Metabolit sekunder dari mikroorganisme

Nur hidayat

Pendahuluan

- Metabolit sekunder adalah metabolit yang dihasilkan oleh mikroorganisme yang seakan tidak terkait dengan metabolisme utama
- Berbagai metabolit sekunder dihasilkan oleh berbagai mikroorganisme dengan berbagai fungsi
- Berikut beberapa contoh metabolit sekunder metabolit sekunder

Table 1 Approximate number of known natural products

Source	All known compounds	"Bioactives"	Antibiotics
Natural Products	over one million	200000 to 250000	25000 to 30000
Plant Kingdom	600000 to 700000	150000 to 200000	~25000
Microbes	over 50000	22000 to 23000	~17000
Algae, Lichens	3000 to 5000	1500 to 2000	~1000
Higher Plants	500000 to 600000	~100000	10000 to 12000
Animal Kingdom	300000 to 400000	50000 to 100000	~5000
Protozoa	several hundreds	100 to 200	~50
Invertebrates:	~100000	?	~500
Marine animals	20000 to 25000	7000 to 8000	3000 to 4000
Insects/worms/*etc.*	8000 to 10000	800 to 1000	150 to 200
Vertebrates (mammals, fishes, amphibians, *etc.*)	200000 to 250000	50000 to 70000	~1000

Table 2 Approximate number of bioactive microbial natural products (2002). According to their producers

Source	Antibiotics	"Other bioactive" metabolites	Total bioactive metabolites	Practically used (in human therapy)	Inactive metabolites
Bacteria	2900	900	3800	10~12 (8~10)	3000 to 5000
Atinomycetales	8700	1400	10100	100~120 (70~75)	5000 to 10000
Fungi	4900	3700	8600	30~35 (13~15)	2000 to 15 000
Total	16500	6000	22500	140~160 (~100)	20000 to 25000

Table 4 Approximate number of bioactive microbial metabolites according to their producers and bioactivities

Source	Bioactive secondary microbial metabolites				
	Antibiotics		Bioactive metabolites		Total bioactive metabolites
	Total	(with other activity)	no antibiotic activity	(antibiotics plus "other bioactives")	
Bacteria	**2900**	**(780)**	**900**	**(1680)**	**3800**
Eubacteriales	2170	(570)	580	(1150)	2750
Bacillus sp.	*795*	*(235)*	*65*	*(300)*	*860*
Pseudomonas sp.	*610*	*(185)*	*185*	*(370)*	*795*
Myxobacter	400	(130)	10	(140)	410
Cyanobacter	300	(80)	340	(420)	640
Actinomycetales	**8700**	**(2400)**	**1400**	**(3800)**	**10100**
Streptomyces sp.	6550	(1920)	1080	(3000)	7630
Rare actinos	2250	(580)	220	(800)	2470
Fungi	**4900**	**(2300)**	**3700**	**(6000)**	**8600**
Microscopic fungi	3770	(2070)	2680	(4750)	6450
Penicillium/Aspergillus	1000	(450)	950	(1400)	1950
Basidiomycetes	1050	(200)	950	(1150)	2000
Yeasts	105	(35)	35	(70)	140
Slime moulds	30	(5)	20	(25)	60
Total Microbial	**16500**	**(5500)**	**6000**	**(11500)**	**22500**

Table 6 Microbial interactions

Microbe – Microbe	Antimicrobial antibiotics, microbial regulators, growth factors, signaling compounds, mating hormones, *etc.*
Microbe – Lower Animals (invertebrates)	Insecticides, miticides, antiparasitic compounds, algicides, antifeedants, (invertebrates) repellents, molluscicides, anti-worm agents, *etc.*
Microbe – Higher Plants	Herbicides, phytotoxins, plant growth regulators, chlorosis inducers, phytoalexins, *etc.*
Microbe – Mammalians (humans)	Antitumor antibiotics, pharmacologically active agents, enzyme inhibitors, (humans) immunoactive, CNS-active, *etc.* agents, feed additives, *etc.*

Table 7 Bioactivity types of microbial metabolites numbers of discovered bioactivities

Type of activity		Numbers of discovered bioactivities
ANTIBIOTIC ACTIVITIES: (16500 compounds)		
Antimicrobial Activity:		
Antibacterial:	Gram-positive	11000~12000
	Gram-negative	5000~5500
	Mycobacteria	800~1000
Antifungal:	Yeasts	3000~3500
	Phytopathogenic fungi	1600~1800
	Other fungi	3800~4000
Antiprotozoal:		~1000
Chemotherapeutic activity:		
Antitumor (cytotoxic)		5000~5500
Antiviral		1500~1600

Metabolit sekunder dari bakteri

- *Pseudomonas flourescent* CHA0 mampu menghasilkan phenazine-1-carboxylic acid (PCA) yang mampu menekan penyakit black root rot pada tembakau yang disebabkan oleh *Thielaviopsis basicola.*
- Strain ini juga menghasilkan metabolit sekunder lain dg sifat2 spt antibiotika yi: hidrogen cyanide, pyoluteorin dan 2,4-diacetylphloroglucinol.

Table 1. Antifungal activity of 2,4-diacetylphloroglucinol (Phl)

Test fungus	MICs (μg/ml)[a] I_{50}	I_{100}
Fusarium oxysporum f. sp. *lycopersici*	16	128
Fusarium oxysporum f. sp. *lini*	32	128
Gaeumannomyces graminis var. *tritici*	16–32	64
Pythium debaryanum	64	128
Pythium ultimum	64	128
Rhizoctonia solani	32–64	128
Thielaviopsis basicola[b]	32–64	128

[a]MICs are defined as the minimal amount of Phl causing 50% (I_{50}) or total (I_{100}) inhibition of fungal growth on malt agar within 7 days. Concentrations of Phl were varied by twofold dilutions.
[b]In addition, germination of endoconidia of *T. basicola* was completely inhibited at 256 μg/ml on malt agar.

Table 2. Antibacterial activity of 2,4-diacetylphloroglucinol (Phl)

Test bacterium	MIC (μg/ml)[a]
Bacillus subtilis[b]	5
Bacillus thuringiensis[b]	5
Enterococcus faecalis[b]	50
Erwinia carotovora pv. *carotovora*[b]	250
Escherichia coli[b]	500
Klebsiella aerogenes[b]	500
Micrococcus luteus[b]	10
Pseudomonas aeruginosa[b]	>1,000
Pseudomonas fluorescens strain CHA0 (Phl^+)	>1,000
Pseudomonas fluorescens strain CHA625 (Phl^-)	1,000
Pseudomonas fluorescens strain P3[c]	500
Pseudomonas putida[b]	>1,000
Pseudomonas syringae pv. *phaseolicola*[b]	5
Pseudomonas syringae pv. *tabaci*[b]	5
Staphylococcus aureus[b]	5
Streptomyces echinatus[b]	250
Streptomyces lividans[b]	5

[a]MIC is defined as the minimal amount of Phl causing total inhibition of bacterial growth at 32°C in NYB, within 72 hr. Concentrations of Phl tested were: 5, 10, 50, 100, 250, 500, and 1,000 μg/ml.
[b]These strains were obtained from the collection of the Department of Microbiology, ETH, Zürich, Switzerland.
[c]Voisard *et al.* (1989).

Table 3. Phytotoxic activity of 2,4-diacetylphloroglucinol (Phl)

Plant tested	MICs (μg/ml)[a] I_{50}	I_{100}
On plant growth		
Corn	16–32	>256
Cress	8–16	64
Cucumber	32	>256
Flax	32	256
Sweet corn	16–32	>256
Tobacco	8	128
Tomato	16	256
Wheat	32–64	>1,024
On seed germination		
Cotton	256–512	512
Cress	16	64
Cucumber	128–256	>256
Flax	16	32
Tobacco	8–16	32
Tomato	8–16	64
Wheat	>1,024	>1,024

[a]MICs are defined as the minimal amount of Phl causing 50% (I_{50}) or total (I_{100}) inhibition of plant growth on Knop nutrient solution agar and of seed germination on 0.85% water agar, respectively, as described in the text. In each experiment, Phl concentrations were varied by twofold dilutions.

Pseudomonas aeruginosa menghasilkan met sek HCN

TABLE 2

Metal ion effect on cyanide production by *P. aeruginosa* strain 9-D2[a]

Metal salts[b]	Total cyanide, μmol/ml culture fluid
$FeCl_3$	0.328
$MnCl_2$	0.007
$ZnCl_2$	0.006
$CuCl_2$	0.004
$Co(NO_3)_2$	0.007

[a]Cultures were incubated for 24 h at 37C in the synthetic medium described in Methods.
[b]All metal salts were in a final concentration of 0.02 mM.

TABLE 3

Effect of mode of incubation on cyanogenesis by *P. aeruginosa* strain 9-D2

Mode of incubation[a]	Incubation time, h	Total cyanide, μmol/ml culture fluid
Shake culture	24	0.320
Stationary culture	48	0.104
Anaerobic culture	20	0.007
	28	0.007
	48	0.005
	72	0.004
Anaerobic shifted to aerobic at 20 h	12	0.041

[a]Incubation was at 37C in the media indicated in Methods.

TABLE 1

Species distribution of cyanogenesis during growth on nutrient agar

Organism	Incidence of HCN production[a]	Organism	Incidence of HCN production[a]
Pseudomonas alcaligenes	0/5	*P. stutzeri*	0/5
P. cepacia	0/4	*Alcaligenes oderans*	0/4
P. cichorii	0/2	*Alcaligenes* species	0/1
P. denitrificans	0/2	*Bordetella bronchiseptica*	0/1
P. dimunata	0/1	*Flavobacterium, Herellea, Mima, Moraxella* species	0/7
P. fluorescens	1/5	*Streptococcus faecalis*	0/1
P. marginalis	0/1	*Escherichia coli*	0/1
P. maltophilia	0/5	*Bacillus megaterium*	0/1
P. polycolor	2/4	*Candida utilis*	0/1
P. pseudoalcaligenes	0/1	*Neurospora crassa*	0/1
P. putida	0/9		
P. putrefaciens	0/3		

[a]Growth temperatures were 37C and room temperature. Incidence of HCN production is the number of strains which produced detectable HCN either at 37C or room temperature within 4 days over the number of strains tested.

Metabolit sekunder dari aktinomisetes

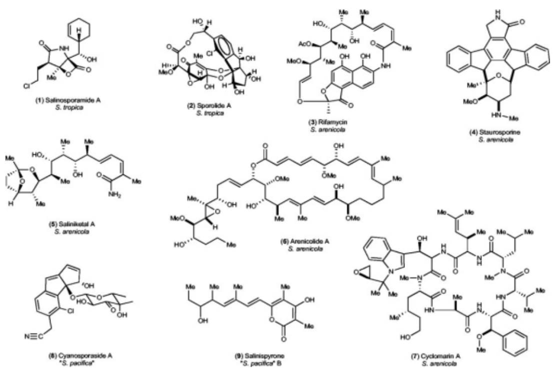

TABLE 1. Secondary metabolites isolated from *Salinispora* spp. and their major biological activities

Compound no. (name)	Source	Biological activity	Molecular target
1 (salinosporamide A)	*S. tropica*	Anticancer	Proteasome
2 (sporolide A)	*S. tropica*	Unknown	Unknown
3 (rifamycin)	*S. arenicola*	Antibiotic	RNA polymerase
4 (staurosporine)	*S. arenicola*	Anticancer	Protein kinase
5 (saliniketal)	*S. arenicola*	Cancer chemoprevention	Ornathine decarboxylase
6 (arenicolide A)	*S. arenicola*	Unknown	Unknown
7 (cyclomarin A)	*S. arenicola*	Anti-inflammatory, antiviral	Unknown, unknown
8 (cyanosporaside A)	"*S. pacifica*"	Unknown	Unknown
9 (salinispyrone A)	"*S. pacifica*" B	Unknown	Unknown