

Conclusion

"If you can't explain it simply, you don't understand it well enough"

-Albert Einstein

It was in August, 2012 when I joined The Molecular Cytogenetics Laboratory, Department of Botany and decided to pursue my research work for PhD degree. From the very first day, I was determined to work on any medicinally important plant of North Bengal. After consulting my PhD guide and searching available literature I was convinced that virtually no work has been done on the various species of *Clerodendrum* of North Bengal. Although, local people used these plants for preparation of herbal medicine. Ethnomedicinally, different parts including leaf, root and stem of *Clerodendrum* have been reported to be useful in healing, rheumatism, asthma, skin disease, malaria and inflammatory diseases. Moreover, tribal people of North-East India often

use different parts like leaf and root of *C. colebrookianum* to treat various ailments including cough, dysentery, bronchitis, asthma, fever, liver disorders, stomach disorders and hypertension. Thus, keeping this in mind I initiated my work with collection of *Clerodendrum* samples from two districts of North Bengal (Darjeeling and Jalpaiguri) and Assam (Kamrup) and once considerable germplasm was obtained, I started working on molecular documentation, micropropagation, antimicrobial activity and assessing the therapeutic properties of *Clerodendrum* encountered in North Bengal and Assam. The major findings of the present study may thus be summarized as follows:

- The inventory resulted in

documentation of 11 different species of *Clerodendrum* from North Bengal and Assam.

- In-depth antioxidant and cytotoxic profiling through different standard methods reflected that *C. indicum* (CIL), *V. inermis* (VIL), *C. serratum* (CSL) and *C. colebrookianum* (CCL) could be used as potent antioxidative as well as non-toxic stuffs which in turn can ameliorate different ROS mediated disorders including liver, kidneys and neurodegenerative ailments leading to a healthy and hassle-free life.
- Generation of ROS (Reactive Oxygen Species) in human hepatic cell line (WRL-68) and human liver cancer cell line (Hep-G2) was diminished properly after the application of CIL, VIL and CCL. Thus, it has been evident that CIL, VIL and CCL have the potential to prevent different types of oxidative stress related disorders.
- Gentamicin induced ROS generation in human embryonic kidney cell line (HEK-293) was diminished proportionately under the influence of CSL extract. Therefore, it can be inferred that CSL plays an important role in reducing the impact of gentamicin on normal intracellular function.
- The antimicrobial activity in the present study offer a scientific support to the use of leaves of four *Clerodendrum* species as a new antibacterial drug against bacterial infection in future.
- Normalization of liver enzymatic markers may provide beneficial under chronic hepatic damage. Thus the potentiality of CIL, VIL and CCL is well justified and holds a new hope for the discovery of new hepatoprotective drug.
- Interestingly, *C. serratum* was found to be effective to ameliorate the brain impairment by means of endorsing brain enzymatic function against oxidative stress. Thus, most importantly, it is the first evidence of neurotherapeutic role of CSL in neutralizing ROS mediated neuronal damage thereby demands utmost attention for developing CNS drug.
- Elevated catalase superoxide dismutase and glutathione reductase activities along with the

inhibition of lipid peroxidation would prove beneficial under nephrotoxicity in rat model.

- The various phytochemicals identified through FTIR and GC-MS analysis, are responsible for the potent bioactivities of *Clerodendrum*.
- In molecular docking study, we also studied the possible interaction and binding affinity of various compounds present in CIL, VIL, CSL and CCL with a variety of human proteins (liver, brain, kidney and ROS-generation protein) and found that a number of compounds bind with considerable strength with various proteins. Hence, present finding could open a new door to understand the roots of several diseases and disorders facilitating new drug discovery.
- Solvent fraction study of the extract of *V. inermis* (syn: *C. inerme*) leaf resulted in identification of two compounds i.e. Squalene and 9, 12, 15-Octadecatrienoic acid, methyl ester (linolenic acid methyl ester). The compounds also showed significant antioxidant and antimicrobial activity.
- A protocol for successful *in-vitro* callus regeneration of *C. thomsoniae* through nodal culture was standardized. The study of somaclonal variation using both RAPD and ISSR primers revealed no genetic variability among the *in-vitro* regenerated plantlets compared to the field grown plant.
- GC-MS analysis was conducted pertaining to the identification of active compounds present in field grown plant and tissue culture plant. However, some of the compounds present in tissue cultured plant were missing in the field grown plant. Hence, it seems likely that the tissue culture plant contain plenty of medicinally important constituents which might be a good source of natural medicine. Taking into account of all the GC-MS and *in-silico* molecular docking data, it can be concluded that some of these compounds may hold promise as medically relevant candidates and might prove beneficial in future drug development.
- A high level of polymorphism was

detected among the different accessions of *Clerodendrum* using both RAPD and ISSR based analysis.

- PCR-RFLP analysis accounted a total of 8, 4 and 12 polymorphic bands with 100%, 50% and 70.58% of polymorphism in case of matK, Rrps16 and trnL-trnF region of the chloroplast genome respectively. It may be presumed that this polymorphism had
- resulted due to their polyphyletic nature of 11 species under the genus *Clerodendrum*.
- DNA barcode analysis by means of matK, Rps16 and TrnL-F clearly reflected that two subfamily Symphorematoideae and Nepetoideae very close to Ajugoideae which validates the traditional classification of Cronquist.