9.0 SUMMARY AND CONCLUSION

The present study was carried out on the isolation and characterization of magnetotactic bacteria from marine sediments of Palk Strait region and to find out the production of magnetosomes with or without ferrous sulphate. Further, the present study was made an attempt to find out the optimum growth factors for the mass scale production of magnetotactic bacteria for the application in agriculture and medicine. The results obtained from the present study are summarized as follows:

- Five different MTB strains were isolated from the sediments of Palk Strait region based on the morphological characteristics. All the isolated MTB strains were identified as gram negative and rod shaped.

- The magnetotaxis test reveals that, the aggregation of bacterial cells towards the magnetic pole was gradual and the aggregation was increased in concentration at different time. Generally, it was observed that, a minimum period of three hours exposure to the external magnetic field is required for 100% of aggregation of cells.
The present study also carried out for the extraction of magnetosome from all the isolated MTB (MTB-1 to MTB-5) and confirmed by the scanning electron microscopic picture.

Molecular identification of MTB’s by following 16s rRNA sequencing has been carried out with the isolated MTB (MTB-1 to MTB-5) and reveals that all the MTB isolates have unique sequence.

Based on the molecular taxonomy and phylogeny, the MTB-1 was identified as *Bacillus licheniformis* strain RUAUMTB001, the MTB-2 strain was identified as *Alcanivorax dieselolei* strain RUAUMTB002, the MTB-3 strain was identified as *Exiguobacterium* sp. RUAUMTB003, the MTB-4 strain is identified as *Alcanivorax dieselolei* RUAUMTB004 and the MTB-5 was identified as *Vibrio cholerae* strain RUAUMTB005. All the sequences from isolated MTB strains (MTB-1 to MTB-5) were deposited in the GenBank under the Accession No. GU339392, GU339393, GU339394, GU339395 and HM002751.

Moreover, the effect of salinity on the growth of MTB reveals that, the *Alcanivorax dieselolei* (RUAUMTB004) and *Vibrio cholerae* (RUAUMTB005) were grown well at 2.5% salinity and both the strains were developed very clear rings with 1.3 cm and 1.2 cm distance from
the surface of the mud agar medium and 7 days minimum period was required for the formation of the rings.

- The effects of temperature on the growth of MTB’s was also carried out by the present study and it reveals that, all the isolated MTB’s viz., *Bacillus licheniformis* (RUAUMTB001), *Alcanivorax dieselolei* (RUAUMTB002), *Exiguobacterium* sp. RUAUMTB003, *Alcanivorax dieselolei* (RUAUMTB004) and *Vibrio cholerae* (RUAUMTB005) were grown well at 30°C and developed very clear ring with the distance of 1.2, 1.1, 1.2, 1.0 and 1.2 cm respectively.

- The effect of pH on the growth of MTB’s reveals that, all the isolated magnetotactic bacteria viz., *Bacillus licheniformis* (RUAUMTB001), *Alcanivorax dieselolei* (RUAUMTB002), *Exiguobacterium* sp. (RUAUMTB003), *Alcanivorax dieselolei* (RUAUMTB004) and *Vibrio cholerae* (RUAUMTB005) were grown well at pH 7 and developed very clear rings with the distance of 1.6, 1.1, 1.4, 1.2 and 1.1 cm respectively.

- The effects of amino acids on the growth of MTB’s were carried out with the supplementation of different aminoacids such as asparagine, valine, leucine, glycine, glutamic acid, alanine, nigrosine and serine. It reveals that, the *Exiguobacterium* sp. RUAUMTB003 was developed clear ring with the distance of 0.8 cm in the presence of asparagine.
The effect of minerals on the growth of MTB’s strains was carried out by the supplementation of CuSO₄, MnCl₂, MgCl₂, FeSO₄, MnSO₄, LiSO₄ and CaCl₂. It reveals that, *Alcanivorax dieselolei* (RUAUMTB002) and *Exiguobacterium* sp. (RUAUMTB003) were grown well in the presence of LiSO₄ and developed clear ring with the distance of 0.6 cm respectively.

The effect of nitrogen sources on the growth of MTB strains were carried out by the supplementation of NH₃NO₃, beef extract and yeast extract. The *Vibrio cholerae* (RUAUMTB005) were developed with the clear ring maximum distance of 0.5 in the presence of NH₃NO₃.

The antibacterial activity of secondary metabolites from *Bacillus licheniformis* (RUAUMTB001), *Alcanivorax dieselolei* (RUAUMTB002), *Exiguobacterium* sp. (RUAUMTB003), *Alcanivorax dieselolei* (RUAUMTB004) and *Vibrio cholerae* (RUAUMTB005) against antibiotic resistant bacterial pathogens were carried out by the present study.

The results shows that, the *Bacillus licheniformis* (RUAUMTB001) enriched with FeSO₄ showed maximum sensitivity (9 ± 0.23 and 9 ± 0.36) against *Klebsiella* sp. and *Pseudomonas aeruginosa* at 250 µg; the *Alcanivorax dieselolei* (RUAUMTB002) enriched with FeSO₄ showed
maximum sensitivity (10 ± 0.53) against *Pseudomonas aeruginosa* at 250 µg, the *Exiguobacterium* sp. (RUAUMTB003) enriched with FeSO₄ showed maximum sensitivity (10 ± 0.56) against *Klebsiella* sp. at 250 µg, the *Alcanivorax dieselolei* (RUAUMTB004) enriched with FeSO₄ showed maximum sensitivity (10 ± 0.57) against *Staphylococcus aureus* at 250 µg, the *Vibrio cholerae* (RUAUMTB005) enriched with FeSO₄ showed maximum sensitivity (10 ± 0.61 and 10 ± 0.52) against *Klebsiella* sp. and *Pseudomonas aeruginosa* at 250 µg than the secondary metabolites obtained from the without the enrichment of FeSO₄.

The antibacterial activities of secondary metabolites from isolated MTB’s strains against ophthalmic pathogens were carried out by the present study. The results shows that, the *Bacillus licheniformis* (RUAUMTB001) enriched with FeSO₄ showed maximum sensitivity (11 ± 0.65 and 11 ± 0.61) against *Streptococcus vividins* and *Acinetobacter sp.* at 250 µg, the *Alcanivorax dieselolei* (RUAUMTB002) enriched with FeSO₄ showed maximum sensitivity (14 ± 0.78) against *Streptococcus vividins* at 250 µg, the *Exiguobacterium* sp. (RUAUMTB003) enriched with FeSO₄ showed maximum sensitivity (12 ± 0.74) against *Staphylococcus aureus* at 250 µg, the *Alcanivorax dieselolei* (RUAUMTB004) enriched with FeSO₄ showed maximum sensitivity (10 ± 0.57) against *E. coli* at 250 µg, the *Vibrio cholerae* (RUAUMTB005)
enriched with FeSO₄ showed maximum sensitivity (11 ± 0.75) against *Streptococcus vividins* at 250 µg than the secondary metabolites obtained from the without the enrichment of FeSO₄.

- The antibacterial activities of secondary metabolites from isolated MTB’s strains against UTI pathogens were carried out by the present study. The results shows that, the *Bacillus licheniformis* (RUAUMTB001) enriched with FeSO₄ showed maximum sensitivity (13 ± 0.75) against *Pseudomonas sp.* at 250 µg, the *Alcanivorax dieselolei* (RUAUMTB002) enriched with FeSO₄ showed maximum sensitivity (14 ± 0.79) against *Klebsiella sp.* at 250 µg, the *Exiguobacterium* sp. (RUAUMTB003) enriched with FeSO₄ showed maximum sensitivity (12 ± 0.89) against *Pseudomonas sp.* and *Klebsiella sp.* at 250 µg, the *Alcanivorax dieselolei* (RUAUMTB004) enriched with FeSO₄ showed maximum sensitivity (13 ± 0.75) against *E. coli* at 250 µg, the *Vibrio cholerae* (RUAUMTB005) enriched with FeSO₄ showed maximum sensitivity (14 ± 0.85) against *Klebsiella sp.* at 250 µg than the secondary metabolites obtained from the without the enrichment of FeSO₄.

- The antibacterial activities of secondary metabolites from isolated MTB’s strains against fish bacterial pathogens were carried out by the present study. The results shows that, the *Bacillus licheniformis*
(RUAUMTB001) enriched with FeSo4 showed maximum sensitivity (13 ± 0.75) against *Vibrio parahaemolyticus* at 250 µg, the *Alcanivorax dieselolei* (RUAUMTB002) enriched with FeSo4 showed maximum sensitivity (10 ± 0.66 and 10 ± 0.57) against *Bacillus subtilis* and *Aeromonas hydrophila* at 250 µg, the *Exiguobacterium* sp. (RUAUMTB003) and *Alcanivorax dieselolei* (RUAUMTB004) enriched with FeSo4 showed maximum sensitivity (11± 0.76 and 13± 0.76) against *Vibrio harveyi* at 250 µg, the *Vibrio cholerae* (RUAUMTB005) enriched with FeSo4 showed maximum sensitivity (13 ± 0.84) against *Bacillus subtilis* at 250 µg than the secondary metabolites obtained from the without the enrichment of FeSo4.

The antibacterial activities of secondary metabolites from isolated MTB’s strains against phytofungal pathogens were carried out by the present study. It reveals that, the *Bacillus licheniformis* (RUAUMTB001) enriched with FeSo4 showed maximum sensitivity (13 ± 0.75) against *Fusarium oxysporium* at 250 µg, the *Alcanivorax dieselolei* (RUAUMTB002) enriched with FeSo4 showed maximum sensitivity (10± 0.73) against *Fusarium moniliforme* at 250 µg, the *Exiguobacterium* sp. (RUAUMTB003), *Alcanivorax dieselolei* (RUAUMTB004) and *Vibrio cholerae* (RUAUMTB005) enriched with FeSo4 showed maximum sensitivity (10± 0.55; 13± 0.96 and 15± 0.95) against *Fusarium*
oxysporium at 250 µg than the secondary metabolites obtained from the
without the enrichment of FeSO₄.

- Biofertilizer effect of Bacillus licheniformis strain (RUAUMTB001) co-
inoculated with Azospirillum sp, phosphate solubilizing bacteria and
phosphatase producing bacteria on the root and shoot growth,
pigmentation and biochemical constituents in Oryza sativa were
analyzed. The maximum root length was significantly increased by
45.11% in treatment 5 (T5) over control.

- The average number of root biomass and shoot height were
significantly enhanced by 14.14% and 6.7% respectively over control.
The effect of inoculated bacterial strain on the content of total
chlorophyll and chlorophyll-a were significantly increased by 66.1%
and 66.67% respectively by in treatment 5(T5). Moreover, the effect of
inoculated bacterial strains on the content of chlorophyll-b and
carotenoid were significantly increased by 65% and 94.03%
respectively in treatment 5 (T5).

- Analysis of biochemical constituents revealed that, the biofertilizer
effect of inoculated bacterial strain on the content of total sugar in the
root and straw of Oryza sativa were significantly increased with the
maximum percentage of 10.61% and 71.45% respectively in treatment
5(T5). The content of protein in root and straw of *Oryza sativa* were significantly increased with the maximum percentage of 33.62% and 22.3% respectively in treatment 5(T5).

- The content of amino acid in root and straw of *Oryza sativa* were significantly increased with the maximum percentage of 84.68% and 86.14% respectively in treatment 5 (T5) than the control. The analysis of yield reveals that, *Oryza sativa* seeds were significantly increased with the maximum percentage of 61.38% in treatment 5 (T5) than the control.

- It is concluded from the present study that, the isolated magnetotactic bacteria have significant effect in the bacterial and fungal diseases in veterinary and human. Hence, the present study is strongly recommended for the development of effective drug from MTB’s. Moreover the biofertilizer effect of MTB’s can be recommended to reduce the production cost and environmental pollution for sustainable agriculture development.