from *Typha latifolia*, and, it is probably also present in *T. angustifolia.* Medicinally active principles in *T. angustifolia* have been mainly identified as flavonoids (Gao *et al.,*1998; Xi and Li, 2000).

Heavy Metal Tolerance

Typha angustifolia has shown high degree of tolerance towards heavy metals, and, accumulation of metals like Cd, Cr, Cu, Fe, Mn, Ni, Pb and Zn found in distillery wastewater. The plant root has shown maximum concentration of the metals in comparison to stem and leaf. Stem has shown the maximum accumulation of iron followed by zinc, manganese, copper, chromium, lead and cadmium. Thus, the plant has been strongly recommended for bioremediation of the general and industrial wastes. Panich-pat *et al.* (2005) conducted electron microscopic study of *T. angustifolia* plant parts to find out the location of Pb accumulation. After 15 and 90 days of planting, most lead was found accumulated in the root cells around vacuoles, and, it was slowly transported to leaves. Some amount of lead was deposited in the rhizome near the cell wall. The leaf cells accumulated lead in the chloroplasts. The study proved that the plant is a good accumulator of heavy metals due to efficient intracellular transport between tissues and organs to optimize its tolerance.

Waste Treatment

According to FAO assessment report for sewage and industrial waste (effluent) treatment (2007), emergent macrophytes take up large amounts of inorganic nutrients (especially N and P) and heavy

metals (such as Cd, Cu, Hg and Zn) as a consequence of the growth requirements. As such, *Typha* stands may be utilized to clear sewage wastes and industrial wastes. Artificial wetlands with floating and emergent macrophytes like *Typha angustifolia* around treatment area containing primary sewage effluents have been found to achieve secondary treatment effluent quality with a 6 day hydraulic retention time, water depth of 60 cm and hydraulic loading 1860 m3/ha d (Reddy and Debusk, 1987).
Cooper *et al.* (1988) estimated that the land area considered necessary for treatment of preliminarytreated sewage in Europe is at 2-5 m^2 per population equivalent to achieve a secondary effluent quality.

Biotechnological Applications for Enhancing Phytoremediation Activity

Genetic engineering approach may be used to optimize the phytoremediation capability of a plant to dispose off contaminants / metals from contaminated sites. Microbes obtained from contaminates oil/sites are known to have developed new genetic systems that confer them the ability to get rid of the contaminants/metals. These genes may be transferred to a macrophyte with large biomass to enhance its phytoremediation potential (Sambukumar, 2003).
Mercury disposal ability can be introduced into *Typha angustifolia* by transfer of the mercury metabolizing genes of the *mer* operon (Fig. 3) of a mercury resistant bacterial strain. The *merB* produced organo-mercurial lyase and *mer A* product mercururic reductase are the two most desirable enzymes that need to be successfully expressed in *Typha* to convert the most prevalent mercury form i.e. methyl mercury into Hg++, and, then Hg++ to volatile mercury, respectively. Czako *et al.* (2006) have developed a green tissue- (leaf-) specific mercuric reductase (*merA*) expression cassette using the wheat rbcS promoter to enhance *merA* expression in fully expanded leaves, decreasing mercury content and enhancing mercury volatilization.

CONCLUSION

Typha angustifolia, *Typha latifolia* and *Typha elephantina* are the three Indian species of *Typha* that can be grown together in the wetlands in common stands. *T. angustifolia* should be grown in North Bihar wetlands with a water depth of 1-2 m with a view to obtain multi-fold advantage from the plant :
1. Rhizome and shoot to be exploited as a source of nutritious food products and food additives,
2. Leaf fibres to be processed suitably to obtain smart fibres that be used with foam making mattresses,
3. Shoot (Rhizome) and flowering inflorescences to be exploited as a cheap source of useful medicines,
4. Stands of plants to be erected in artificial wetlands around townships to get rid of water pollutants, sewage sludge , heavy metals and industrial effluents,
5. Plant to be grown along with some other useful taxa (that have been in use in the said region) such as *Vetiveria zizanioides* (source of “khus”) and *Sacchrum munja*, called (“munj” in Mithila, and, used to make artful baskets, plates etc.), and
6. Superior varieties /strains of the plant to be raised by biotransformation or genetic intervention for better fibre quality, higher drug output, greater contaminant and heavy metal disposal ability and other optimized features.

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