Contents

Preface ix

Acknowledgments xi

Introduction xiii

Chapter 1. Biology and Ecology of Microalgae 1

1.1. Biological characteristics 1
1.1.1. General characteristics 1
1.1.2. The different groups in traditional and phylogenetic classification 3
1.1.3. The special case of cyanobacteria (Cyanophyceae) 10
1.2. Ecological features 12
1.2.1. Marine microalgae 13
1.2.2. Microalgae in brackish and freshwater environments 15
1.2.3. Microalgae in terrestrial and aerial environments 16

Chapter 2. Production Techniques 21

2.1. Production by harvesting in the natural environment 21
2.2. Production by culture in open systems 24
2.2.1. Production in open basins 24
2.2.2. Production in open raceway-type basins 25
2.2.3. Open-tank production 30
2.3. Production by culture in a closed system 31
2.3.1. Production in discontinuous mode 31
2.3.2. Production in continuous mode 34

Chapter 3. Food Valorizations 43

3.1. Animal feed. 43
3.1.1. Forage microalgae 43
3.1.2. Dietary supplements 51
3.2. Human food 56
3.2.1. Ingredients or vegetables 56
3.2.2. Dietary supplements 60
3.2.3. Functional foods 66
3.2.4. Food coloring 73
3.2.5. Regulations 74

Chapter 4. Valorized Molecules 77

4.1. Polysaccharides 77
4.2. Proteins and enzymes 83
4.2.1. Phycobiliproteins 83
4.2.2. Enzymes 87
4.3. Non-protein pigments 89
4.4. Fat, sterols and fatty acids 90
4.5. The special case of biofuel 94
4.5.1. Biofuel production processes 94
4.5.2. Algal species used as biosources 99
4.5.3. The economic context 99
4.6. Other applications 101

Chapter 5. Extraction Processes 105

5.1. Conventional processes 105
5.1.1. Ball mills 105
5.1.2. Ultrasonication 106
5.1.3. Extraction using supercritical fluid 109
5.1.4. Extraction by microwaves 113
5.1.5. High-pressure extraction 114
5.1.6. Extraction facilitated by lyophilization 116
5.2. Enzymatic hydrolysis 118
5.3. Other methods 122

Chapter 6. Biotechnological Approaches 125

6.1. Biorefinery 125
6.2. Physiological forcing 127
6.3. Genetic transformation 131

Conclusion 137

References 139

Index 155