VI. SUMMARY

➢ For the present study, Indian major carp Common carp *Cyprinus carpio* was collected from A.M Fish Farm Arumbanoor, Madurai, Tamil Nadu, India.

➢ Two different plants Bush mint (*Hyptis suveolens* (L) poit) and Tulsi (*Ocimum sanctum*) were collected from surrounding area of Gandhigram Rural Institute-Deemed to be University, Gandhigram, Dindigul.

➢ Three different solvents such as aqueous, ethanol and methanol were used for the extraction of Bush mint (*Hyptis suveolens* (L) poit) and Tulsi (*Ocimum sanctum*) by using Soxhlet apparatus for 48 hrs, it gives greenish black, semi-solid residue.
Three different solvents of both plants extracts are analyzed for phytochemical analysis.

The antibacterial activity was tested against the selected pathogens such as *E.coli*, *Staphylococcus aureus* and *Bacillus cereus* by well and disk diffusion method and antioxidant activity (DPPH Assay) are also done.

Based on the above tests, bioactive compounds were analyzed by GC – MS (Gas Chromatography-Mass Spectrum)

Biologically synthesized CuO Nps obtained by simple precipitation method by using Bush mint methanol extraction (*Hyptis suovelens* (L) poit) and CuSO$_4$5H$_2$O in ratio1:1 in 60°C at pH 7.

Chemically synthesized CuO Nps produced by chemical reduction method by using 0.1M of Copper (II) sulfate Pentahydrate as a precursor, 1.2 % Starch and 0.2 M ascorbic acid in 80°C at pH 7.

Both biologically and chemically synthesized CuO Nps were characterized by UV – Visible Spectroscopy, FT - IR, XRD, SEM and EDAX.

Physico-chemical parameters such as pH, Temperature (°C), Dissolved Oxygen (mg/l), Chloride (mg/l), Total Hardness (mg/l) and Dissolved Carbon dioxide (mg/ l) were estimated during the experimental period.

The acute toxicity test for *Cyprinus carpio* in biologically synthesized CuO Nps exposed in different concentration such as 0 (control), 5, 10, 15, 20 and 25 ppm for 96 hrs. The mortality was also observed in chemically synthesized CuO Nps exposed to 0 (control) 0.5,1, 1.5, 2 and 2.5 ppm for 96 hrs under static condition.
Sublethal test for both biologically and chemically synthesized CuO Nps in *Cyprinus carpio* were done for 14 days under static condition in different concentration (0 (control), 0.23, 0.31, 0.46, 0.93 ppm and 0.018, 0.024, 0.036, 0.072 ppm).

After experimental period, the fishes are sacrificed to analyse toxicological parameters such as biochemical (muscle, gill, liver), hematological and histopathological (gills and liver).

Antibacterial activity of biologically and chemically synthesized CuO Nps were tested against the selected pathogens *E.coli, Staphylococcus aureus* and *Bacillus cereus* and compared with the commercial antibiotic (Amoxicillin). Antioxidant activities of biologically and chemically synthesized CuO Nps were analyzed (DPPH Assay).

Biologically and chemically synthesized CuO Nps were used for the detection of melatonin hormone in a serum sample to study their chemical sensing properties by using the electrochemical method.

Three different solvents used for both plant *Hyptis suveolens* (L) poit and *Ocimum sanctum* extracts were analyzed for their bioactive compounds (alkaloids, phenols, flavonoids, saponins, amino acids and phytosterols) and showed good response in methanol extraction of Bush mint (*Hyptis suveolens* (L) poit).

The antibacterial activity of leaf extracts was compared with the commercial antibiotic Amoxicillin and showed the best response for methanol extraction of Bush mint (25, 23, 20 mm) than other extracts.

Three different solvents of both plants were analyzed for their scavenging activity (DPPH assay). Methanol extraction of Bush mint (*Hyptis suveolens* (L) poit) was
good response (96.22 %) than the other extracts in the concentration of 300 µl, while in control (97.08%) in 300 µl ascorbic acid.

- Both biologically and chemically synthesized CuO Nps were characterized by UV – Vis spectrophotometer analysis and peaks are observed in 249 nm and 264 nm, indicates the formation of CuO Nps.

- Biologically synthesized CuO Nps were analyzed by Fourier Transform Infrared Spectroscopy (FT – IR) and absorption peaks are 3947.47, 3407.04, 2924.51, 1610.08, 1276.10, 1107.36, 817.95, and 616.56 cm\(^{-1}\) and functional groups are phenolic compounds, amines, carboxylic group, aliphatic amines, alkaloids, alkanes and for chemically synthesized CuO Nps peaks at 608.07, 1027.54, 1375.48, 1108.019, 1009.96, 1108.01, 1634.39, 617.07, 1018.60, 1411.25, 1099.07, 1625.45 and 617.01 cm\(^{-1}\) are responsible for alcohol, nitro group, carbonyl and alkaline halide.

- The XRD analysis of biologically and chemically synthesized CuO Nps are in good agreement with those of powder CuO Nps obtained from the International Centre of diffraction peaks are indexed according to the hexagonal phase and good spherical shape was found as 65 nm of copper oxide nanoparticles ((JCPDS-80-1916).

- The SEM and EDAX analysis of biologically and chemically synthesized CuO Nps are in clear and uniform size, almost in spherical in nature and the elemental composition of CuO Nps were 82 % and 67% by using Dispersive X-ray Spectroscopy.

- Biologically and chemically synthesized CuO Nps shows that mortality increased with increasing concentrations.
The protein level in muscle, gill and liver of *Cyprinus carpio* decreased with increasing concentration (0.23, 0.31, 0.46, 0.93 ppm and 0.018, 0.024, 0.036, 0.072 ppm) of biologically and chemically synthesized CuO Nps, when compared to control.

Carbohydrate level in muscle, gill and liver of *Cyprinus carpio* decreased with increasing concentration (0.23, 0.31, 0.46, 0.93 ppm and 0.018, 0.024, 0.036, 0.072 ppm) of biologically and chemically synthesized CuO Nps, when compared to control.

The lipid level in muscle, gill and liver of *Cyprinus carpio* decreased with increasing concentration (0.23, 0.31, 0.46, 0.93 ppm and 0.018, 0.024, 0.036, 0.072 ppm) of CuO Nps, when compared to control.

The hematological parameters on *cyprinus carpio* such as WBC, Polymorphic Neutrophils, Lymphocytes, Eosinophils, RBC and Hemoglobin level are decreasing with increase in the concentration (0.23, 0.31, 0.46, 0.93 ppm and 0.018, 0.024, 0.036, 0.072 ppm) of CuO Nps when compared to control.

In gills increasing the concentration of CuO Nps exhibited a proliferation of bronchial chloride cells that leads to lamellae fusion and formation of an aneurysm, risk rupture, hemorrhage than the control group. In the liver increasing the concentrations, CuO Nps shows congestive enlargement of the liposome, which leads to vascular degeneration in the liver.

The antibacterial activity of biologically and chemically synthesized CuO Nps against *E.coli, Staphylococcus aureu, Bacillus cereus* and compared with the commercial antibiotic (amoxicillin). Shows the best response in biosynthesized CuO Nps (22, 20, 18 mm) than chemically synthesized CuO Nps.
➢ In biologically and chemically synthesized CuO Nps DPPH scavenging activity are 72.56% and 69.04 % in a concentration of 300 µl CuO Nps while in control, 97.08% in 300 µl ascorbic acid.

➢ Biologically and chemically synthesized CuO Nps were used for the detection of melatonin hormone in a serum sample to study their chemical sensing properties. In pH 12 the biologically synthesized CuO Nps are highly potential than chemically synthesized CuO Nps.

➢ From the present study, it is concluded that more awareness is needed on the discharges from the industries such as electroplating, mining ect... into the aquatic system. The biologically synthesized copper oxide nanoparticles are less toxic than chemically synthesized copper oxide nanoparticles on Cyprinus carpio. This information may provide great benefit in the field of nanotechnology, biomedical and aquaculture industries.