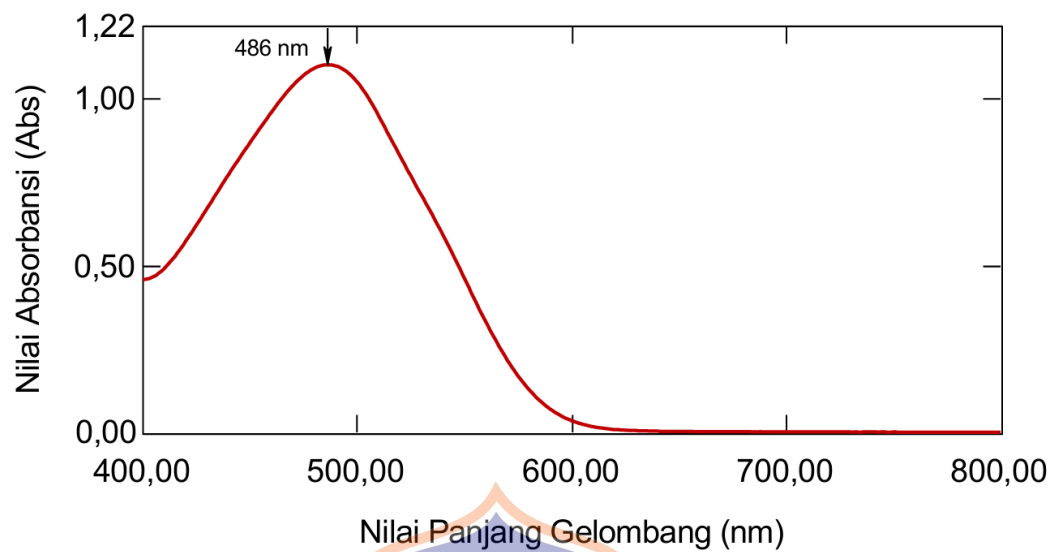


LAMPIRAN



Lampiran 1. Nilai Absorbansi Maksimum *Congo Red* pada Media *Nutrient Broth* (486 nm)

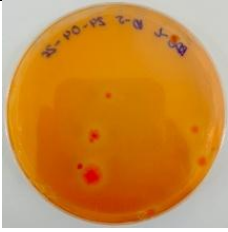
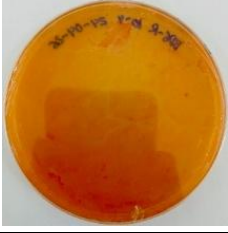
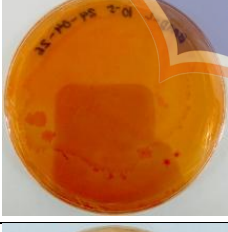


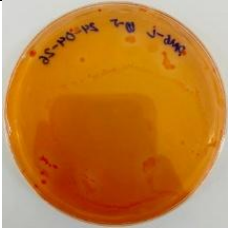
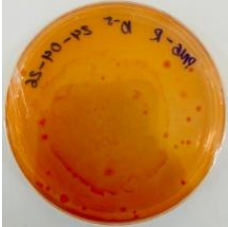
Keterangan: Nilai absorbansi maksimum *Congo Red* dalam media *nutrient broth* terdapat pada panjang gelombang 486 nm.

Lampiran 2. Kondisi Visual Pewarna Azo *Congo Red* pada Media NB Setelah Inokulasi Sampel Sedimen Mangrove



Lampiran 3. Hasil Isolasi Bakteri Potensial Biodegradasi *Congo Red* pada Sampel Sedimen Mangrove setelah 72 Jam Inkubasi

Sampel	Hasil Isolasi	Jumlah Koloni (CFU/mL)	Isolat Potensial
BDG-L		$1,25 \times 10^{-5}$ CFU/mL	3 isolat dengan zona dekolorisasi
BDG-R		$2,10 \times 10^{-5}$ CFU/mL	2 isolat dengan zona dekolorisasi
MTI-L		$2,45 \times 10^{-5}$ CFU/mL	3 isolat dengan zona dekolorisasi
MTI-R		$2,15 \times 10^{-5}$ CFU/mL	2 isolat dengan zona dekolorisasi
TBN-L		$1,55 \times 10^{-5}$ CFU/mL	3 isolat dengan zona dekolorisasi
TBN-R		$2,35 \times 10^{-5}$ CFU/mL	3 isolat dengan zona dekolorisasi

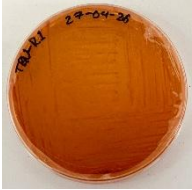
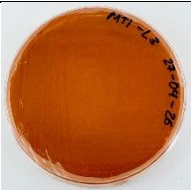
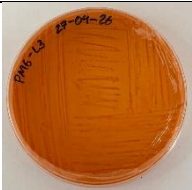
Sampel	Hasil Isolasi	Jumlah Koloni (CFU/mL)	Isolat Potensial
PMG-L		$3,25 \times 10^{-5}$ CFU/mL	4 isolat dengan zona dekolorisasi
PMG-R		$3,55 \times 10^{-5}$ CFU/mL	2 isolat dengan zona dekolorisasi

Lampiran 4. Kondisi Lingkungan dan Vegetasi pada Ekosistem Mangrove Teluk Benoa, Provinsi Bali

Lokasi	pH	Temperatur	Vegetasi	Sedimen	Gambar
Tukad Badung (BDG)	7,79	31,0°C	<i>Rhizophora</i> sp.	Lumpur	
Tukad Mati (MTI)	7,52	33,4°C	<i>Rhizophora</i> sp.	Lumpur	
Tuban (TBN)	8,44	30,2°C	<i>Sonneratia</i> sp.	Lumpur	
Pemogan (PMG)	7,87	30,8°C	<i>Sonneratia</i> sp.	Lumpur	

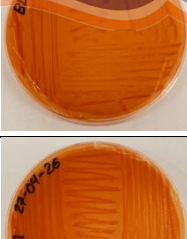
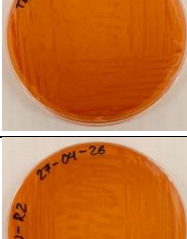
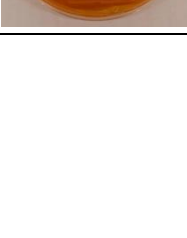
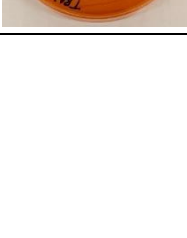
Lampiran 5. Skrining Isolat Bakteri Potensial Biodegradasi *Congo Red* setelah 24 Jam dan 48 Jam Inkubasi

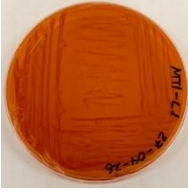
A. Setelah 24 jam inkubasi

Isolat	Hasil Uji	Gambar	Isolat	Hasil Uji	Gambar
BDG-L1	Positif (Zona Dekolorisasi)		TBN-L2	Negatif (Tanpa Zona Dekolorisasi)	
BDG-L2	Negatif (Tanpa Zona Dekolorisasi)		TBN-L3	Negatif (Tanpa Zona Dekolorisasi)	
BDG-L3	Negatif (Tanpa Zona Dekolorisasi)		TBN-R1	Negatif (Tanpa Zona Dekolorisasi)	
BDG-R1	Negatif (Tanpa Zona Dekolorisasi)		TBN-R2	Negatif (Tanpa Zona Dekolorisasi)	
BDG-R2	Negatif (Tanpa Zona Dekolorisasi)		TBN-R3	Negatif (Tanpa Zona Dekolorisasi)	
MTI-L1	Negatif (Tanpa Zona Dekolorisasi)		PMG-L1	Negatif (Tanpa Zona Dekolorisasi)	
MTI-L2	Negatif (Tanpa Zona Dekolorisasi)		PMG-L2	Negatif (Tanpa Zona Dekolorisasi)	
MTI-L3	Negatif (Tanpa Zona Dekolorisasi)		PMG-L3	Negatif (Tanpa Zona Dekolorisasi)	

MTI-R1	Positif (Zona Dekolorisasi)		PMG-L4	Negatif (Tanpa Zona Dekolorisasi)	
MTI-R2	Negatif (Tanpa Zona Dekolorisasi)		PMG-R1	Negatif (Tanpa Zona Dekolorisasi)	
TBN-L1	Negatif (Tanpa Zona Dekolorisasi)		PMG-R2	Negatif (Tanpa Zona Dekolorisasi)	

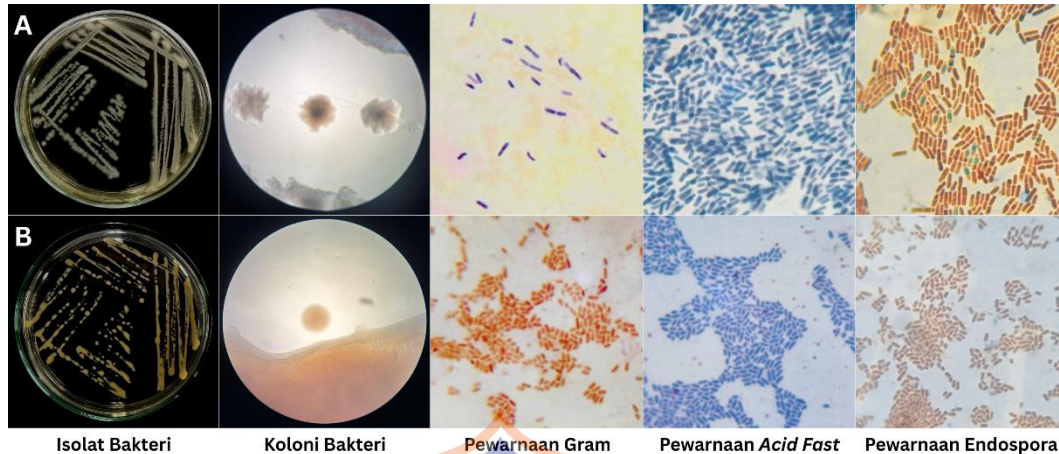
B. Setelah 48 jam inkubasi

Isolat	Hasil Uji	Gambar	Isolat	Hasil Uji	Gambar
BDG-L1	Positif (Zona Dekolorisasi)		TBN-L2	Negatif (Tanpa Zona Dekolorisasi)	
BDG-L2	Negatif (Tanpa Zona Dekolorisasi)		TBN-L3	Negatif (Tanpa Zona Dekolorisasi)	
BDG-L3	Negatif (Tanpa Zona Dekolorisasi)		TBN-R1	Negatif (Tanpa Zona Dekolorisasi)	
BDG-R1	Negatif (Tanpa Zona Dekolorisasi)		TBN-R2	Negatif (Tanpa Zona Dekolorisasi)	
BDG-R2	Negatif (Tanpa Zona Dekolorisasi)		TBN-R3	Negatif (Tanpa Zona Dekolorisasi)	

MTI-L1	Negatif (Tanpa Zona Dekolorisasi)		PMG-L1	Negatif (Tanpa Zona Dekolorisasi)	
MTI-L2	Negatif (Tanpa Zona Dekolorisasi)		PMG-L2	Negatif (Tanpa Zona Dekolorisasi)	
MTI-L3	Negatif (Tanpa Zona Dekolorisasi)		PMG-L3	Negatif (Tanpa Zona Dekolorisasi)	
MTI-R1	Positif (Zona Dekolorisasi)		PMG-L4	Negatif (Tanpa Zona Dekolorisasi)	
MTI-R2	Negatif (Tanpa Zona Dekolorisasi)		PMG-R1	Negatif (Tanpa Zona Dekolorisasi)	
TBN-L1	Negatif (Tanpa Zona Dekolorisasi)		PMG-R2	Negatif (Tanpa Zona Dekolorisasi)	

Lampiran 6. Kenampakan Visual Karakteristik Morfologi dan Biokimia Isolat Bakteri Indigenous Asal Sedimen Mangrove Potensial Biodegradasi *Congo Red*

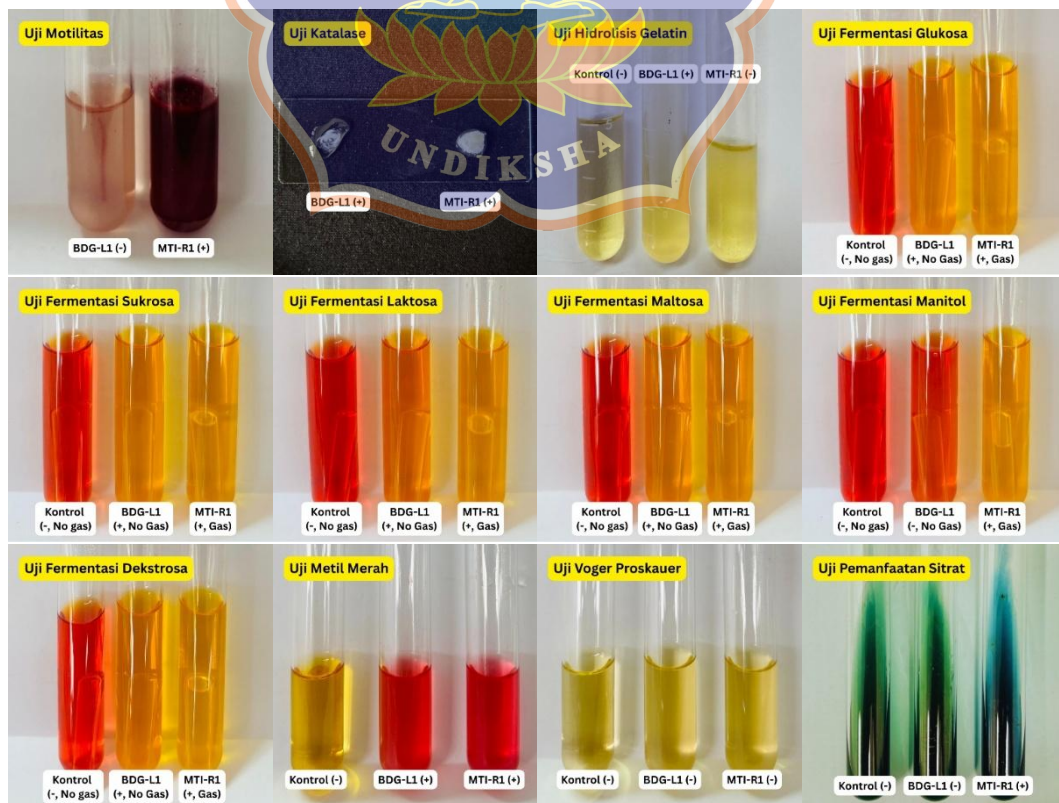
A. Karakteristik morfologi isolat bakteri (A: BDG-L1 dan B: MTI-R1)

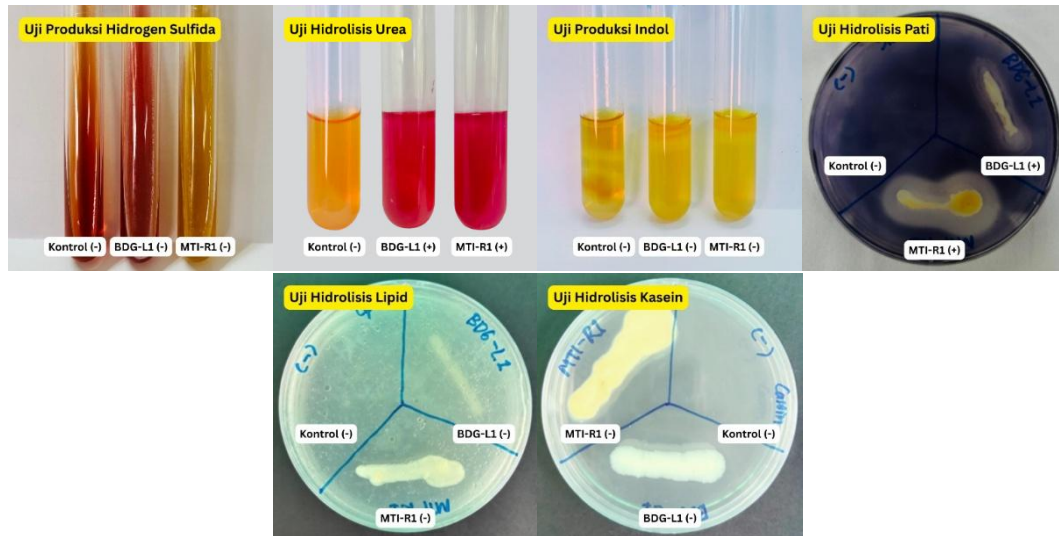


Keterangan:

- Pengamatan koloni bakteri menggunakan mikroskop stereo pada perbesaran 40x (objektif 4x dan okuler 10x)
- Pengamatan hasil pewarnaan bakteri menggunakan mikroskop cahaya (binokuler) pada perbesaran 1000x (objektif 100x dan okuler 10x)

B. Karakteristik biokimia isolat bakteri BDG-L1 dan MTI-R1





Lampiran 7. Nilai Absorbansi, Konsentrasi Residu, dan Persentase Biodegradasi Congo Red oleh Bakteri Indigenous Setelah 48 Jam Inkubasi

Perlakuan	Absorbansi (Abs)	Konsentrasi Residu (ppm)	Persentase Biodekolorisasi (%)
Kontrol Positif (<i>Bacillus cereus</i>)	0.85 ± 0.01	65.25 ± 0.93	35.16 %
BDG-L1	0.23 ± 0.01	16.64 ± 1.12	82.65 %
MTI-R1	0.14 ± 0.00	9.61 ± 0.19	89.52 %
BDG-L1 + MTI-R1	0.22 ± 0.01	16.09 ± 0.63	83.18 %

Lampiran 8. Hasil Analisis Statistika

A. Hasil Uji Normalitas Sampel Biodegradasi Congo Red oleh Bakteri Indigenous Sedimen Mangrove

Perlakuan	Statistik	df	Signifikansi	Keterangan
Kontrol Positif (<i>B. cereus</i>)	0.979	12	0.977	Signifikan
BDG-L1	0.872	12	0.070	Signifikan
MTI-R1	0.974	12	0.947	Signifikan
BDG-L1 + MTI-R1	0.936	12	0.447	Signifikan

B. Hasil Uji Homogenitas Sampel Biodegradasi Congo Red oleh Bakteri Indigenous Sedimen Mangrove

Variabel	Statistik Levene	Signifikansi	Keterangan
Nilai Absorbansi (Abs)	8.443	< 0.001	Tidak Signifikan

C. Hasil Uji *Welch ANOVA* Sampel Biodegradasi *Congo Red* oleh Bakteri Indigenous Sedimen Mangrove

	Statistik	df1	df2	Signifikansi	Keterangan
Welch	151864.167	4	25.028	< 0.001	Signifikan

D. Hasil Uji *Post Hoc Games-Howell* Sampel Biodegradasi *Congo Red* oleh Bakteri Indigenous Sedimen Mangrove

Perlakuan	BDG-L1		MTI-R1		BDG-L1 + MTI-R1	
	PR	Sig	PR	Sig	PR	Sig
Kontrol (<i>B. cereus</i>)	0.662*	< 0.001	0.712*	< 0.001	0.629*	< 0.001
BDG-L1			0.090*	< 0.001	0.007	0.590
MTI-R1					0.083*	< 0.001

PR: Perbedaan Rerata; Sig: Signifikansi

Lampiran 9. Perbandingan Intensitas Warna *Congo Red* dengan Inokulasi Bakteri Indigenous: (A) Jam ke-0, dan (B) Jam ke-48 (Setelah Sentrifugasi)



Lampiran 10. Fitotoksisitas Kacang Hijau (*Vigna radiata*) terhadap Produk Hasil Biodegradasi *Congo Red* oleh Bakteri Indigenous Sedimen Mangrove

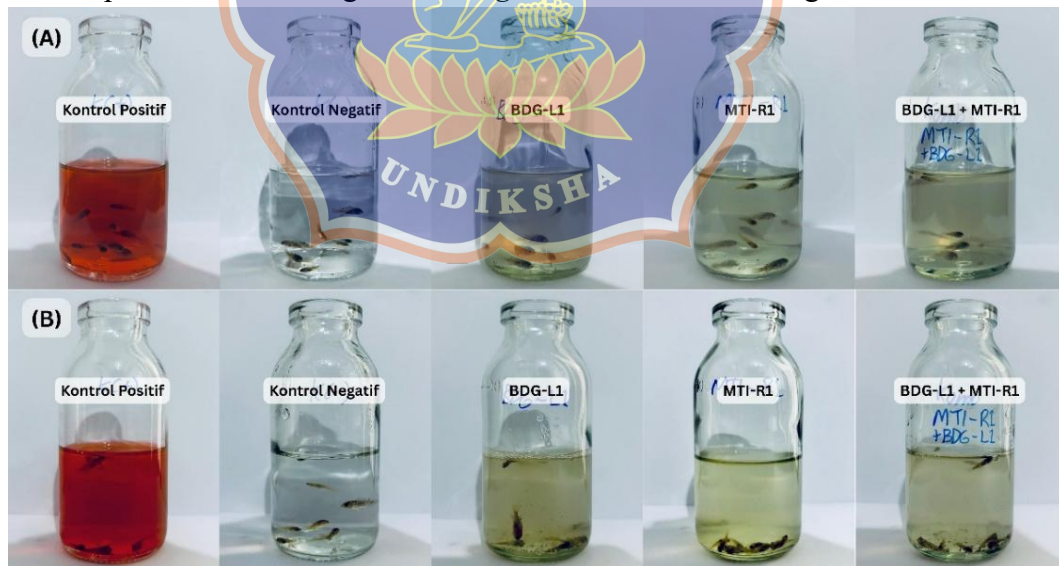
Parameter	Perlakuan				
	K(+) (<i>Congo Red</i>)	K(-) (Akuades)	Produk Biodegradasi BDG-L1	Produk Biodegradasi MTI-R1	Produk Biodegradasi BDG-L1 + MTI-R1
Germinasi	100%	100%	100%	100%	100%
Panjang Pucuk (cm)	6.24 ± 0.65	7.16 ± 0.72	6.23 ± 0.50	6.19 ± 1.02	6.31 ± 0.66
Panjang Akar (cm)	6.08 ± 1.02	6.19 ± 0.62	5.56 ± 0.78	5.83 ± 0.82	5.52 ± 0.77
Berat Basah (mg)	400.85 ± 48.04	527.00 ± 62.74	481.58 ± 42.70	410.40 ± 49.25	465.01 ± 60.77

Lampiran 11. Mortalitas Benih Ikan Nila (*Oreochromis niloticus*) dan Larva Artemia (*A. salina*) terhadap Produk Hasil Biodegradasi *Congo Red* oleh Bakteri Indigenous Sedimen Mangrove

A. Rerata mortalitas benih ikan nila setelah perlakuan dengan pemberian produk biodegradasi *Congo Red* oleh bakteri indigenous sedimen mangrove dalam interval 6 jam selama 48 jam

Waktu (Jam)	Mortalitas Benih Ikan Nila (<i>Oreochromis niloticus</i>) (%)				
	K(-) (<i>Congo Red</i>)	K(+) (Akuades)	Produk Biodegradasi BDG-L1	Produk Biodegradasi MTI-R1	Produk Biodegradasi BDG-L1 + MTI-R1
0	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
6	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	25.0 ± 9.72	0.00 ± 0.00
12	0.00 ± 0.00	0.00 ± 0.00	10.00 ± 9.43	81.0 ± 5.68	9.00 ± 5.68
18	0.00 ± 0.00	29.00 ± 5.68	28.00 ± 4.22	98.0 ± 4.22	49.00 ± 5.68
24	0.00 ± 0.00	39.00 ± 3.16	62.00 ± 7.89	100.00 ± 0.00	59.00 ± 8.76
30	0.00 ± 0.00	51.00 ± 5.68	78.00 ± 4.22	100.00 ± 0.00	63.00 ± 4.83
36	0.00 ± 0.00	61.00 ± 7.38	89.00 ± 8.76	100.00 ± 0.00	71.00 ± 5.68
42	0.00 ± 0.00	72.00 ± 4.22	94.00 ± 5.16	100.00 ± 0.00	82.00 ± 10.33
48	0.00 ± 0.00	84.00 ± 6.99	100.00 ± 0.00	100.00 ± 0.00	94.00 ± 5.16

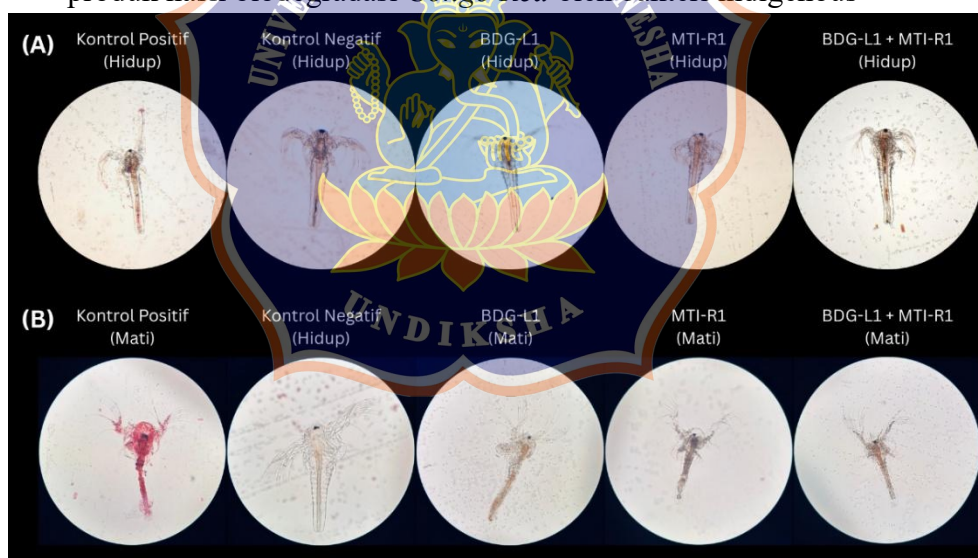
B. Kondisi benih ikan nila sebelum (A) dan sesudah (B) perlakuan dengan produk hasil biodegradasi *Congo Red* oleh bakteri indigenous



- C. Rerata mortalitas larva artemia setelah perlakuan dengan pemberian produk biodegradasi *Congo Red* oleh bakteri indigenous sedimen mangrove dalam interval 6 jam selama 48 jam

Waktu (Jam)	Mortalitas Larva Artemia (<i>Artemia salina</i>) (%)				
	K(-) (<i>Congo Red</i>)	K(+) (Akuades)	Produk Biodegradasi BDG-L1	Produk Biodegradasi MTI-R1	Produk Biodegradasi BDG-L1 + MTI-R1
0	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
6	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
12	0.00 ± 0.00	11.00 ± 9.94	12.00 ± 4.22	15.00 ± 5.27	11.00 ± 3.16
18	0.00 ± 0.00	41.00 ± 5.68	51.00 ± 8.76	55.00 ± 7.07	48.00 ± 6.32
24	0.00 ± 0.00	72.00 ± 7.89	82.00 ± 10.33	85.00 ± 5.27	82.00 ± 4.22
30	0.00 ± 0.00	76.00 ± 8.43	85.00 ± 7.07	89.00 ± 5.68	86.00 ± 6.99
36	0.00 ± 0.00	78.00 ± 6.32	89.00 ± 7.38	93.00 ± 6.75	89.00 ± 7.38
42	0.00 ± 0.00	80.00 ± 6.67	97.00 ± 4.83	99.00 ± 3.16	98.00 ± 4.22
48	0.00 ± 0.00	87.00 ± 8.23	100.00 ± 0.00	100.00 ± 0.00	100.00 ± 0.00

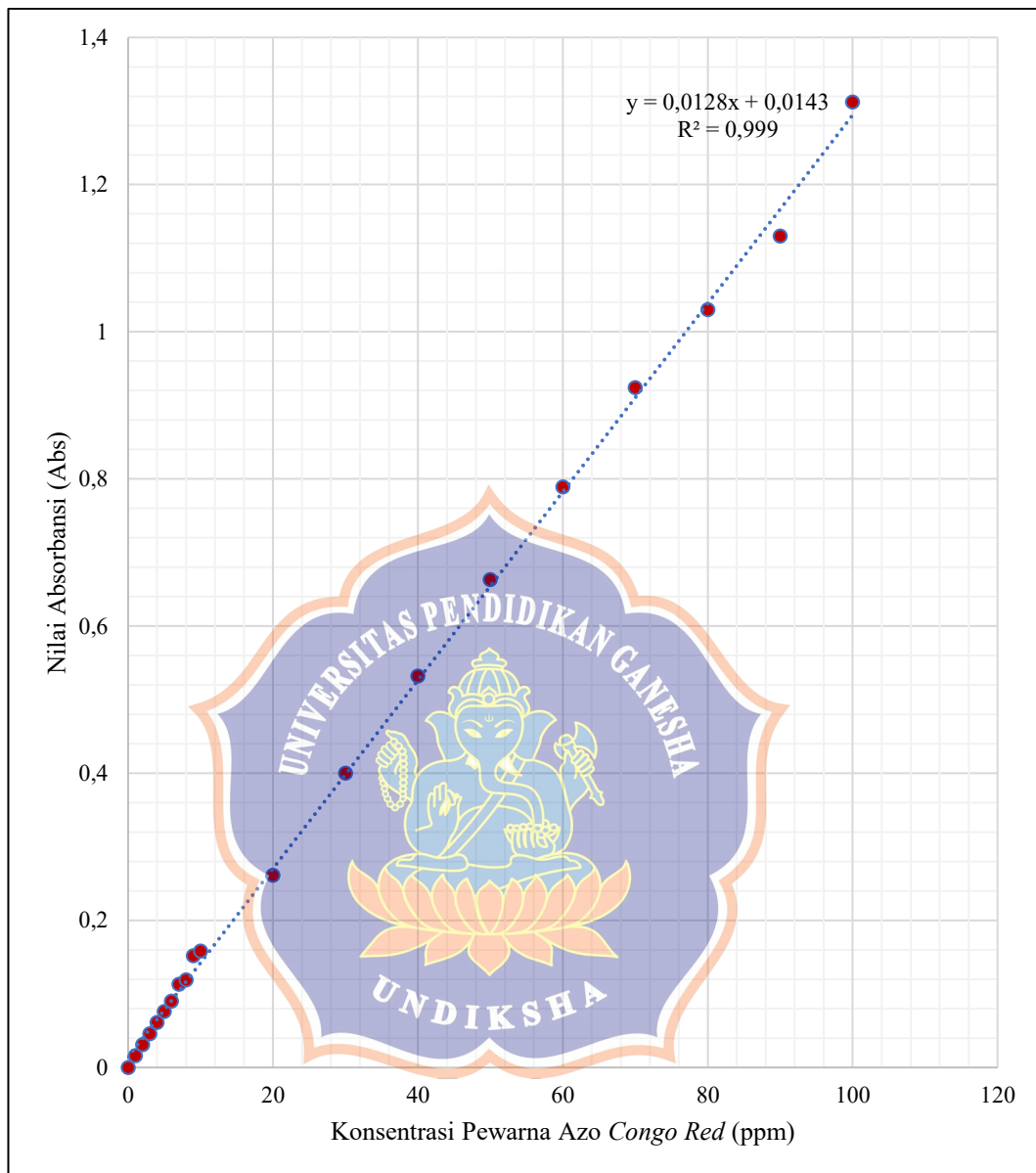
- D. Kondisi larva artemia sebelum (A) dan sesudah (B) perlakuan dengan produk hasil biodegradasi *Congo Red* oleh bakteri indigenous



Lampiran 12. Penyetaraan Nilai OD600 Isolat Bakteri yang Diinokulasikan pada Media *Nutrient Broth* dengan *Congo Red* dalam Uji Biodegradasi dengan Nilai 0,5 OD

Isolat Bakteri	Nilai OD600 (Abs)
<i>Bacillus cereus</i> (kontrol positif)	0.5094
BDG-L1	0.5008
MTI-R1	0.5016

Lampiran 13. Grafik Kurva Standar Konsentrasi *Congo Red* dengan Rumus Penghitungan Konsentrasi dan Nilai R^2



- Nilai R^2 yang mendekati 1 ($R^2 = 0,999$) menandakan kurva regresi standar konsentrasi *Congo Red* yang dapat dipercaya
- Rumus penghitungan konsentrasi *Congo Red*: $y = 0,0128x + 0,0143$; dimana y adalah nilai absorbansi (A) yang ditampilkan pada spektrofotometer UV-Vis dan x adalah konsentrasi (ppm) *Congo Red*

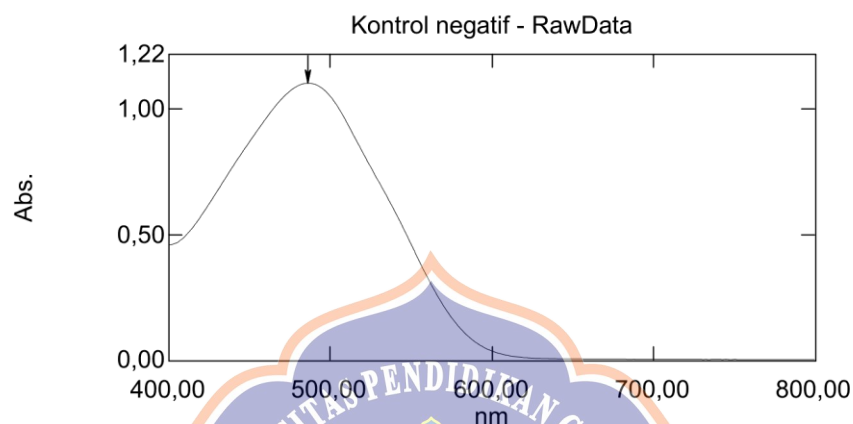
Lampiran 14. *Output* Spektrofotometer UV-Vis *double-beam* tipe Shimadzu UV-2600i pada Pengukuran Panjang Gelombang Maksimum *Congo Red*

Lokasi penelitian: Laboratorium Riset FMIPA, Universitas Pendidikan Ganesha

Spectrum Point Pick

Print Date : 23/04/2026 16:04:35

File Name: Kontrol negatif - RawData



[Summary]

Data Information

Data is:

Data Set Name:

Sample Name:

Sample ID:

Option:

Analyst:

Date/Time:

Comments:

Parameter File Name: D:\NuhurLujji biodecolorisasi.vspm

Report File Name:

Measurement Data
RawData

Software Information

Software Name:

Version:

LabSolutions UV-Vis

1,15

Instrument Information

Instrument Name:

Instrument Type:

Model (S/N):

UV-2600i

UV-2600 Series

UV-2600i (A12596280396ML)

[Point Pick Table]

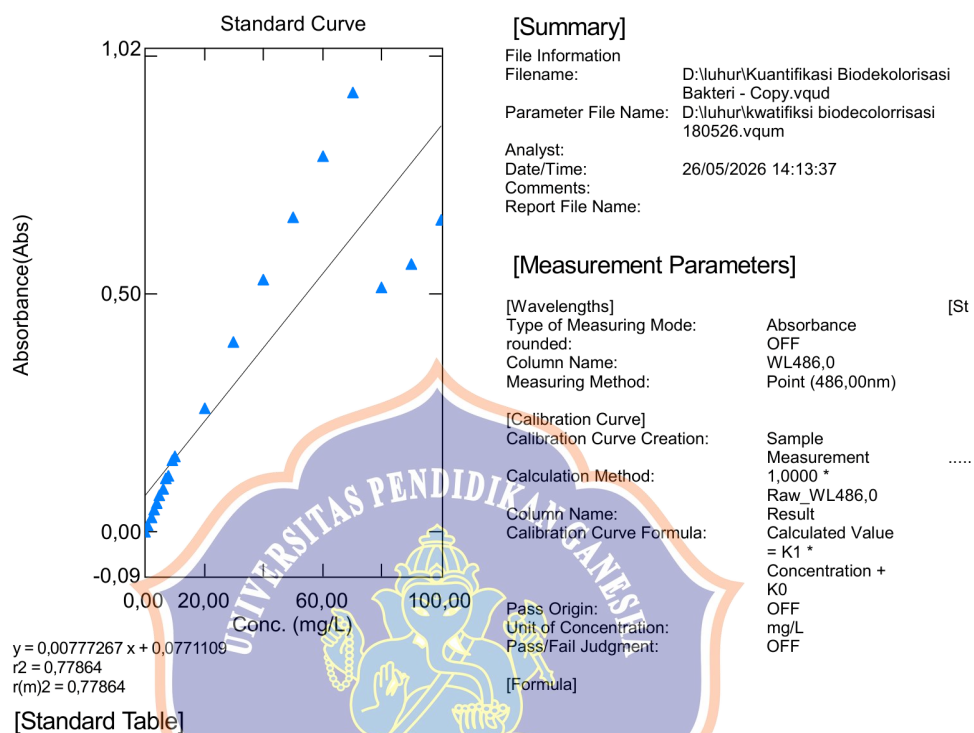
No.	Wavelength nm.	Absorbance	Description
1	486,0	1,1050	

Lampiran 15. Output Spektrofotometer UV-Vis *double-beam* tipe Shimadzu UV-2600i pada Pengukuran Kurva Standar *Congo Red*

Lokasi penelitian: Laboratorium Riset FMIPA, Universitas Pendidikan Ganesha

Quantitation Standard Table

Print Date : 26/05/2026 14:14:56



	Sample Name	Sample ID	Option	Type	Ex	Conc	Raw_WL486,0	Resu
1	STD 0			STD		0,000	0,0003	(
2	STD 1			STD		1,000	0,0157	(
3	STD 2			STD		2,000	0,0309	(
4	STD 3			STD		3,000	0,0463	(
5	STD 4			STD		4,000	0,0607	(
6	STD 5			STD		5,000	0,0759	(
7	STD 6			STD		6,000	0,0903	(
8	STD 7			STD		7,000	0,1133	(
9	STD 8			STD		8,000	0,1193	(
10	STD 9			STD		9,000	0,1518	(

	Sample Name	Sample ID	Option	Type	Ex	Conc	Raw_WL486,0	Resu
11	STD 10			STD		10,000	0,1579	(
12	STD 20			STD		20,000	0,2608	(
13	STD 30			STD		30,000	0,4005	(
14	STD 40			STD		40,000	0,5318	(
15	STD 50			STD		50,000	0,6626	(
16	STD 60			STD		60,000	0,7894	(
17	STD 70			STD		70,000	0,9242	(
18	STD 80			STD		80,000	0,5150	(
19	STD 90			STD		90,000	0,5646	(
20	STD 100			STD		100,000	0,6557	(

Lampiran 16. Output Spektrofotometer UV-Vis *double-beam* tipe Shimadzu UV-2600i pada Pengukuran OD600 Kultur Isolat Bakteri Indigenous

Lokasi penelitian: Laboratorium Riset FMIPA, Universitas Pendidikan Ganesha

Quantitation Sample Table

Print Date : 22/05/2026 10:03:21

[Summary]

File Information
 Filename: D:\uhur\Nilai OD Bakteri 18 05 26.vqud
 Parameter File Name: D:\uhur\Nilai OD600 Bakteri 180526.vqum
 Analyst:
 Date/Time: 18/05/2026 15:36:40
 Comments:
 Report File Name:
 Instrument Information
 Instrument Name: UV-2600i

[Measurement Parameters]

[Wavelengths]
 Type of Measuring Mode: Absorbance
 rounded: OFF
 Column Name: WL600,0
 Measuring Method: Point (600,00nm)
 [Calibration Curve]
 Calibration Curve Creation: Sample Measurement
 Calculation Method: 1,0000 * Raw_WL600,0
 Column Name: Result
 Calibration Curve Formula: Calculated Value = K1 * Concentration + K0
 Pass Origin: OFF
 Unit of Concentration: mg/L
 Pass/Fail Judgment: OFF

De

[Formula]

[Standard]
 Acquiring Method: Measurement
 Repeat: OFF

[Unknown Sample]
 Acquiring Method: Measurement
 Repeat: OFF

[Instrument]
 Slit Width: 2.0 nm
 Accumulation Time (sec.): 0.1

Calibration Curve

r2 = *****
 r(m)2 = *****

[Sample Table]

	Sample Name	Sample ID	Option	Type	Ex	Conc	Raw_WL600,0	Result
1	Bacillus cereus			UNK		*****	0,5094	0
2	BDG-L1			UNK		*****	0,5008	0
3	MTI-R1			UNK		*****	0,5016	0

Lampiran 17. Output Spektrofotometer UV-Vis *double-beam* tipe Shimadzu UV-2600i pada Pengukuran Nilai Absorbansi Akhir *Congo Red* setelah 48 Jam Perlakuan Biodegradasi oleh Bakteri Indigenous Sedimen Mangrove

Lokasi penelitian: Laboratorium Riset FMIPA, Universitas Pendidikan Ganesha

Quantitation Sample Table

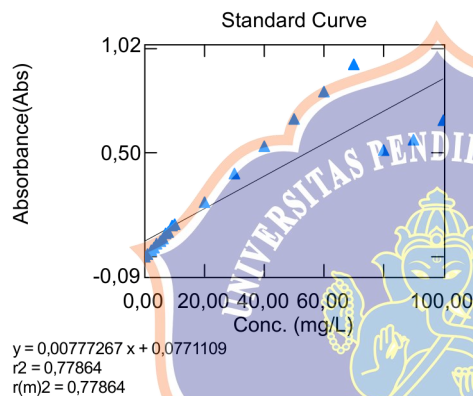
Print Date : 26/05/2026 14:16:13

[Summary]

File Information
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 Parameter File Name: D:\uhur\kwatifikasi biodekolorisasi 180526.vqum
 Analyst:
 Date/Time: 26/05/2026 14:13:37
 Comments:
 Report File Name:
 Instrument Information
 Instrument Name: UV-2600i

[Measurement Parameters]

[Wavelengths]
 Type of Measuring Mode: Absorbance
 rounded: OFF
 Column Name: WL486,0
 Measuring Method: Point (486,00nm)
 [Calibration Curve]
 Calibration Curve Creation: Sample
 Measurement
 Calculation Method: 1,0000 *
 Raw_WL486,0
 Result
 Column Name: Calculated Value
 Calibration Curve Formula: = K1 *
 Concentration +
 K0
 Pass Origin: OFF
 Unit of Concentration: mg/L
 Pass/Fail Judgment: OFF



[Sample Table]

	Sample Name	Sample ID	Option	Type	Ex	Conc	Raw_WL486,0	Re:
1	Kontrol + U1			UNK		98,480	0,8426	
2	Kontrol + U2			UNK		96,399	0,8264	
3	Kontrol + U3			UNK		102,283	0,8721	
4	Kontrol + U4			UNK		99,174	0,8480	
5	Kontrol + U5			UNK		98,910	0,8459	
6	Kontrol + U6			UNK		100,678	0,8597	
7	Kontrol + U7			UNK		100,165	0,8557	
8	Kontrol + U8			UNK		98,992	0,8465	
9	Kontrol + U9			UNK		99,129	0,8476	
10	Kontrol + U10			UNK		97,778	0,8371	

	Sample Name	Sample ID	Option	Type	Ex	Conc	Raw_WL486,0	Re:
11	Kontrol + U11			UNK		99,589	0,8512	
12	Kontrol + U12			UNK		100,799	0,8606	
13	BDG-L1 U1			UNK		19,854	0,2314	
14	BDG-L1 U2			UNK		21,618	0,2451	
15	BDG-L1 U3			UNK		18,108	0,2179	
16	BDG-L1 U4			UNK		18,224	0,2188	
17	BDG-L1 U5			UNK		20,741	0,2383	
18	BDG-L1 U6			UNK		22,003	0,2481	
19	BDG-L1 U7			UNK		22,053	0,2485	
20	BDG-L1 U8			UNK		17,041	0,2096	

	Sample Name	Sample ID	Option	Type	Ex	Conc	Raw_WL486,0	Re:
21	BDG-L1 U9			UNK		18,586	0,2216	
22	BDG-L1 U10			UNK		17,997	0,2170	
23	BDG-L1 U11			UNK		18,214	0,2187	
24	BDG-L1 U12			UNK		17,422	0,2125	
25	MTI-R1 U1			UNK		8,092	0,1400	
26	MTI-R1 U2			UNK		7,549	0,1358	
27	MTI-R1 U3			UNK		7,956	0,1390	
28	MTI-R1 U4			UNK		7,600	0,1362	
29	MTI-R1 U5			UNK		7,993	0,1392	
30	MTI-R1 U6			UNK		7,481	0,1353	

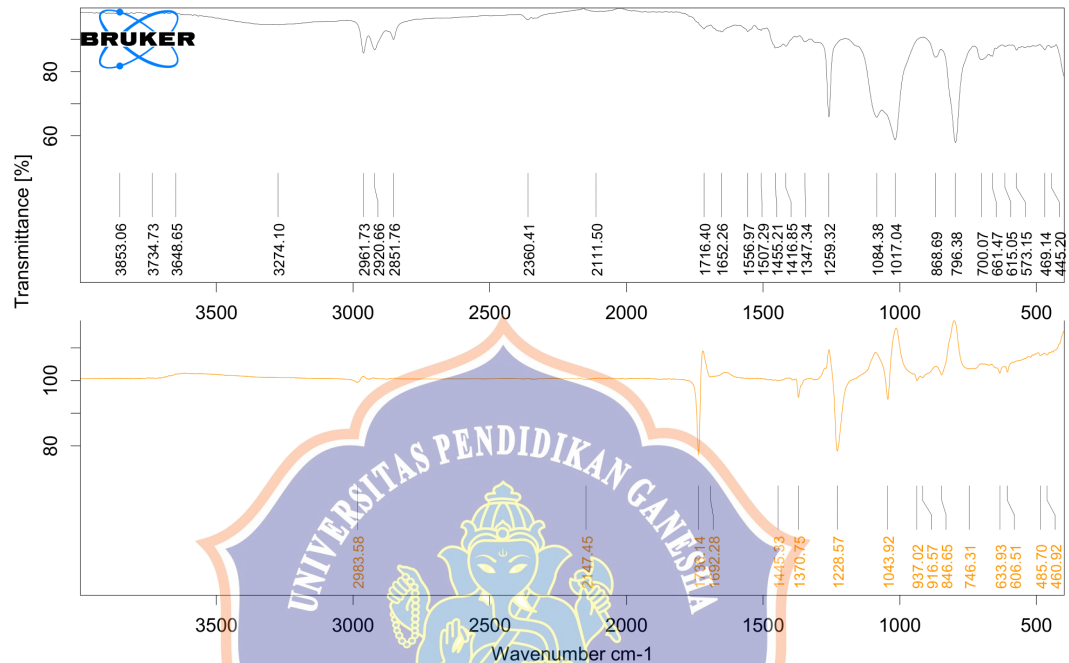
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31	MTI-R1 U7			UNK		7,743	0,1373	
32	MTI-R1 U8			UNK		7,774	0,1375	
33	MTI-R1 U9			UNK		7,070	0,1321	
34	MTI-R1 U10			UNK		7,619	0,1363	
35	MTI-R1 U11			UNK		8,256	0,1413	
36	MTI-R1 U12			UNK		7,852	0,1381	
37	BDG-L1 + MTI-R1 U1			UNK		19,053	0,2252	
38	BDG-L1 + MTI-R1 U2			UNK		18,365	0,2199	
39	BDG-L1 + MTI-R1 U3			UNK		18,747	0,2228	
40	BDG-L1 + MTI-R1 U4			UNK		17,144	0,2104	

	Sample Name	Sample ID	Option	Type	Ex	Conc	Raw_WL486,0	Re:
41	BDG-L1 + MTI-R1 U5			UNK		17,172	0,2106	
42	BDG-L1 + MTI-R1 U6			UNK		20,637	0,2375	
43	BDG-L1 + MTI-R1 U7			UNK		17,348	0,2120	
44	BDG-L1 + MTI-R1 U8			UNK		18,009	0,2171	
45	BDG-L1 + MTI-R1 U9			UNK		19,742	0,2306	
46	BDG-L1 + MTI-R1 U10			UNK		18,132	0,2180	
47	BDG-L1 + MTI-R1 U11			UNK		18,606	0,2217	
48	BDG-L1 + MTI-R1 U12			UNK		18,100	0,2178	
49	Kontrol - U1			UNK		75,016	0,6602	
50	Kontrol - U2			UNK		74,710	0,6578	

	Sample Name	Sample ID	Option	Type	Ex	Conc	Raw_WL486,0	Re:
51	Kontrol - U3			UNK		75,054	0,6605	
52	Kontrol - U4			UNK		75,100	0,6608	
53	Kontrol - U5			UNK		74,388	0,6553	
54	Kontrol - U6			UNK		74,380	0,6552	
55	Kontrol - U7			UNK		74,359	0,6551	
56	Kontrol - U8			UNK		74,311	0,6547	
57	Kontrol - U9			UNK		74,852	0,6589	
58	Kontrol - U10			UNK		74,604	0,6570	
59	Kontrol - U11			UNK		74,505	0,6562	
60	Kontrol - U12			UNK		74,514	0,6563	

Lampiran 18. Output Spektrofotometer FTIR (*Fourier Transform Infrared*) tipe Bruker ATR-FTIR INVENIO dalam Pengukuran Puncak Gugus Fungsi pada Produk Hasil Biodegradasi *Congo Red* oleh Isolat MTI-R1

Lokasi penelitian: Laboratorium Biomedis, Universitas Pendidikan Ganesha



C:\Users\perma\Documents\2026\Juni\Luhur.1	Biodekolorisasi	Instrument type and / or accessory	04/06/2026
C:\Users\perma\Documents\2026\Juni\Luhur.2	Biodekolorisasi	Instrument type and / or accessory	04/06/2026

Lampiran 19. Output Kromatogram LC-MS tipe Shimadzu LCMS – 8040 LCM/MS pada Analisis Kemunculan Puncak Senyawa dalam Produk Biodegradasi Congo Red oleh Isolat MTI-R1

LCMS CHROMATOGRAM RESULT, SAMPLE ID: LARUTAN HASIL DEGRADASI AZO DYE

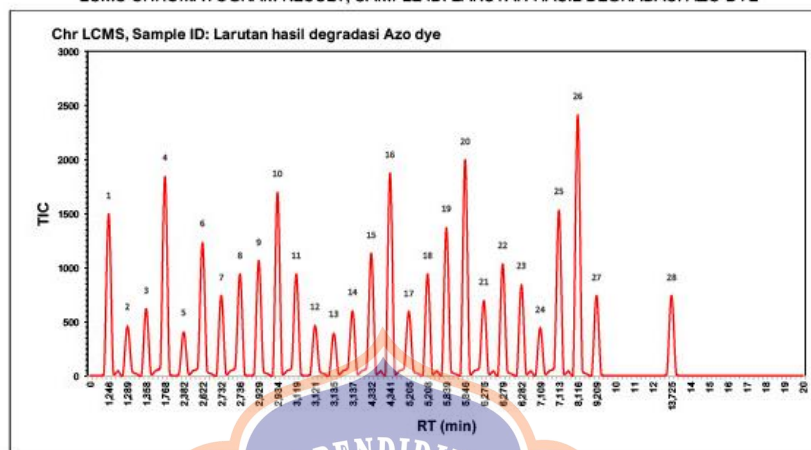
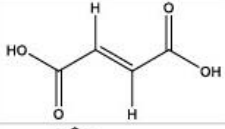
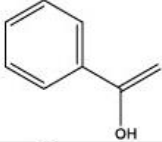
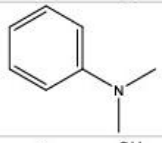
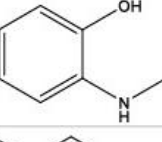
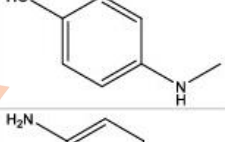
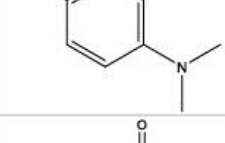
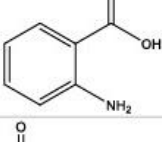
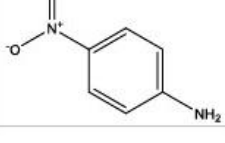
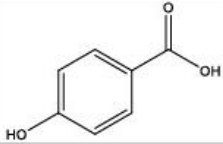
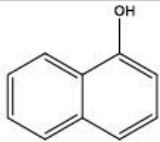
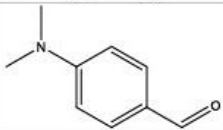
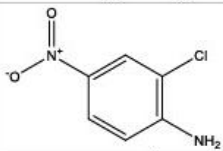
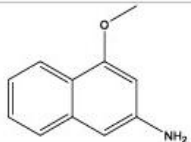
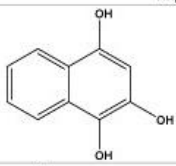
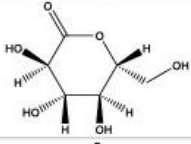
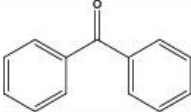


Table 1. Chromatogram Result

Peak number	RT (min)	Similarity index (%)	Peak area	Composition (%)	Chromatogram Result	Structure
1	1,246	92	1498,84124	5,10822	butanedioic acid Chemical Formula: $C_4H_6O_4$ Exact Mass: 118,0266 Molecular Weight: 118,0880 m/z: 118.0266 (100.0%), 119.0300 (4.3%)	<chem>OC(=O)CCC(=O)O</chem>
2	1,289	92	463,69852	1,58034	benzoic acid Chemical Formula: $C_7H_6O_2$ Exact Mass: 122,0368 Molecular Weight: 122,1230 m/z: 122.0368 (100.0%), 123.0401 (7.6%)	<chem>O=C(O)c1ccccc1</chem>
3	1,358	92	623,46213	2,12483	aniline Chemical Formula: C_6H_7N Exact Mass: 93,0578 Molecular Weight: 93,1290 m/z: 93.0578 (100.0%), 94.0612 (6.5%)	<chem>Nc1ccccc1</chem>
4	1,768	92	1843,36211	6,28239	2-oxobutanedioic acid Chemical Formula: $C_4H_4O_5$ Exact Mass: 132,0059 Molecular Weight: 132,0710 m/z: 132.0059 (100.0%), 133.0082 (4.3%), 134.0101 (1.0%)	<chem>OC(=O)C(=O)CC(=O)O</chem>
5	2,382	92	411,46987	1,40234	N-phenylhydroxylamine Chemical Formula: C_6H_7NO Exact Mass: 109,0528 Molecular Weight: 109,1280 m/z: 109.0528 (100.0%), 110.0561 (6.5%)	<chem>ONc1ccccc1</chem>

Peak number	RT (min)	Similarity index (%)	Peak area	Composition (%)	Chromatogram Result	
					Analysis	Structure
6	2,622	92	1234,54163	4,20746	(E)-but-2-enedioic acid Chemical Formula: $C_4H_4O_4$ Exact Mass: 116,0110 Molecular Weight: 116,0720 m/z : 116.0110 (100.0%), 117.0143 (4.3%)	
7	2,732	92	746,31021	2,54351	1-phenylethenol Chemical Formula: C_9H_8O Exact Mass: 120,0575 Molecular Weight: 120,1510 m/z : 120.0575 (100.0%), 121.0609 (8.7%)	
8	2,736	92	944,51446	3,21901	N,N-dimethylaniline Chemical Formula: $C_9H_{11}N$ Exact Mass: 121,0891 Molecular Weight: 121,1830 m/z : 121.0891 (100.0%), 122.0925 (8.7%)	
9	2,929	92	1069,87456	3,64625	2-(methylamino)phenol Chemical Formula: C_7H_9NO Exact Mass: 123,0684 Molecular Weight: 123,1550 m/z : 123.0684 (100.0%), 124.0718 (7.6%)	
10	2,934	92	1698,37414	5,78995	4-(methylamino)phenol Chemical Formula: C_7H_9NO Exact Mass: 123,0684 Molecular Weight: 123,1550 m/z : 123.0684 (100.0%), 124.0718 (7.6%)	
11	3,119	92	944,03014	3,21736	4-N,N-dimethylbenzene-1,4-diamine Chemical Formula: $C_8H_{12}N_2$ Exact Mass: 136,1000 Molecular Weight: 136,1980 m/z : 136.1000 (100.0%), 137.1034 (8.7%)	
12	3,121	92	469,98436	1,60176	2-aminobenzoic acid Chemical Formula: $C_7H_7NO_2$ Exact Mass: 137,0477 Molecular Weight: 137,1360 m/z : 137.0477 (100.0%), 138.0510 (7.6%)	
13	3,135	92	398,54414	1,35828	4-nitroaniline Chemical Formula: $C_6H_6N_2O_2$ Exact Mass: 138,0429 Molecular Weight: 138,1260 m/z : 138.0429 (100.0%), 139.0463 (6.5%)	

Peak number	RT (min)	Similarity index (%)	Peak area	Composition (%)	Chromatogram Result	
					Analysis	Structure
14	3,137	92	601,46987	2,04988	4-hydroxybenzoic acid Chemical Formula: $C_7H_6O_3$ Exact Mass: 138.0317 Molecular Weight: 138.1220 m/z: 138.0317 (100.0%), 139.0360 (7.6%)	
15	4,332	92	1136,48746	3,87328	naphthalen-1-ol Chemical Formula: $C_{10}H_8O$ Exact Mass: 144.0575 Molecular Weight: 144.1730 m/z: 144.0575 (100.0%), 145.0609 (10.8%)	
16	4,341	92	1876,30213	6,39465	4-(dimethylamino)benzaldehyde Chemical Formula: $C_{11}H_{13}NO$ Exact Mass: 149.0841 Molecular Weight: 149.1930 m/z: 149.0841 (100.0%), 150.0874 (9.7%)	
17	5,205	92	597,55415	2,03653	2-chloro-4-nitroaniline Chemical Formula: $C_6H_5ClN_2O_2$ Exact Mass: 172.0040 Molecular Weight: 172.5680 m/z: 172.0040 (100.0%), 174.0010 (32.0%), 173.0073 (6.5%), 175.0044 (2.1%)	
18	5,208	92	944,36541	3,21850	4-methoxynaphthalen-2-amine Chemical Formula: $C_{11}H_{11}NO$ Exact Mass: 173.0841 Molecular Weight: 173.2150 m/z: 173.0841 (100.0%), 174.0874 (11.9%)	
19	5,839	92	1369,87414	4,66869	naphthalene-1,2,4-triol Chemical Formula: $C_{10}H_6O_3$ Exact Mass: 176.0473 Molecular Weight: 176.1710 m/z: 176.0473 (100.0%), 177.0507 (10.8%)	
20	5,846	92	2001,23654	6,82044	(3R,4S,5S,6R)-3,4,5-trihydroxy-6-(hydroxymethyl)oxan-2-one Chemical Formula: $C_6H_{12}O_8$ Exact Mass: 178.0477 Molecular Weight: 178.1400 m/z: 178.0477 (100.0%), 179.0511 (6.5%), 180.0520 (1.2%)	
21	6,275	92	697,84635	2,37834	diphenylmethanone Chemical Formula: $C_{13}H_{10}O$ Exact Mass: 182.0732 Molecular Weight: 182.2220 m/z: 182.0732 (100.0%), 183.0765 (14.1%)	

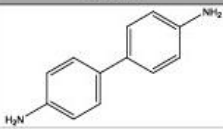
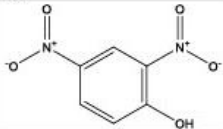
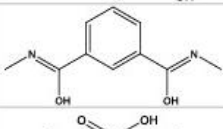
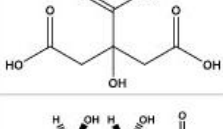
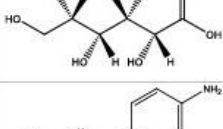
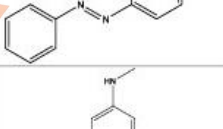
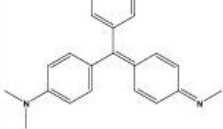
Peak number	RT (min)	Similarity index (%)	Peak area	Composition (%)	Chromatogram Result	
					Analysis	Structure
22	6,279	92	1036,64125	3,53299	4-(4-aminophenyl)aniline Chemical Formula: $C_{12}H_{11}N_2$ Exact Mass: 184,1000 Molecular Weight: 184,2420 m/z: 184.1000 (100.0%), 185.1034 (13.0%)	
23	6,282	92	844,69854	2,87883	2,4-dinitrophenol Chemical Formula: $C_6H_5N_2O_5$ Exact Mass: 184,0120 Molecular Weight: 184,1070 m/z: 184.0120 (100.0%), 185.0154 (6.5%), 186.0163 (1.0%)	
24	7,109	92	449,36529	1,53149	1-N,3-N-dimethylbenzene-1,3-dicarboxamide Chemical Formula: $C_{12}H_{11}N_3O_2$ Exact Mass: 192,0899 Molecular Weight: 192,2180 m/z: 192.0899 (100.0%), 193.0932 (10.8%)	
25	7,113	92	1532,03652	5,22135	2-hydroxypropane-1,2,3-tricarboxylic acid Chemical Formula: $C_6H_8O_7$ Exact Mass: 192,0270 Molecular Weight: 192,1230 m/z: 192.0270 (100.0%), 193.0304 (6.5%), 194.0312 (1.4%)	
26	8,116	92	2413,63325	3,22593	(2R,3S,4R,5R)-2,3,4,5,6-pentahydroxyhexanoic acid Chemical Formula: $C_6H_{12}O_7$ Exact Mass: 196,0583 Molecular Weight: 196,1550 m/z: 196.0583 (100.0%), 197.0617 (6.5%), 198.0625 (1.4%)	
27	9,209	92	746,36985	2,54371	4-phenyldiazenylaniline Chemical Formula: $C_{12}H_{11}N_2$ Exact Mass: 197,0953 Molecular Weight: 197,2410 m/z: 197.0953 (100.0%), 198.0987 (13.0%), 199.0923 (1.5%)	
28	13,725	92	746,36652	2,54370	4-[[4-(dimethylamino)phenyl]-(4-methyliminocyclohexa-2,5-dien-1-ylidene)methyl]-N-methylaniline Chemical Formula: $C_{23}H_{28}N_3$ Exact Mass: 343,2048 Molecular Weight: 343,4740 m/z: 343.2048 (100.0%), 344.2082 (24.9%), 345.2116 (2.7%), 346.2019 (1.1%)	

Table 3 LCMS Properties

LCMS apparatus model	Shimadzu LCMS – 8040 LC/MS
Column	Shimadzu Shim Pack FC-ODS (2 mm x 150 mm, 3 µm)
Injection volume	1 µl
Capillary voltage	3,0 kV
Column temperature	35 °C
Mobile phase mode	Isocratic
Flow rate	0,5 ml/min
Sampling cone	23,0 V
Solvent	Ethyl acetate
MS focused ion mode	Io type [M] ⁺
Collision energy	5,0 V
Desolvation gas flow	60 ml/hr
Desolvation temperature	350 °C
Fragmentation method	Low energy CID
Ionization	ESI
Scanning	0,6 sec/scan (mz: 10-1000)
Source temperature	100 °C
Run time	20 minutes
LCMS method	LCMS method
User name	Luhur, Univ Pendidikan Ganesha Bali
Sample ID	Larutan hasil degradasi Azo dye
Injection date	7/15/2026

Lampiran 20. Sertifikasi Isolat Bakteri *Bacillus cereus* FNCC 0057 yang Digunakan sebagai Kontrol Positif dalam Uji Biodegradasi Congo Red



**UNIVERSITAS GADJAH MADA
PUSAT STUDI PANGAN DAN GIZI**

Alamat : Gedung PAU-UGM, Jalan Teknik Utara, Berek, Yogyakarta 55281, Phone/Fax. (0274) 589242
http://cfns.ugm.ac.id, E-mail : cfns@ugm.ac.id

**SERTIFIKAT MIKROBIA
FNCC-PSPG/63/III/2026**

***Bacillus cereus* FNCC 0057**

Nama mikrobial : *Bacillus cereus*
Nomor strain : FNCC 0057
Bentuk awetan : Kultur hidup dalam ampul
Media : Nutrient Agar (NA) / Nutrient Broth (NB)
Suhu inkubasi : 37 °C
Pathologi : Pathogen
Cara pembiakan : Kultur diinokulasikan ke media Nutrient Agar (NA) / NB dan diinkubasi 37°C selama 24-48 jam. Pertumbuhan ditandai dengan adanya koloni bakteri di permukaan media. Setelah tumbuh kultur dapat disimpan pada suhu 4°C selama 2 minggu.

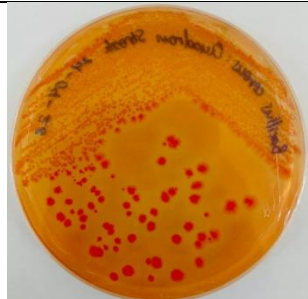
Yogyakarta, 6 Maret 2026

Kurator FNCC

Prof. Dr. Ir. Endang S. Rahayu, M.S.

Lampiran 21. Peremajaan Kultur *Bacillus cereus* FNCC 0057 dan Uji Validitas Kemampuan Biodegradasi Congo Red

Isolat	Strain	Media Peremajaan	Suhu Inkubasi	Metode Peremajaan
<i>Bacillus cereus</i>	FNCC 0057	Nutrient Agar + Congo Red (100 ppm)	37°C	Kultur agar cawan dan goresan kuadran

Isolat	Strain	Hasil Uji Kemampuan Biodegradasi	Gambar
<i>Bacillus cereus</i>	FNCC 0057	Positif (Zona Dekolorisasi)	

Lampiran 22. Dokumentasi Kegiatan Penelitian



RIWAYAT HIDUP



Made Luhur Sahadeva, lahir di Singaraja, 29 September 2003. Berkebangsaan Indonesia dan beragama Hindu, beralamat di Banjar Dinas Dauh Margi, Desa Pamaron, Buleleng, Bali. Menyelesaikan pendidikan di SDN 5 Banyuasri tahun 2016, SMPN 2 Singaraja tahun 2019, dan SMAN 4 Singaraja tahun 2022, lalu melanjutkan pendidikan di Program Studi Biologi, FMIPA, Universitas Pendidikan Ganesha pada tahun 2022.

Selama menempuh perguruan tinggi, aktif berorganisasi dengan menjadi:

1. Sekretaris Bidang 1 HMJ Biologi dan Perikanan Kelautan (2023/2024)
2. Koordinator Bidang 1 HMJ Biologi dan Perikanan Kelautan (2024/2025)
3. Bendahara Umum Kelompok Kerja (POKJA) Penalaran FMIPA (2024/2025)
4. Ketua Umum Kelompok Kerja (POKJA) Penalaran FMIPA (2025/2026)

Gemar mengikuti berbagai ajang perlombaan pada tingkat nasional seperti:

1. KN-MIPA PT (Kompetisi Nasional MIPA Perguruan Tinggi) Bidang Biologi oleh AMLI LPTK Tahun 2024 di Universitas Negeri Padang (Juara Harapan 2)
2. DIMAS-TI Bidang Riset dan Karya Tulis oleh AMLI LPTK Tahun 2024 di Universitas Pendidikan Indonesia (Medali Perunggu)
3. PKM (Program Kreativitas Mahasiswa) Bidang Riset Eksakta oleh Direktorat BELMAWA (Kemendikti Saintek) Tahun 2024 (Peraih Pendanaan)
4. PKM (Program Kreativitas Mahasiswa) Bidang Riset Eksakta oleh AMLI LPTK Tahun 2025 di Universitas Negeri Gorontalo (Medali Emas)
5. ON-MIPA PT Bidang Biologi oleh Direktorat BELMAWA (Kemendikti Saintek) Tahun 2025 di Universitas Padjajaran (Finalis)
6. PKM (Program Kreativitas Mahasiswa) Bidang Riset Eksakta oleh Direktorat BELMAWA (Kemendikti Saintek) Tahun 2025 (Peraih Pendanaan dan Medali Perunggu Kategori Poster dalam PIMNAS-38 di Universitas Hasanuddin).

Pada tahun 2026 telah menyelesaikan skripsi “Biodegradasi Limbah Pewarna Tekstil *Congo Red* oleh Bakteri Indigenous Asal Sedimen Mangrove Teluk Benoa”. Tulisan-tulisan penulis dapat dilihat pada: *Google Scholar* (Made Luhur Sahadeva).

<https://scholar.google.com/citations?user=mehquSsAAAAJ&hl=en&oi=ao>