Review article Available online www.ijsrr.org ISSN: 2279–0543

International Journal of Scientific Research and Reviews

Antibacterial Compounds from Non-Heterocystous Cyanobacteria: A Review

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ABSTRACT

Diterpenoids (Abietane), Cyclic peptide (Brunsvicamides A, Brunsvicamides B , Brunsvicamides C), Fatty acid (Coriolic acid& α-dimorphecolic acid), Polyphenyl ether (Crossbyanol A, Crossbyanol B, Crossbyanol C , Crossbyanol D), Cyclic undecapeptide (Kawaguchipeptin A and Kawaguchipeptin B, Lyngbyazothrin A, Lyngbyazothrin B, Lyngbyazothrin C, Lyngbyazothrin D), Polyketide hybrid (Malyngolide), Diterpenoid (Norbietane), Cyclic peptide (Pahayokolide A and Pahayokolide B), Cyclic depsipeptide (Pitipeptolide A, Pitipeptolides B), Lipopeptide (Schizotrin A) and Terpenoid (20-nor-3a-acetoxy-12-hydroxy-abieta-5,7,9,11,13–pentaene) are diverse group of antibacterial compounds isolated and characterized from non-heterocystous cyanobacteria. Genus *Lyngbya* is extensively explored for antibacterial compounds among non-heterocystous cyanobacteria. Most of the non-heterocystous cyanobacterial genera are not searched for antibacterial compounds. Hence, there is a wide scope for mining of antibacterial compounds from Non-heterocystous cyanobacteria.

KEYWORDS: Cyanobacteria, Non-heterocystous, *Lyngbya*

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INTRODUCTION

Cyanobacteria are an ancient photosynthetic prokaryotic organism. Non-heterocystous cyanobacteria improve soil quality by adding organic matter and helping in binding soil particles. Cyanobacteria are the rich source of secondary metabolites and many of them with antimicrobial properties. According to data of Marine Literature, (2011)[1] Three hundred twenty-six secondary metabolites from *Lyngbya* sp., Eighty-four from *Nostoc* sp., Eighty-two from *oscillatoria* sp. Thirty-nine from *Schizothrix* sp., Fifty from *Microcystis* sp. Thirty-five from *Synecococcus* sp. Twenty-eight from *Anabaena* sp. and only four from *Fischerella* Sp. have been isolated. Alkaloids, aromatic compounds, cyclic depsipeptides, cyclic peptides, cyclic undecapeptides, cyclophane, extracellular pigment, fatty acids, linear peptides, lipopeptides, nucleosides, phenols, macrolides, polyketides, polyphenyl ethers, porphinoids and terpenoids type of antimicrobial compounds have been isolated and characterized from cyanobacteria[2].The cyanobacterium lacking heterocyst is called non-heterocystous cyanobacteria. Non-heterocystous cyanobacteria belong to three orders, i.e. Chroococales, Chamaesiphonales, Pleurocapsales and family Oscillatoriaceae of order Nostocales of phylum cyanophyta[3]. Non-heterocystous genera are *Synechocystis, Gloeocapsa,* Chroococcus, *Gloeothece, Dactylococcopsis, Synechococcus, Rhabdoderma, Microcystis, Aphanocapsa, Aphanothece, Chroococcus, Merismopedia, Eucapsis, Coelosphaerium, Gomphosphaeria, Johannesbaptistia, Chlorogloea, Entophysalis, Placoma, Chroococcidiopsis, Chamaesiphon, Dermocarpa, Stichosiphon, Myxosarcina, Hyella, Scopulonema, Hydrococcus, Xenococcus, Crinalium, Microcoleus, Sirocoleus, Polychlamydum, Dasygloea, Hydrocoleum, Schizothrix, Porphyrosiphon, Lyngbya, Symploca, Trichodesmium, Oscillatoria, Spirulina, Arthrospira, Katagnymene* and *Phormidium*[3] and some new reported genera including *Leptolyngbya* and *Tychonema*. Non-heterocystous cyanobacteria have the rich diversity of genera and species, but only a few have been searched for antibacterial compounds. This review article deals with potentials of Non-heterocystous cyanobacteria for antibacterial compounds.

ANTIBACTERIAL COMPOUNDS FROM NON-HETEROCYSTOUS CYANOBACTERIA:

Cyanobacteria are a rich source of antibacterial compounds, but most of them have been isolated from heterocystous cyanobacteria. An updated list of antibacterial compounds isolated from Non-heterocystous cyanobacteria is presented in Table-1.

Table-1 List of antibacterial compounds isolated from Non-heterocystous cyanobacteria

S.N.	Name of active compounds	Cyanobacteria/ Activity	References
1	Abietane (Diterpenoid),$C_{20}H_{36}$	*Microcoleous lacustris*/ Antibacterial	[4]Thajuddin & Subramanian, 2005
2	Brunsvicamides A (Cyclic peptide) $C_{45}H_{64}N_8O_8$ Brunsvicamides B (Cyclic peptide), $C_{46}H_{66}N_8O_8$ Brunsvicamides C (Cyclicpeptide), $C_{45}H_{64}N_8O_{10}$	*Tychonema* sp/ Antimycobacterial	[5]Muller et al., 2006
3	Coriolic acid (Fatty acid) $C_{18}H_{32}O_3$ & α-dimorphecolic acid (Fatty acid) C18H32O3	*Oscillatoria redekei*/ Antibacterial	[6]Mundit et al., 2003
4	Crossbyanol A (Polyphenyl ether) $C_{30}H_{15}Br_7O_6$, Crossbyanol B (Polyphenyl ether) $C_{30}H_{15}Br_7O_{12}S_2$, Crossbyanol C (Polyphenyl ether) $C_{30}H_{15}Br_7O_9S$, Crossbyanol D (Polyphenyl ether)$C_{30}H_{15}Br_7O_9S$	*Leptolyngbya crosbyana*/ Antibacterial	[7]Choi et al., 2010
5	Diterpenoid and majusculoic acid	*Aphanothece bullosa*/ Antibacterial	[8]Kumar et al., 2014
6	Kawaguchipeptin A (Cyclic undecapeptide) $C_{68}H_{92}N_{16}O_{18}$, Kawaguchipeptin B (Cyclic undecapeptide), $C_{58}H_{76}N_{16}O_{18}$	*Microcystis aeruginosa*/ Antibacterial	[9]Ishida et al., 1997.
7	Lyngbyazothrin A (Cyclic undecapeptide) $C_{62}H_{96}N_{12}O_{19}$, Lyngbyazothrin B (Cyclic undecapeptide) $C_{61}H_{94}N_{12}O_{18}$, Lyngbyazothrin C (Cyclic undecapeptide) $C_{74}H_{109}N_{13}O_{21}$, Lyngbyazothrin D (Cyclic undecapeptide) $C73H_{107}N_{13}O_{20}$	*Lyngbya sp.*/ Antibacterial	[10]Zainuddin et al., 2009
8	Malyngolide (Polyketide hybrid), $C_{16}H_{30}O_3$	*Lyngbya majuscule*/ Antifungal & Antibacterial	[11]Bruja et al., 2001
9	Malyngamides, amides of the fatty acid (&) -7(S)-methoxytetradec-4(E)-enoate,	*Lyngbya majuscule*/ Antibacterial	[12]Gerwick *et al*., 1987
10	20-nor-3a-acetoxy-12-hydroxy-abieta-5,7,9,11,13 -pentaene (Terpenoid), Norbietane (Diterpenoid), $C_{19}H_{34}$	*Microcoleous lacustris*/ Antibacterial	[13]Pérez-Gutiérrez et al., 2008
11	Pahayokolide A (Cyclic peptide) $C_{72}H_{105}N_{13}O_{20}$	*Lyngbya* sp./ Antibacterial	[14]Berry et al., 2004.
12	Pahayokolide B (Cyclic peptide) $C_{63}H_{90}N_{12}O_{18}$	*Lyngbya* sp./ Antibacterial	[15]Luesch et al., 2001
13	Pitipeptolide A (Cyclic depsipeptide), $C_{44}H_{65}N_5O_9$, Pitipeptolides B (Cyclicdepsipeptide), $C_{44}H_{67}N_5O_9$ Pitipeptolides C (Cyclicdepsipeptide), $C_{44}H_{69}N_5O_9$, Pitipeptolides D (Cyclic depsipeptide), $C_{43}H_{63}N_5O_9$, Pitipeptolides E (Cyclic depsipeptide), $C_{43}H_{63}N_5O_9$, Pitipeptolides F (Cyclic depsipeptide), $C_{43}H_{63}N_5O_9$	*Lyngbya majuscula* / Antimycobacterial	[15]Luesch et al., 2001
14	Schizotrin A (Lipopeptide)	*Schizothrix* sp/ Antibacterial &Antifungul	[16]Pergament et al., 1994

DISCUSSION:

Cyanobacteria are a well-known source of biologically active metabolites. A number of antibacterial compounds have been isolated and characterized from cyanobacteria. Only eight non-heterocystouscyanobacterial genera, i.e., *Microcoleous, Microcystis,Tychonema, Oscillatoria, Leptolyngbya, Microcystis, Lyngbya,* and *Schizothrix*were explored for antibacterial compounds (Tab.1). Diterpenoids (Abietane), Cyclic peptide (Brunsvicamides A, Brunsvicamides B , Brunsvicamides C), Fatty acid (Coriolic acid and α-dimorphecolic acid), Polyphenyl ether (Crossbyanol A, Crossbyanol B, Crossbyanol C, Crossbyanol D), Cyclic undecapeptide (Kawaguchipeptin A and Kawaguchipeptin B, Lyngbyazothrin A, Lyngbyazothrin B, Lyngbyazothrin C, Lyngbyazothrin D), Polyketide hybrid (Malyngolide), Diterpenoid (Norbietane), Cyclic peptide (Pahayokolide A and Pahayokolide B), Cyclic depsipeptide (Pitipeptolide A, Pitipeptolides B), Lipopeptide (Schizotrin A) and Terpenoid (20-nor-3a-acetoxy-12-hydroxy-abieta-5,7,9,11,13–pentaene) are diverse group of antibacterial compounds isolated and characterized from non-heterocystous cyanobacteria (Tab.1). Genus *Lyngbya* is extensively explored among non-heterocystous cyanobacteria (Tab.1). Most of non-heterocystous genera i.e. *Synechocystis, Gloeocapsa,* Chroococcus, *Gloeothece, Dactylococcopsis, Synechococcus, Rhabdoderma, Aphanocapsa, Aphanothece, Chroococcus, Merismopedia, Eucapsis, Coelosphaerium, Gomphosphaeria, Johannesbaptistia, Chlorogloea, Entophysalis, Placoma, Chroococcidiopsis, Chamaesiphon, Dermocarpa, Stichosiphon, Myxosarcina, Hyella, Scopulonema, Hydrococcus, Xenococcus, Crinalium, Sirocoleus, Polychlamydum, Dasygloea, Hydrocoleum, Porphyrosiphon, Lyngbya, Symploca, Trichodesmium, Spirulina, Arthrospira, Katagnymene* and *Phormidium* are not explored for antibacterial compounds (Tab.1). Each cyanobacterial genera have a score of species and strains with worldwide distribution. Hence, there is a wide scope for mining of antibacterial compounds from Non-heterocystous cyanobacteria.

CONCLUSION:

Diterpenoids (Abietane), Cyclic peptide (Brunsvicamides A, Brunsvicamides B, Brunsvicamides C), Fatty acid (Coriolic acid and α-dimorphecolic acid), Polyphenyl ether (Crossbyanol A, Crossbyanol B, Crossbyanol C, Crossbyanol D), Cyclic undecapeptide (Kawaguchipeptin A and Kawaguchipeptin B, Lyngbyazothrin A, Lyngbyazothrin B, Lyngbyazothrin C, Lyngbyazothrin D), Polyketide hybrid (Malyngolide), Diterpenoid (Norbietane), Cyclic peptide (Pahayokolide A and Pahayokolide B), Cyclic depsipeptide (Pitipeptolide A, Pitipeptolides B),

Lipopeptide (Schizotrin A) and Terpenoid (20-nor-3a-acetoxy-12-hydroxy-abieta-5,7,9,11,13–pentaene) are diverse group of antibacterial compounds isolated and characterized from non-heterocystous cyanobacteria (Tab.1). Genus *Lyngbya* is extensively explored among non-heterocystous cyanobacteria (Tab.1). Most of the non-heterocystous genera are not investigated for antibacterial compounds.

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