

# **CONTENTS**

---

	<b>Page No.</b>
Acknowledgements	i
Contents	iii
Abbreviations	vii
List of Figures	viii
List of Tables	x
Preface	xi
<b>Chapter 1: Introduction</b>	<b>1-19</b>
1.1 History of bioremediation	<b>1</b>
1.2 Types of the pesticides and its uses	<b>5</b>
1.3 Bioremediation	<b>7</b>
1.4 Types of bioremediation	<b>7</b>
1.4.1 Bio-stimulation	<b>7</b>
1.4.2 Bio-augmentation	<b>8</b>
1.5 Influencing factors for the bioremediation of pesticides in soil	<b>12</b>
1.5.1 Pesticides Structures	<b>12</b>
1.5.2 Pesticide concentration	<b>13</b>
1.5.3 Types of Soil	<b>14</b>
1.5.4 Moisture content	<b>15</b>
1.5.5 Temperature	<b>15</b>
1.5.6 pH	<b>16</b>
1.6 Field applications of pesticides bioremediation techniques	<b>16</b>
1.6.1 In-situ bioremediation techniques	<b>16</b>
1.6.2 Ex-situ bioremediation techniques	<b>17</b>
1.7 Bioreactors	<b>18</b>
<b>Chapter 2: Literature survey</b>	<b>20-26</b>
2.1 Bioremediation of pesticides	<b>20</b>

---

<b>Finding of literature survey</b>	<b>27</b>
<b>Objective of research work</b>	<b>28</b>
<b>Chapter 3: Materials and methods</b>	<b>29-57</b>
3.1 Materials and chemicals	29
3.1.1 Equipments	29
3.1.2 Glass Wares	29
3.2 Methods	30
3.2.1 Site description and soil sampling	30
3.2.2 Packing media (PUF and Loofa)	31
3.2.3 Identification of bacterial species	34
3.2.4 Selection of best bacterial isolate for malathion degradation	36
3.2.5 Effect of pH and temperature on free cell biodegradation	37
3.2.6 Biodegradation of malathion in the packed batch bioreactor	37
3.2.7 Operational of continuous bioreactor	38
3.2.8 Batch bioreactor and parametric optimization	39
3.2.9 Continuous study	40
3.3 Malathion biodegradation: growth and inhibition kinetics	42
3.4 Proteomics study for malathion degradation	43
3.4.1 Extraction, quantification and 2-DE separation of proteins	43
3.4.2 Identification of protein: MALDI-TOF MS/MS Analysis	44
3.5 In silico analysis and characterization of identified protein	45
3.5.1 Functional domain analysis, Phylogenic classification and Structural prediction	45
3.5.2 Active site analysis and docking	47
3.6 Integrated two stage bioreactor study for mixed pesticides	47
3.6.1 Experimental setup for treatment of mixed pesticides: reactor setup and operations	47
3.6.2 Kinetic study	49
3.7 Hybrid bioreactor study for atrazine removal	51
3.7.1 Isolation of atrazine degradating microbes	51
3.7.2 Parametric optimization in batch process	51

3.7.2.1	UV Fenton	51
3.7.2.2	Biological process: bioreactor	52
3.7.3	Experimental set-up	52
3.8	Treated effluent analysis	54
3.8.1	Malathion and its metabolites analysis	54
3.8.2	Effluent analysis of IATP for mixed pesticide treatment	55
3.8.3	Effluent analysis of hybrid bioreactor for atrazine removal	56
<b>Chapter 4. Results and Discussions</b>		<b>58-109</b>
<b>Section A: Malathion Biodegradation</b>		<b>58</b>
4.1	Bacterial identification	58
4.2	Selection of most efficient bacterial isolate	59
4.3	Effect of pH and temperature in free cell system	61
4.4	Biodegradation in packed batch bioreactor	62
4.5	Continuous PBBR: operation and performance estimation	63
4.6	Effect of inlet loading rate, RE and EC for PBBR performance	66
4.7	Analysis of metabolites: FTIR and GC/MS analysis	68
4.8	Growth and inhibition kinetics	71
4.9	Proposed pathway: Malathion biodegradation	74
4.10	Proteomic analysis, spot identification and Maldi-Tof MS-MS Analysis	77
4.11	In silico characterization of identified protein	78
4.11.1	Functional domain analysis, Phylogenic classification and Structural prediction	78
4.11.2	Molecular Docking and Active side analysis	86
<b>Section B: Treatment of mixtures of pesticide</b>		<b>89</b>
4.12	Experimental study for mixed pesticides: Startup and performance of IATP	89
4.13	Intermediates/ Metabolites confirmation: GC-MS	96
4.14	Biodegradation kinetics and evaluation of death phase	101
<b>Section C: Hybrid reactor for atrazine removal</b>		<b>103</b>
4.15	Parametric optimization: UV Fenton	103
4.16	Parametric optimization: bioreactor	104
4.17	Performance evaluation of coupled process: UV Fenton and bioreactor	105

---

4.18	Analysis of residual Atrazine: HPLC and GC-MS	<b>108</b>
	<b>Chapter 5. Conclusion</b>	<b>110-111</b>
	<b>References</b>	<b>112-134</b>
	<b>Appendix</b>	<b>134-141</b>
	<b>List of research publications</b>	<b>142-144</b>

---

\*\*\*\*\*