CONTENTS

Abstract  
List of Tables  
List of Figures  
List of Abbreviations / Notations

CHAPTER I: INTRODUCTION  

1.1 North-East Indian and its biodiversity  
1.2 Free radical antioxidant and health  
  1.2.1. Free radicals and reactive species  
  1.2.2. Endogenous and exogenous antioxidants  
  1.2.3. Redox homeostasis, oxidative stress and phytochemicals  
1.3 Inflammation and pain  
  1.3.1. Inflammation  
  1.3.2. Pain  
1.4 Antitussive and expectorant activity  
  1.4.1. Acute and Chronic chough  
  1.4.2. Mechanism of cough  
  1.4.3. Cough as a symptom  
  1.4.4. Expectorant  
  1.4.5. Antitussive  
1.5 Nephroprotective activity  
  1.5.1. Contribution of kidney in different body system  
  1.5.2. Risk factor of nephrotoxicity  
  1.5.3. Drug induced nephrotoxicity  
1.6 Hepatoprotective activity  
  1.6.1. Liver anatomy  
  1.6.2. Disease of liver  
  1.6.3. Hepatotoxicity
1.6.4. Hepatotoxicity effects of liver enzyme 42
1.6.5. Types of Hepatotoxicity 43

1.7. **Tuberculosis**
  
  1.7.1. Symptoms of tuberculosis 46
  1.7.2. Types of tuberculosis 46

**CHAPTER II: LITERATURE REVIEW** 49-104

2.1 **Ethnobotanical of North-East India** 49
2.2. **Literature on Antioxidant Activity** 57
2.3. **Literature on expectorant and antitussive activity** 63
2.4. **Literature on analgesic and anti-inflammatory activity** 67
2.5. **Literature survey on hepatoprotective activity** 75
2.6 **Literature on Nephroprotective activity** 80
2.7. **Literature on Anti-TB activity** 88
2.8. **Literature on *Marsilea minuta*** 91
  
  2.8.1. Scientific name 91
  2.8.2. Family 91
  2.8.3. Vernacular name 91
  2.8.4. Taxonomical classification 91
  2.8.5. Botanical description 92
  2.8.6. Distribution 93
  2.8.7. Traditional and folk medicinal uses 93
  2.8.8. Biological evaluation 96
  2.8.9. Phytochemical studies 97

2.9. **Literature on *Phyllanthus acidus*** 98
  
  2.9.1. Scientific name 98
  2.9.2. Family 98
  2.9.3. Synonym 98
  2.9.4. Vernacular name 98
  2.9.5. Taxonomical classification 98
2.9.6. Botanical description 100
2.9.7. Distribution 100
2.9.8. Traditional and folk medicinal uses 100
2.9.9. Medicinal uses 101
2.9.10. Phytochemistry 104

CHAPTER III: THEORETICAL ANALYSIS 105-110
3.1. Scope and objective of the study 106
3.2. Plan of the work 108

CHAPTER IV: EXPERIMENTAL INVESTIGATIONS 111-158
4.1. Selection of Plants 111
4.2. Plant collection and authentication 116
4.3. Drugs and chemicals 116
4.4. Instrument used 117
4.5. Preparation of extracts 118
4.6. Physicochemical properties of extract 119
  4.6.1. Colour and yield determination 119
  4.6.2. Determination of pH 119
  4.6.3. Determination of specific gravity 119
4.7. Preliminary phytochemical investigation 120
  4.7.1. Detection of alkaloid 120
  4.7.2. Determination of carbohydrate 121
  4.7.3. Detection of protein and amino acid 122
  4.7.4. Detection of glycosides 122
  4.7.5. Detection of tannins 124
  4.7.6. Detection of flavonoids 125
  4.7.7. Detection of steroids and triterpenoids 125
4.8. Experimental animals 126
4.9. Determination of antioxidant compounds 126
  4.9.1. Total phenolic content determination 126
<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.9.2.</td>
<td>Total flavonoid content determination</td>
<td>127</td>
</tr>
<tr>
<td>4.10.</td>
<td><strong>In vitro antioxidant activity of extracts</strong></td>
<td>127</td>
</tr>
<tr>
<td>4.10.1.</td>
<td>DPPH radical scavenging assay</td>
<td>127</td>
</tr>
<tr>
<td>4.10.2.</td>
<td>Superoxide anion radical scavenging activity</td>
<td>128</td>
</tr>
<tr>
<td>4.10.3.</td>
<td>Hydroxyl radical scavenging activity</td>
<td>129</td>
</tr>
<tr>
<td>4.10.4.</td>
<td>Nitric oxide radical scavenging activity</td>
<td>129</td>
</tr>
<tr>
<td>4.10.5.</td>
<td>Hydrogen peroxide scavenging activity</td>
<td>130</td>
</tr>
<tr>
<td>4.10.6.</td>
<td>Reducing power ability</td>
<td>131</td>
</tr>
<tr>
<td>4.10.7.</td>
<td>Metal chelating activity</td>
<td>131</td>
</tr>
<tr>
<td>4.10.8.</td>
<td>Ferric thiocyanate method (FTC)</td>
<td>132</td>
</tr>
<tr>
<td>4.11.</td>
<td><strong>Ex vivo antioxidant activity of extracts</strong></td>
<td>133</td>
</tr>
<tr>
<td>4.11.1.</td>
<td>Lipid peroxidation assay</td>
<td>133</td>
</tr>
<tr>
<td>4.11.2.</td>
<td>Oxidative haemolysis assay</td>
<td>133</td>
</tr>
<tr>
<td>4.12.</td>
<td>Acute toxicity study</td>
<td>134</td>
</tr>
<tr>
<td>4.13.</td>
<td>Animal grouping</td>
<td>135</td>
</tr>
<tr>
<td>4.14.1.</td>
<td>Nociceptive tests</td>
<td>136</td>
</tr>
<tr>
<td>4.14.1</td>
<td>Anti-inflammatory activity</td>
<td>137</td>
</tr>
<tr>
<td>4.15.</td>
<td>Expectorant and antitussive activity of <em>M. minuta</em></td>
<td>139</td>
</tr>
<tr>
<td>4.15.1.</td>
<td>Antitussive activity</td>
<td>139</td>
</tr>
<tr>
<td>4.15.1</td>
<td>Expectorant activity</td>
<td>140</td>
</tr>
<tr>
<td>4.16.</td>
<td>Chromatographic separation of extracts</td>
<td>140</td>
</tr>
<tr>
<td>4.17.</td>
<td>Determination of retardation (<em>R</em>$_f$) value</td>
<td>141</td>
</tr>
<tr>
<td>4.18.</td>
<td><strong>In vitro and ex vivo antioxidant activity of fractions</strong></td>
<td>142</td>
</tr>
<tr>
<td>4.19.</td>
<td>Hepatoprotective and in vivo antioxidant activity of fractions</td>
<td>142</td>
</tr>
<tr>
<td>4.19.1.</td>
<td>Paracetamol induced hepatotoxicity</td>
<td>142</td>
</tr>
<tr>
<td>4.19.2.</td>
<td>Biochemical determination</td>
<td>143</td>
</tr>
<tr>
<td>4.19.3.</td>
<td><em>In vivo</em> antioxidant activity</td>
<td>148</td>
</tr>
</tbody>
</table>
4.20  Nephroprotective activity of fractions 151
   4.20.1  Sampling and biochemical analyses 151
4.21  Antitubercular activity of fractions 155
4.22  Isolation and identification of chemical constituent 156
4.23  Antioxidant activity and selection of potent subfraction 158
4.24  TLC and spectral analysis 158
4.25  Statistical analysis 158

CHAPTER V: EXPERIMENTAL RESULTS 159-238
5.1  Physicochemical properties of extracts 159
5.2  Phytochemical tests of extracts 159
5.3  Total phenolic and total flavonoid content 162
5.4  In vitro antioxidant activity of extracts 164
   5.4.1  DPPH· scavenging assay effect 164
   5.4.2  Superoxide anion radical scavenging effect 164
   5.4.3  Hydroxyl radical scavenging effect 169
   5.4.4  Nitric oxide radical scavenging effect 169
   5.4.5  Hydrogen peroxide scavenging effect 174
   5.4.6  Metal chelating effect 174
   5.4.7  Reducing power ability 179
   5.4.8  Total antioxidant activity 179
5.5  Ex vivo antioxidant activity of extracts 182
   5.4.1  Lipid peroxidation inhibition assay 182
   5.4.2  Inhibition of oxidative hemolysis 182
5.6  Yield of fraction 186
5.7  Rf value 186
5.8  Antioxidant activity of fractions 188
   5.8.1  DPPH· scavenging assay effect 188
   5.8.2  Nitric oxide radical scavenging effect 188
5.8.3 Total antioxidant activity 193
5.8.4 Lipid peroxidation inhibition effect 193

5.9 Acute toxicity study 197

5.10 Antitussive activity of M. minuta extract 197

5.11 Expectorant activity of M. minuta extract 197

5.12 Expectorant and antitussive activity of M. minuta methanol extract fractions 200
  5.12.1 Antitussive activity 200
  5.12.2 Expectorant activity 200

5.13 Analgesic activity of P. acidus leaf extract 203

5.14 Anti-inflammatory activity of P. acidus leaf extract 206

5.15 Analgesic and anti-inflammatory activity of P. acidus methanol extract fractions 209
  5.15.1 Analgesic activity 209
  5.15.2 Anti-inflammatory activity 212

5.16 Hepatoprotective activity of M. minuta and P. acidus fractions 215

5.17 *In vivo* antioxidant effect of fractions 218

5.18 Nephroprotective activity 222

5.19 Anti TB activity 225

5.20 Antioxidant effect of sub-fractions 226

5.21 TLC and Spectral analysis 231
  5.21.1 Structure of PA2 231
  5.21.2 Structure of MM8 235

CHAPTER VI: DISCUSSION OF RESULTS 239-262
CHAPTER VII: SUMMARY, CONCLUSION AND RECOMMENDATION 263-266

7.1 Summary 263

7.2 Conclusion 264

7.3 Recommendation 265
CHAPTER VIII: REFERENCES 267-295
APPENDIX