LAMPIRAN-LAMPIRAN

Lampiran 01. Hasil pengukuran berat kering *Rhodotorula mucilaginosa* UICC Y-18 pada medium standar dengan sumber nitrogen yang berbeda

Perlakuan	Ulangan	Waktu Inkubasi (jam)										
		0	12	24	36	48	60	72	84	96	108	120
P1	1	0.00	1.60	2.90	3.20	2.90	4.30	4.70	3.90	3.70	3.80	3.40
	2	0.00	1.90	2.20	3.50	2.90	4.10	4.50	4.30	4.30	4.10	3.50
	3	0.00	1.50	2.60	3.50	3.40	3.30	4.60	4.70	4.10	4.10	3.50
	4	0.00	2.00	2.90	4.50	3.40	4.00	4.00	4.70	3.80	3.60	4.00
	5	0.00	1.40	2.00	3.80	3.80	3.00	3.60	4.00	3.80	3.20	3.80
P2	1	0.00	0.80	2.60	2.80	2.60	2.90	3.10	3.10	3.70	2.90	2.80
	2	0.00	2.00	2.40	1.90	3.00	3.30	2.40	2.60	3.10	2.40	3.20
	3	0.00	1.00	2.20	1.60	2.40	2.40	2.00	2.40	3.00	2.00	2.30
	4	0.00	1.10	1.80	2.40	2.50	2.90	3.10	3.10	3.00	2.70	3.00
	5	0.00	1.80	2.70	2.80	2.50	3.90	2.40	3.30	3.60	3.30	2.60
P3	1	0.00	1.20	2.20	4.50	4.80	4.50	4.40	3.20	4.30	4.40	4.40
	2	0.00	1.00	2.20	3.60	3.90	3.60	4.60	4.30	4.90	3.60	3.60
	3	0.00	1.60	2.40	3.80	4.20	4.00	4.60	3.30	5.00	3.80	4.10
	4	0.00	1.00	1.60	2.90	4.30	3.90	4.10	4.50	4.20	4.60	3.80
	5	0.00	0.80	1.70	3.30	4.10	2.70	4.00	4.60	4.40	4.60	4.10
P4	1	0.00	0.70	1.60	2.60	3.40	2.70	2.90	3.10	2.50	2.60	3.50
	2	0.00	2.00	2.00	2.40	3.10	2.60	2.00	2.10	2.50	3.20	4.00
	3	0.00	1.50	3.10	2.20	3.10	2.00	2.10	3.20	2.70	3.10	4.20
	4	0.00	0.60	2.80	3.00	3.20	2.40	2.60	2.70	2.40	3.00	3.80
	5	0.00	0.80	3.10	2.40	3.50	3.00	2.10	2.10	2.20	3.10	4.00

Sumber : Data primer Handayani (2004)

Lampiran 02. Uji normalitas (Uji W dari Shapiro dan Wilk) berat kering *Rhodotorula mucilaginosa* UICC Y-18 pada medium standar dengan sumber nitrogen yang berbeda

Tabel 07. Perhitungan uji normalitas berat kering *R. mucilaginosa* UICC Y-18 pada inkubasi 48 jam

Perlakuan	Y_i					$Y_i - \overline{Y}$					$(Y_i - \overline{Y})^2$				
	Ulangan					Ulangan					Ulangan				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
P1	2.90	2.90	3.40	3.40	3.80	-0.525	-0.3	0.125	0.05	0.325	0.275625	0.09	0.015625	0.0025	0.105625
P2	2.60	3.00	2.40	2.50	2.50	-0.825	-0.2	-0.875	-0.85	-0.975	0.680625	0.04	0.765625	0.7225	0.950625
P3	4.80	3.80	4.20	4.30	4.10	1.375	0.6	0.925	0.95	0.625	1.890625	0.36	0.855625	0.9025	0.390625
P4	3.40	3.10	3.10	3.20	3.50	-0.025	-0.1	-0.175	-0.15	0.025	0.000625	0.01	0.030625	0.0225	0.000625
Jumlah	13.70	12.80	13.10	13.40	13.90						2.8475	0.5	1.6675	1.65	1.4475
Rataan	3.425	3.200	3.275	3.350	3.475										

Keterangan :

Y_i = Data ke-i

$\overline{Y}_i$ = Rataan data ke-i

Perhitungan :

1. $$\sum_{i=1}^{n} (Y_i - \overline{Y})^2 = (Y_1 - \overline{Y})^2 + (Y_2 - \overline{Y})^2 + \ldots + (Y_n - \overline{Y})^2$$

$$= 8.1125$$

2: $b = \sum_{i=1}^{k} a_{n-i+1}\left(Y_{n-i+1} - Y_i\right)$

$= (0.4734)(4.80 - 2.40) + (0.3211)(4.30 - 2.50) + \ldots + (0.0140)(3.40 - 3.20)$

$= 2.8168$

3. $W_0 = \dfrac{b^2}{\sum_{i=1}^{n}\left(Y_i - \overline{Y}\right)^2}$

$= 0.9803$

$W_{tabel}\ (\alpha = 0.05\ ;\ 20) = 0.905$

$W_{tabel}\ (\alpha = 0.01\ ;\ 20) = 0.868$

$W_0 > W_{tabel} \rightarrow$ asumsi normalitas diterima

Dengan perhitungan analog seperti di atas didapatkan hasil sebagai berikut :

Tabel 08. Hasil uji normalitas berat kering *R. mucilaginosa* UICC Y-18

Umur	W_0	Asumsi Normalitas
12 jam	1.1996	Diterima
24 jam	1.0384	Diterima
36 jam	1.0175	Diterima
48 jam	0.9803	Diterima
60 jam	1.0595	Diterima
72 jam	0.9264	Diterima
84 jam	0.9554	Diterima
96 jam	0.9729	Diterima
108 jam	0.9938	Diterima
120 jam	0.9424	Diterima

Lampiran 03. Uji homogenitas (Uji Bartlett) berat kering *Rhodotorula mucilaginosa* UICC Y-18 pada medium standar dengan sumber nitrogen yang berbeda (Widasari, 1988)

Tabel. 09. Perhitungan uji homogenitas berat kering *R. mucilaginosa* UICC Y-18 pada inkubasi 48 jam

Perlakuan	Y_i							$(Y_i - Y)^2$						S^2	$Log\ S^2$
	Ulangan					Jumlah	Rataan	Ulangan					Jumlah		
	1	2	3	4	5			1	2	3	4	5			
P1	2.90	2.90	3.40	3.40	3.80	16.40	3.28	0.1444	0.1444	0.0144	0.0144	0.2704	0.5880	0.147	-0.83268
P2	2.60	3.00	2.40	2.50	2.50	13.00	2.60	0.0000	0.1600	0.0400	0.0100	0.0100	0.2200	0.055	-1.25964
P3	4.80	3.80	4.20	4.30	4.10	21.20	4.24	0.3136	0.1936	0.0016	0.0036	0.0196	0.5320	0.133	-0.87615
P4	3.40	3.10	3.10	3.20	3.50	16.30	3.26	0.0196	0.0256	0.0256	0.0036	0.0576	0.1320	0.033	-1.48149
Jumlah								0.4776	0.5236	0.0816	0.0316	0.3576		0.368	-4.44995

$$S_i^2 = \frac{1}{4}\left\{\left(Y_{i1} - \overline{Y}_i\right)^2 + \left(Y_{i2} - \overline{Y}\right)^2 + \left(Y_{i3} - \overline{Y}\right)^2 + \left(Y_{i4} - \overline{Y}\right)^2 + \left(Y_{i5} - \overline{Y}\right)^2\right\}$$

Perhitungan :

1. $S^2 = \dfrac{\sum S_i^2}{a} = \dfrac{0.368}{4} = 0.092$

   $LogS^2 = -1.0362$

2. $m = 2.30256\ (d.b)\left\{a \log S^2 - \left(\sum \log S^2\right)\right\}$

   $= 2.8101$

3. $c = 1 + \frac{a+1}{3a(n-1)} = 1.1042$

4. $\chi^2_{hit} = \frac{m}{c} = \frac{2.8105}{1.1042} = 2.5449$

$\chi^2_{tabel\,(0.05;3)} = 7.81$

$\chi^2_{hit} < \chi^2_{tabel}$ → asumsi homogenitas diterima

Dengan perhitungan analog seperti di atas didapatkan hasil sebagai berikut :

Tabel 10. Hasil uji homogenitas berat kering *R. mucilaginosa* UICC Y-18

Umur	χ^2_{hit}	Asumsi Homogenitas
12 jam	3.4550	Diterima
24 jam	2.4353	Diterima
36 jam	1.6325	Diterima
48 jam	2.5449	Diterima
60 jam	1.1775	Diterima
72 jam	1.2105	Diterima
84 jam	1.7679	Diterima
96 jam	1.9861	Diterima
108 jam	0.8186	Diterima
120 jam	0.4964	Diterima

Lampiran 04. Perhitungan analisis sidik ragam (ANOVA) berat kering *Rhodotorula mucilaginosa* UICC Y-18 pada medium standar dengan sumber nitrogen yang berbeda (Gomez and Gomez, 1995; Hanafiah, 2000)

Tabel 11. Berat kering *R. mucilaginosa* UICC Y-18 pada inkubasi 48 jam

Perlakuan	Ulangan					Jumlah	Rataan
	1	2	3	4	5		
P1	2.90	2.90	3.40	3.40	3.80	16.40	3.28
P2	2.60	3.00	2.40	2.50	2.50	13.00	2.60
P3	4.80	3.80	4.20	4.30	4.10	21.20	4.24
P4	3.40	3.10	3.10	3.20	3.50	16.30	3.26
Jumlah	13.70	12.80	13.10	13.40	13.90	66.90	13.38
Rataan							3.35

Perhitungan :

1. $FK = \frac{\left(\sum_{i=1}^{n} Y_i\right)^2}{n} = \frac{(66.90)^2}{20} = 223.78$

2. $JKT = \left(\sum Y_i^2\right) - FK$

$= \left[(2.90)^2 + (2.90)^2 + (3.40)^2 + \ldots + (3.50)^2\right] - 223.78$

$= 8.31$

3. $JKU = \frac{\sum_{j=1}^{r} R_j^2}{t} - FK$

$= \frac{\left[(13.70)^2 + (12.80)^2 + (13.10)^2 + (13.40)^2 + (13.90)^2\right]}{4} - 223.78$

$= 0.20$

4. $JKP = \frac{\left(\sum T_p^2\right)}{r} - FK$

$= \frac{\left[(16.40)^2 + (13.00)^2 + (21.20)^2 + (16.30)^2\right]}{5} - 223.78$

$= 6.84$

5. $JKG = JKT - JKU - JKP$

$= 8.31 - 0.20 - 6.84$

$= 1.27$

6. $KTP = \frac{JKP}{db\ Perlakuan} = \frac{6.84}{3} = 2.28$

7. $KTU = \frac{JKU}{db\ Ulangan} = \frac{0.20}{4} = 0.05$

8. $KTG = \frac{JKG}{db\ Galat} = \frac{1.27}{12} = 0.11$

9. $F_{hit} = \frac{KTP}{KTG} = \frac{2.28}{0.11} = 20.73$

$F_{tabel\ (5\%)} = 3.24$ dan $F_{tabel\ (1\%)} = 5.29$

$F_{hit} < F_{tabel(5\%)} \rightarrow$ perlakuan tidak berbeda nyata

$F_{hit} < F_{tabel(5\%)} \leq F_{tabel(1\%)} \rightarrow$ perlakuan berbeda nyata

$F_{hit} > F_{tabel(1\%)} \rightarrow$ perlakuan berbeda sangat nyata

Koefisien Keragaman :

$KK = \frac{\sqrt{KTG}}{\bar{y}} \times 100\ \%$ dimana $\bar{y} = \frac{T_{ij}}{rt} = \frac{\sum Y_{ij}}{r \cdot t}$

Tabel 12. Hasil perhitungan analisis sidik ragam (Anova) berat kering *R. mucilaginosa* UICC Y-18 pada inkubasi 12 jam

Sb. Keragaman	d.b	JK	KT	F_{hit}	$F_{0.05}$	$F_{0.01}$
Ulangan	4	1.06	0.27	1.47	3.26	5.41
Perlakuan	3	1.04	0.35	1.93	3.49	5.95
Galat	12	2.16	0.18			
Total	19	4.26				

Tabel 13. Hasil perhitungan analisis sidik ragam (Anova) berat kering *R. mucilaginosa* UICC Y-18 pada inkubasi 24 jam

Sb. Keragaman	d.b	JK	KT	F_{hit}	$F_{0.05}$	$F_{0.01}$
Ulangan	4	0.32	0.08	0.30	3.26	5.41
Perlakuan	3	0.83	0.28	1.03	3.49	5.95
Galat	12	3.22	0.27			
Total	19	4.37				

Tabel 14. Hasil perhitungan analisis sidik ragam (Anova) berat kering *R. mucilaginosa* UICC Y-18 pada inkubasi 36 jam

Sb. Keragaman	d.b	JK	KT	F_{hit}	$F_{0.05}$	$F_{0.01}$
Ulangan	4	0.75	0.19	0.71	3.26	5.41
Perlakuan	3	7.94	2.65	9.96**	3.49	5.95
Galat	12	3.19	0.27			
Total	19	11.88				

Keterangan:

** = berbeda sangat nyata

$$KK = \frac{\sqrt{0.27}}{3.035} \times 100\ \% = 17.121\ \%$$

Tabel 15. Hasil perhitungan analisis sidik ragam (Anova) berat kering *R. mucilaginosa* UICC Y-18 pada inkubasi 48 jam

Sb. Keragaman	d.b	JK	KT	F_{hit}	$F_{0.05}$	$F_{0.01}$
Ulangan	4	0.20	0.05	0.47	3.26	5.41
Perlakuan	3	6.84	2.28	21.54**	3.49	5.95
Galat	12	1.27	0.11			
Total	19	8.31				

$$KK = \frac{\sqrt{0.11}}{3.345} \times 100\ \% = 9.915\ \%$$

Tabel 16. Hasil perhitungan analisis sidik ragam (Anova) berat kering *R. mucilaginosa* UICC Y-18 pada inkubasi 60 jam

Sb. Keragaman	d.b	JK	KT	F_{hit}	$F_{0.05}$	$F_{0.01}$
Ulangan	4	1.04	0.26	0.83	3.26	5.41
Perlakuan	3	5.06	1.69	5.35**	3.49	5.95
Galat	12	3.78	0.32			
Total	19	9.88				

$$KK = \frac{\sqrt{0.32}}{3.275} \times 100\,\% = 17.273\,\%$$

Tabel 17. Hasil perhitungan analisis sidik ragam (Anova) berat kering *R. mucilaginosa* UICC Y-18 pada inkubasi 72 jam

Sb. Keragaman	d.b	JK	KT	F_{hit}	$F_{0.05}$	$F_{0.01}$
Ulangan	4	1.16	0.29	2.22	3.26	5.41
Perlakuan	3	17.11	5.70	43.59**	3.49	5.95
Galat	12	1.57	0.13			
Total	19	19.84				

$$KK = \frac{\sqrt{0.13}}{3.390} \times 100\,\% = 10.636\,\%$$

Tabel 18. Hasil perhitungan analisis sidik ragam (Anova) berat kering *R. mucilaginosa* UICC Y-18 pada inkubasi 84 jam

Sb. Keragaman	d.b	JK	KT	F_{hit}	$F_{0.05}$	$F_{0.01}$
Ulangan	4	0.51	0.13	0.43	3.26	5.41
Perlakuan	3	9.98	3.33	11.15**	3.49	5.95
Galat	12	3.58	0.30			
Total	19	14.07				

$$KK = \frac{\sqrt{0.30}}{3.460} \times 100\,\% = 15.830\,\%$$

Tabel 19. Hasil perhitungan analisis sidik ragam (Anova) berat kering *R. mucilaginosa* UICC Y-18 pada inkubasi 96 jam

Sb. Keragaman	d.b	JK	KT	F_{hit}	$F_{0.05}$	$F_{0.01}$
Ulangan	4	0.35	0.09	1.02	3.26	5.41
Perlakuan	3	12.17	4.06	47.26**	3.49	5.95
Galat	12	1.03	0.09			
Total	19	13.55				

$$KK = \frac{\sqrt{0.09}}{3.560} \times 100\,\% = 8.427\,\%$$

Tabel 20. Hasil perhitungan analisis sidik ragam (Anova) berat kering *R. mucilaginosa* UICC Y-18 pada inkubasi 108 jam

Sb. Keragaman	d.b	JK	KT	F_{hit}	$F_{0.05}$	$F_{0.01}$
Ulangan	4	0.20	0.05	0.23	3.26	5.41
Perlakuan	3	7.15	2.38	10.83**	3.49	5.95
Galat	12	2.64	0.22			
Total	19	9.99				

$$KK = \frac{\sqrt{0.22}}{3.420} \times 100\,\% = 13.715\,\%$$

Tabel 21. Hasil perhitungan analisis sidik ragam (Anova) berat kering *R. mucilaginosa* UICC Y-18 pada inkubasi 120 jam

Sb. Keragaman	d.b	JK	KT	F_{hit}	$F_{0.05}$	$F_{0.01}$
Ulangan	4	0.05	0.01	0.11	3.26	5.41
Perlakuan	3	4.61	1.54	13.66**	3.49	5.95
Galat	12	1.35	0.11			
Total	19	6.01				

$$KK = \frac{\sqrt{0.11}}{3.580} \times 100\,\% = 9.264\,\%$$

Lampiran 05. Uji Duncan rata-rata berat kering *Rhodotorula mucilaginosa* UICC Y-18 pada medium standar dengan sumber nitrogen yang berbeda (Gomez dan Gomez,1995)

1. Waktu inkubasi 36 jam

$$S_{\bar{d}} = \sqrt{\frac{2(KTG)}{r}} = \sqrt{\frac{2(0.27)}{5}} = 0.3286$$

$$R_p = \frac{r_p \cdot S_{\bar{d}}}{\sqrt{2}}$$

Perlakuan	Nilai Tengah	P_2	P_4	P_3	P_1
P_2	2.30	-	0.22^{tn}	1.32^{**}	1.40^{**}
P_4	2.52		-	1.10^{**}	1.18^{**}
P_3	3.62			-	0.08^{tn}
P_1	3.70				-
P			2	3	4
$r_{p(0.05)}$			3.08	3.23	4.33
$r_{p(0.01)}$			4.32	4.55	4.68
$R_{p(0.05)}$			0.71565	0.75051	0.77374
$R_{p(0.01)}$			1.00377	1.05722	1.08742

Keterangan: tn = berbeda tidak nyata
** = berbeda sangat nyata

2. Waktu inkubasi 60 jam

$$S_{\bar{d}} = \sqrt{\frac{2(KTG)}{r}} = \sqrt{\frac{2(0.32)}{5}} = 0.3578$$

$$R_p = \frac{r_p \cdot S_{\bar{d}}}{\sqrt{2}}$$

Perlakuan	Nilai Tengah	P_4	P_2	P_3	P_1
P_4	2.54	-	0.54^{tn}	1.20^{**}	1.20^{**}
P_2	3.08		-	0.66^{tn}	0.66^{tn}
P_3	3.74			-	0.00^{tn}
P_1	3.74				-
P			2	3	4
$r_{p(0.05)}$			3.08	3.23	4.33
$r_{p(0.01)}$			4.32	4.55	4.68
$R_{p(0.05)}$			0.77925	0.81720	0.84250
$R_{p(0.01)}$			1.09297	1.15116	1.18405

Keterangan: tn = berbeda tidak nyata
** = berbeda sangat nyata

3. Waktu inkubasi 72 jam

$$S_{\bar{d}} = \sqrt{\frac{2(KTG)}{r}} = \sqrt{\frac{2(0.13)}{5}} = 0.2280$$

$$R_p = \frac{r_p \cdot S_{\bar{d}}}{\sqrt{2}}$$

Perlakuan	Nilai Tengah	P_4	P_2	P_1	P_3
P_4	2.34	-	0.26^{tn}	1.94^{**}	2.00^{**}
P_2	2.60		-	1.68^{**}	1.74^{**}
P_1	4.28			-	0.06^{tn}
P_3	4.34				-
P			2	3	4
$r_{p(0.05)}$			3.08	3.23	4.33
$r_{p(0.01)}$			4.32	4.55	4.68
$R_{p(0.05)}$			0.49656	0.52074	0.53686
$R_{p(0.01)}$			0.69647	0.73355	0.75451

Keterangan: tn = berbeda tidak nyata
** = berbeda sangat nyata

4. Waktu inkubasi 84 jam

$$S_{\bar{d}} = \sqrt{\frac{2(KTG)}{r}} = \sqrt{\frac{2(0.30)}{5}} = 0.3464$$

$$R_p = \frac{r_p \cdot S_{\bar{d}}}{\sqrt{2}}$$

Perlakuan	Nilai Tengah	P_4	P_2	P_3	P_1
P_4	2.64	-	0.26^{tn}	1.34^{**}	1.68^{**}
P_2	2.90		-	1.08^{*}	1.42^{**}
P_3	3.98			-	0.34^{tn}
P_1	4.32				-
P			2	3	4
$r_{p(0.05)}$			3.08	3.23	4.33
$r_{p(0.01)}$			4.32	4.55	4.68
$R_{p(0.05)}$			0.75442	0.79116	0.81566
$R_{p(0.01)}$			1.05815	1.11449	1.14633

Keterangan: tn = berbeda tidak nyata
* = berbeda nyata
** = berbeda sangat nyata

5. Waktu inkubasi 108 jam

$$S_{\bar{d}} = \sqrt{\frac{2(KTG)}{r}} = \sqrt{\frac{2(0.22)}{5}} = 0.2967$$

$$R_p = \frac{r_p \cdot S_{\bar{d}}}{\sqrt{2}}$$

Perlakuan	Nilai Tengah	P_4	P_2	P_3	P_1
P_4	2.64	-	0.26^{tn}	1.34^{**}	1.68^{**}
P_2	2.90		-	1.08^{**}	1.42^{**}
P_3	3.98			-	0.34^{tn}
P_1	4.32				-
P			2	3	4
$r_{p(0.05)}$			3.08	3.23	4.33
$r_{p(0.01)}$			4.32	4.55	4.68
$R_{p(0.05)}$			0.49656	0.52074	0.53686
$R_{p(0.01)}$			0.69647	0.73355	0.75451

Keterangan: tn = berbeda tidak nyata
* = berbeda nyata
** = berbeda sangat nyata

Lampiran 06. Uji Beda Nyata Terkecil rata-rata berat kering *Rhodotorula mucilaginosa* UICC Y-18 pada medium standar dengan sumber nitrogen yang berbeda (Hanafiah, 2000)

1. Waktu inkubasi 48 jam

$$S_{\bar{d}} = \sqrt{\frac{2(KTG)}{r}} = \sqrt{\frac{2(0.11)}{5}} = 0.2098$$

$$BNT_{\alpha} = t_{\alpha(v)} \cdot S_{\bar{d}}$$

Perlakuan	Nilai Tengah	P_2	P_4	P_1	P_3
P_2	**2.60**	-	0.26^{tn}	1.34^{**}	1.68^{**}
P_4	**3.26**		-	1.08^{**}	1.42^{**}
P_1	**3.28**			-	0.34^{tn}
P_3	**4.24**				-
$t_{0.05(12)}$			2.179		
$t_{0.01(12)}$			3.055		
$BNT_{(0.05)}$			0.45519		
$BNT_{(0.05)}$			0.63819		

Keterangan: tn = berbeda tidak nyata
** = berbeda sangat nyata

2. Waktu inkubasi 96 jam

$$S_{\bar{d}} = \sqrt{\frac{2(KTG)}{r}} = \sqrt{\frac{2(0.09)}{5}} = 0.1897$$

$$BNT_{\alpha} = t_{\alpha(v)} \cdot S_{\bar{d}}$$

Perlakuan	Nilai Tengah	P_4	P_2	P_1	P_3
P_4	**2.46**	-	0.66^{**}	0.02^{tn}	0.98^{**}
P_2	**3.28**		-	0.68^{**}	1.64^{**}
P_1	**3.94**			-	0.96^{**}
P_3	**4.56**				-
$t_{0.05(12)}$			2.179		
$t_{0.01(12)}$			3.055		
$BNT_{(0.05)}$			0.41336		
$BNT_{(0.05)}$			0.57953		

Keterangan: tn = berbeda tidak nyata
** = berbeda sangat nyata

3. Waktu inkubasi 120 jam

$$S_{\bar{d}} = \sqrt{\frac{2(KTG)}{r}} = \sqrt{\frac{2(0.11)}{5}} = 0.2098$$

$$BNT_{\alpha} = t_{\alpha(v)} \cdot S_{\bar{d}}$$

Perlakuan	Nilai Tengah	P_2	P_1	P_4	P_3
P_2	**2.78**	-	0.86^{**}	1.12^{**}	0.98^{**}
P_1	**3.64**		-	0.26^{tn}	0.36^{tn}
P_4	**3.90**			-	0.10^{tn}
P_3	**4.00**				-
$t_{0.05(12)}$			2.179		
$t_{0.01(12)}$			3.055		
$BNT_{(0.05)}$			0.45519		
$BNT_{(0.05)}$			0.63819		

Keterangan: tn = berbeda tidak nyata
** = berbeda sangat nyata

Lampiran 07. Hasil pengukuran pigmen total *Rhodotorula mucilaginosa* UICC Y-18 pada medium standar dengan sumber nitrogen yang berbeda

Waktu Inkubasi	Perlakuan	Ulangan	BK (gr/L)	A-480	X'	X"	Rataan
24 jam	P1	1	2.90	0.0022	0.0122	4.2015	
		2	2.20	0.0000	0.0000	0.0000	
		3	2.60	0.0044	0.0244	9.3961	3.5598
		4	2.90	0.0022	0.0122	4.2015	
		5	2.00	0.0000	0.0000	0.0000	
	P2	1	2.60	0.0000	0.0000	0.0000	
		2	2.40	0.0000	0.0000	0.0000	
		3	2.20	0.0000	0.0000	0.0000	0.0000
		4	1.80	0.0000	0.0000	0.0000	
		5	2.70	0.0000	0.0000	0.0000	
	P3	1	2.20	0.0000	0.0000	0.0000	
		2	2.20	0.0022	0.0122	5.5383	
		3	2.40	0.0044	0.0244	10.1791	4.6665
		4	1.60	0.0022	0.0122	7.6152	
		5	1.70	0.0000	0.0000	0.0000	
	P4	1	1.60	0.0022	0.0022	6.3460	
		2	2.00	0.0000	0.0000	0.0000	
		3	3.10	0.0022	0.0122	3.2753	1.9243
		4	2.80	0.0000	0.0000	0.0000	
		5	3.10	0.0000	0.0000	0.0000	

Keterangan : BK : Berat kering sel (g/L)

A-480 : Absorbansi pada λ 480 nm

$$X' : \frac{(A-480)\cdot Vol_{methanol}}{(E_{cm}^{1\%})\cdot Vol_{sampel}}\cdot 10^{4}$$

$$X'' : \frac{(X')}{(BK)}\cdot 10^{3} \quad (\mu g/g)$$

Waktu Inkubasi	Perlakuan	Ulangan	BK (gr/L)	A-480	X'	X"	Rataan
36 jam	P1	1	3.20	0.0088	0.0491	15.3462	
		2	3.50	0.0066	0.0367	10.4964	
		3	3.50	0.0088	0.0491	14.0308	9.7017
		4	4.50	0.0044	0.0244	5.4289	
		5	3.80	0.0022	0.0122	3.2064	
	P2	1	2.80	0.0000	0.0000	0.0000	
		2	1.90	0.0022	0.0122	6.4128	
		3	1.60	0.0000	0.0000	0.0000	2.1529
		4	2.40	0.0000	0.0000	0.0000	
		5	2.80	0.0022	0.0122	4.3515	
	P3	1	4.50	0.0022	0.0122	2.7076	
		2	3.60	0.0044	0.0244	6.7861	
		3	3.80	0.0088	0.0491	12.9231	7.6488
		4	2.90	0.0044	0.0244	8.4241	
		5	3.30	0.0044	0.0244	7.4030	
	P4	1	2.60	0.0044	0.0244	9.3961	
		2	2.40	0.0000	0.0000	0.0000	
		3	2.20	0.0022	0.0122	5.5383	3.7992
		4	3.00	0.0022	0.0122	4.0614	
		5	2.40	0.0000	0.0000	0.0000	

Waktu Inkubasi	Perlakuan	Ulangan	BK (gr/L)	A-480	X'	X''	Rataan
48 jam	P_1	1	2.90	0.0155	0.0866	29.8624	
		2	2.90	0.0110	0.0615	21.2211	
		3	3.40	0.0177	0.0992	29.1848	21.6073
		4	3.40	0.0110	0.0615	18.1004	
		5	3.80	0.0066	0.0367	9.6678	
	P_2	1	2.60	0.0022	0.0122	4.6862	
		2	3.00	0.0044	0.0244	8.1433	
		3	2.40	0.0022	0.0122	5.0768	6.5104
		4	2.50	0.0022	0.0122	4.8737	
		5	2.50	0.0044	0.0244	9.7720	
	P_3	1	4.80	0.0088	0.0491	10.2308	
		2	3.80	0.0110	0.0615	16.1951	
		3	4.20	0.0177	0.0992	23.6258	15.8495
		4	4.30	0.0132	0.0740	17.2183	
		5	4.10	0.0088	0.0491	11.9775	
	P_4	1	3.40	0.0088	0.0491	14.4435	
		2	3.10	0.0066	0.0367	11.8508	
		3	3.10	0.0110	0.0615	19.8520	15.8151
		4	3.20	0.0088	0.0491	15.3462	
		5	3.50	0.0110	0.0615	17.5832	

Waktu Inkubasi	Perlakuan	Ulangan	BK (gr/L)	A-480	X'	X''	Rataan
60 jam	P_1	1	4.30	0.0315	0.1764	41.0236	
		2	4.10	0.0177	0.0992	24.2020	
		3	3.30	0.0246	0.1375	41.6693	28.1582
		4	4.00	0.0155	0.0866	21.6502	
		5	3.00	0.0066	0.0367	12.2458	
	P_2	1	2.90	0.0022	0.0122	4.2015	
		2	3.30	0.0044	0.0244	7.4030	
		3	2.40	0.0066	0.0367	15.3073	7.4755
		4	2.90	0.0022	0.0122	4.2015	
		5	3.90	0.0044	0.0244	6.2641	
	P_3	1	4.50	0.0110	0.0615	13.6759	
		2	3.60	0.0223	0.1247	34.6337	
		3	4.00	0.0269	0.1504	37.6010	29.7182
		4	3.90	0.0246	0.1357	35.2586	
		5	2.70	0.0132	0.0740	27.4218	
	P_4	1	2.70	0.0177	0.0992	36.7512	
		2	2.60	0.0223	0.1247	47.9544	
		3	2.00	0.0177	0.0992	49.6141	45.1599
		4	2.40	0.0177	0.0992	41.3451	
		5	3.00	0.0269	0.1504	50.1346	

Waktu Inkubasi	Perlakuan	Ulangan	BK (gr/L)	A-480	X'	X''	Rataan
72 jam	P_1	1	4.70	0.0531	0.2970	63.1828	
		2	4.50	0.0580	0.3246	72.1293	
		3	4.60	0.0706	0.3950	85.8790	77.5250
		4	4.00	0.0434	0.2426	60.6596	
		5	3.60	0.0680	0.3808	105.7741	
	P_2	1	3.10	0.0088	0.0491	15.8412	
		2	2.40	0.0155	0.0866	36.0837	
		3	2.00	0.0177	0.0992	49.6141	34.1036
		4	3.10	0.0269	0.1504	48.5174	
		5	2.40	0.0088	0.0491	20.4616	
	P_3	1	4.40	0.0339	0.1895	43.0694	
		2	4.60	0.0386	0.2159	46.9406	
		3	4.60	0.0506	0.2833	61.5793	64.4294
		4	4.10	0.0680	0.3808	92.8748	
		5	4.00	0.0555	0.3107	77.6828	
	P_4	1	2.90	0.0269	0.1504	51.8634	
		2	2.00	0.0269	0.1504	75.2019	
		3	2.10	0.0177	0.0992	47.2515	53.9045
		4	2.40	0.0223	0.0125	47.9544	
		5	3.00	0.0177	0.0992	47.2515	

Waktu Inkubasi	Perlakuan	Ulangan	BK (gr/L)	A-480	X'	X''	Rataan
84 jam	P_1	1	3.90	0.0655	0.3666	94.0034	
		2	4.30	0.0757	0.4238	98.5605	
		3	4.70	0.0835	0.4676	99.4912	97.2608
		4	4.70	0.0680	0.9808	81.0184	
		5	4.00	0.0809	0.4529	113.2303	
	P_2	1	3.10	0.0233	0.1247	40.2198	
		2	2.60	0.0269	0.1504	57.8476	
		3	2.40	0.0223	0.1247	51.9505	53.7707
		4	3.10	0.0362	0.2027	65.3807	
		5	3.30	0.0315	0.1764	53.4550	
	P_3	1	3.20	0.0655	0.3666	114.5666	
		2	4.30	0.0731	0.4094	95.2056	
		3	3.30	0.0706	0.3950	119.7101	105.7365
		4	4.50	0.0835	0.4676	103.9130	
		5	4.60	0.0783	0.4383	95.2874	
	P_4	1	3.10	0.0315	0.1764	56.9037	
		2	2.10	0.0177	0.0992	47.2515	
		3	3.20	0.0132	0.0740	23.1371	52.6769
		4	2.70	0.0458	0.2561	94.8538	
		5	2.10	0.0155	0.0866	41.2385	

Waktu Inkubasi	Perlakuan	Ulangan	BK (gr/L)	A-480	X'	X''	Rataan
96 jam	P_1	1	3.70	0.0680	0.3808	102.9153	
		2	4.30	0.0835	0.4676	108.7462	
		3	4.10	0.0915	0.5122	124.9294	125.2157
		4	3.80	0.0969	0.5424	142.7386	
		5	3.80	0.0996	0.5576	146.7491	
	P_2	1	3.70	0.0315	0.1764	47.6760	
		2	2.10	0.0410	0.2292	73.9503	
		3	2.00	0.0506	0.2833	94.4216	79.3568
		4	3.00	0.0506	0.2833	94.4216	
		5	3.60	0.0555	0.3107	86.3143	
	P_3	1	4.30	0.0783	0.4383	101.9353	
		2	4.90	0.0969	0.5424	110.6953	
		3	5.00	0.0915	0.5122	102.4421	117.0456
		4	4.20	0.1024	0.5730	136.4245	
		5	4.40	0.1051	0.5884	133.7309	
	P_4	1	2.50	0.0292	0.1634	65.3471	
		2	2.50	0.0315	0.1764	70.5606	
		3	2.70	0.0177	0.0992	36.7512	62.6047
		4	2.40	0.0458	0.2561	106.7106	
		5	2.20	0.0132	0.0740	33.6540	

Waktu Inkubasi	Perlakuan	Ulangan	BK (gr/L)	A-480	X'	X''	Rataan
108 jam	P_1	1	3.80	0.0942	0.5273	138.7531	
		2	4.10	0.0862	0.4824	117.6549	
		3	4.10	0.0969	0.5424	132.2943	145.6209
		4	3.60	0.0969	0.5424	150.6686	
		5	3.20	0.1079	0.6039	188.7338	
	P_2	1	2.90	0.0362	0.2027	69.8897	
		2	2.40	0.0410	0.2292	95.5191	
		3	2.00	0.0506	0.2833	141.6324	94.9030
		4	2.70	0.0434	0.2426	89.8661	
		5	3.30	0.0458	0.2561	77.6077	
	P_3	1	4.40	0.0680	0.3808	86.5424	
		2	3.60	0.0835	0.4676	129.8912	
		3	3.80	0.0809	0.4529	119.1898	105.8744
		4	4.60	0.0783	0.4383	95.2874	
		5	4.60	0.0809	0.4529	98.4611	
	P_4	1	2.60	0.0269	0.1504	57.8476	
		2	3.20	0.0269	0.1504	47.0012	
		3	3.10	0.0177	0.0992	32.0091	43.9084
		4	3.00	0.0315	0.1764	58.8005	
		5	3.10	0.0132	0.0740	23.8835	

Waktu Inkubasi	Perlakuan	Ulangan	BK (gr/L)	A-480	X'	X''	Rataan
120 jam	P1	1	3.40	0.1051	0.5884	173.0636	
		2	3.50	0.0862	0.4824	137.8243	
		3	3.50	0.1051	0.5884	168.1189	154.6530
		4	4.00	0.0996	0.5576	139.4117	
		5	3.80	0.1051	0.5884	154.8463	
	P2	1	2.80	0.0269	0.1504	53.7156	
		2	3.20	0.0458	0.2561	80.0329	
		3	2.30	0.0458	0.2561	111.3502	77.8721
		4	3.00	0.0410	0.2292	76.4153	
		5	2.60	0.0315	0.1764	67.8467	
	P3	1	4.40	0.0531	0.2970	67.4908	
		2	3.60	0.0706	0.3950	109.7343	
		3	4.10	0.0655	0.3666	89.4178	100.6975
		4	3.80	0.0809	0.4529	119.1898	
		5	4.10	0.0862	0.4824	117.6549	
	P4	1	3.50	0.0315	0.1764	50.4004	
		2	4.00	0.0362	0.2027	50.6700	
		3	4.20	0.0269	0.1504	35.8104	40.3624
		4	3.80	0.0315	0.1764	46.4214	
		5	4.00	0.0132	0.0740	18.5097	

Lampiran 08. Data produksi pigmen karotenoid *Rhodotorula mucilaginosa* UICC Y-18 pada medium standar dengan sumber nitrogen yang berbeda

Perlakuan	Ulangan	Waktu Inkubasi (jam)										
		0	12	24	36	48	60	72	84	96	108	120
P1	1	0.0000	0.0000	4.2015	15.3462	29.8624	41.0236	63.1828	94.0034	102.9153	138.7531	173.0636
	2	0.0000	0.0000	0.0000	10.4964	21.2211	24.2020	72.1293	98.5605	108.7462	117.6549	137.8243
	3	0.0000	0.0000	9.3961	14.0308	29.1848	41.6693	85.8790	99.4912	124.9294	132.2943	168.1189
	4	0.0000	0.0000	4.2015	5.4289	18.1004	21.6502	60.6596	81.0184	142.7386	150.6686	139.4117
	5	0.0000	0.0000	0.0000	3.2064	9.6678	12.2458	105.7741	113.2303	146.7491	188.7338	154.8465
P2	1	0.0000	0.0000	0.0000	0.0000	4.6862	4.2015	15.8412	40.2198	47.6761	69.8897	53.7156
	2	0.0000	0.0000	0.0000	6.4128	8.1433	7.4030	36.0837	57.8476	73.9503	95.5191	80.0329
	3	0.0000	0.0000	0.0000	0.0000	5.0768	15.3073	49.6141	51.9505	94.4216	141.6324	111.3502
	4	0.0000	0.0000	0.0000	0.0000	4.8757	4.2015	48.5174	65.3807	94.4216	89.8661	76.4153
	5	0.0000	0.0000	0.0000	4.3515	9.7720	6.2641	20.4616	53.4550	86.3143	77.6077	67.8467
P3	1	0.0000	0.0000	0.0000	2.7076	10.2308	13.6759	43.0694	114.5666	101.9353	86.5424	67.4908
	2	0.0000	0.0000	5.5383	6.7861	16.1951	34.6337	46.9406	95.2056	110.6953	129.8912	109.7343
	3	0.0000	0.0000	10.1791	12.9231	23.6258	37.6010	61.5793	119.7101	102.4421	119.1898	89.4178
	4	0.0000	0.0000	7.6152	8.4241	17.2183	35.2586	92.8748	103.9130	136.4245	95.2874	119.1898
	5	0.0000	0.0000	0.0000	7.4030	11.9775	27.4218	77.6828	95.2874	133.7309	98.4611	117.6549
P4	1	0.0000	0.0000	6.3460	9.3961	14.4435	36.7512	51.8634	56.9037	65.3471	57.8476	50.4004
	2	0.0000	0.0000	0.0000	0.0000	11.8508	47.9544	75.2019	47.2515	70.5606	47.0012	50.6700
	3	0.0000	0.0000	3.2753	5.5383	19.3462	49.6141	47.2515	23.1371	36.7512	32.0091	35.8104
	4	0.0000	0.0000	0.0000	4.0614	15.3462	41.3451	47.9544	94.8538	106.7106	58.8005	46.4214
	5	0.0000	0.0000	0.0000	0.0000	17.5832	50.1346	47.2515	41.2385	33.6540	23.8835	18.5097

Sumber : Data primer Handayani (2004)

Lampiran 09. Uji normalitas (Uji W dari Shapiro dan Wilk) pigmen total *Rhodotorula mucilaginosa* UICC Y-18 pada medium standar dengan sumber nitrogen yang berbeda

Tabel 22. Perhitungan uji normalitas pigmen total *R. mucilaginosa* UICC Y-18 pada inkubasi 48 jam

Perlakuan	Y_i					$Y_i - \overline{Y}$					$(Y_i - \overline{Y})^2$				
	Ulangan					Ulangan					Ulangan				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
P1	29.86	21.22	29.18	18.10	9.67	15.055	6.9	9.750	4.22	-2.579	226.6553	47.173888	95.071275	17.769808	6.6531754
P2	4.69	8.14	5.08	4.87	9.77	-10.119	-6.2	-14.358	-9.01	-2.479	102.3886	38.598573	206.13924	81.262562	6.1473004
P3	10.23	16.20	23.63	17.22	11.98	-4.575	1.8	4.191	3.33	-0.272	20.92994	3.4122402	17.568253	11.113722	0.073916
P4	14.44	11.85	19.85	15.35	17.58	-0.361	-2.5	0.416	1.47	5.331	0.130628	6.2638827	0.1727649	2.1474704	28.415563
Jumlah	59.22	57.41	77.74	55.54	49.00						350.1044	95.448584	318.95154	112.29356	41.289955
Rataan	14.805	14.353	19.434	13.885	12.249										

Keterangan :

Y_i = Data ke-i

$\overline{Y}_i$ = Rataan data ke-i

Perhitungan :

1. $$\sum_{i=1}^{n} (Y_i - \overline{Y})^2 = (Y_1 - \overline{Y})^2 + (Y_2 - \overline{Y})^2 + \ldots + (Y_n - \overline{Y})^2$$

$$= 918.0886$$

2. $b = \sum_{i=1}^{k} a_{n-i+1}\left(Y_{n-i+1} - Y_i\right)$

$= (0.4734)(29.86 - 4.69) + (0.3211)(29.18 - 4.87) + \ldots + (0.0140)(15.35 - 14.44)$

$= 31.3023$

3. $W_0 = \dfrac{b^2}{\sum_{i=1}^{n}\left(Y_i - \overline{Y}\right)^2}$

$= 1.0673$

$W_{tabel}\ (\alpha = 0.05\ ;\ 20) = 0.905$

$W_{tabel}\ (\alpha = 0.01\ ;\ 20) = 0.868$

$W_0 > W_{tabel} \rightarrow$ asumsi normalitas diterima

Dengan perhitungan analog seperti di atas didapatkan hasil sebagai berikut :

Tabel 23. Hasil uji normalitas pigmen total *R. mucilaginosa* UICC Y-18

Waktu Inkubasi	W_0	Asumsi Normalitas
24 jam	1.0580	Diterima
36 jam	1.5507	Diterima
48 jam	1.0673	Diterima
60 jam	0.9941	Diterima
72 jam	1.0807	Diterima
84 jam	0.9474	Diterima
96 jam	1.1734	Diterima
108 jam	0.9986	Diterima
120 jam	0.9656	Diterima

Lampiran 10. Uji homogenitas (Uji Bartlett) pigmen total *Rhodotorula mucilaginosa* UICC Y-18 pada medium standar dengan sumber nitrogen yang berbeda (Widasari, 1988)

Tabel 24. Perhitungan uji homogenitas pigmen total *R. mucilaginosa* UICC Y-18 pada inkubasi 48 jam

Perlakuan	Y_i							$(Y_i - \bar{Y})^2$						S^2	$Log\ S^2$
	Ulangan					Jumlah	Rataan	Ulangan					Jumlah		
	1	2	3	4	5			1	2	3	4	5			
P1	29.86	21.22	29.18	18.10	9.67	108.03	21.61	68.1163	0.1487	57.4270	12.2972	142.5383	280.5275	70.13188	1.845915
P2	4.69	8.14	5.08	4.87	9.77	32.54	6.51	3.3211	2.6615	2.0501	2.6850	10.6367	21.3544	5.3386	0.727427
P3	10.23	16.20	23.63	17.22	11.98	79.25	15.85	31.5880	0.1223	60.4581	1.8714	14.9987	109.0385	27.25962	1.43552
P4	14.44	11.85	19.85	15.85	17.58	79.57	15.91	2.1644	16.5218	15.4866	0.0042	2.7732	36.9502	9.237553	0.965557
Jumlah								105.1899	19.45425	135.4217	16.85779	170.947		111.9677	4.97442

$$S_i^2 = \frac{1}{4}\left\{\left(Y_{i1} - \bar{Y}_i\right)^2 + \left(Y_{i2} - \bar{Y}\right)^2 + \left(Y_{i3} - \bar{Y}\right)^2 + \left(Y_{i4} - \bar{Y}\right)^2\right\}$$

Perhitungan :

1. $S^2 = \frac{\sum S_i^2}{a} = \frac{111.9677}{4} = 27.9919$

   $LogS^2 = 1.4470$

2. $m = 2.30256\ (d.b)\left\{a \log S^2 - \left(\sum \log S^2\right)\right\}$

   $= 7.4934$

3. $c = 1 + \frac{a+1}{3a(n-1)} = 1.1042$

4. $\chi^2_{hit} = \frac{m}{c} = \frac{7.4934}{1.1042} = 6.7863$

$\chi^2_{tabel\ (0.001;3)} = 7.81$

$\chi^2_{hit} < .\chi^2_{tabel}$ → asumsi homogenitas diterima

Dengan perhitungan analog seperti di atas didapatkan hasil sebagai berikut :

Tabel 25. Hasil uji homogenitas pigmen total *R. mucilaginosa* UICC Y-18

Waktu Inkubasi	χ^2_{hit}	Asumsi Homogenitas
24 jam	6.3409	Diterima
36 jam	4.2264	Diterima
48 jam	6.7863	Diterima
60 jam	4.4492	Diterima
72 jam	1.1667	Diterima
84 jam	5.6601	Diterima
96 jam	1.4149	Diterima
108 jam	1.7537	Diterima
120 jam	1.0935	Diterima

Lampiran 11. Perhitungan analisis sidik ragam (ANOVA) pigmen total *Rhodotorula mucilaginosa* UICC Y-18 pada medium standar dengan sumber nitrogen yang berbeda (Gomez and Gomez, 1995; Hanafiah, 2000)

Tabel 26. Pigmen total *R. mucilaginosa* UICC Y-18 pada inkubasi 48 jam

Perlakuan	Ulangan					Jumlah	Rataan
	1	2	3	4	5		
P1	29.86	21.22	29.18	18.10	9.67	108.03	21.61
P2	4.69	8.14	5.08	4.87	9.77	32.54	6.51
P3	10.23	16.20	23.63	17.22	11.98	79.25	15.85
P4	14.44	11.85	19.85	15.35	17.58	79.07	15.81
Jumlah	59.22	57.41	77.74	55.54	49.00	298.90	59.78
Rataan							14.95

Perhitungan :

1. $FK = \frac{\left(\sum_{i=1}^{n} Y_i\right)^2}{n} = \frac{(298.91)^2}{20} = 4467.3594$

2. $JKT = \left(\sum Y_i^2\right) - FK$

$= \left[(29.86)^2 + (21.22)^2 + \ldots + (17.58)^2\right] - 4467.3594$

$= 1033.5364$

3. $JKU = \frac{\sum_{j=1}^{r} R_j^2}{t} - FK$

$= \frac{\left[(59.22)^2 + (57.41)^2 + (77.74)^2 + (55.54)^2 + (49.00)^2\right]}{4} - 4467.3594$

$= 115.6696$

4. $JKP = \frac{\left(\sum T_p^2\right)}{r} - FK$

$= \frac{\left[(108.03)^2 + (32.54)^2 + (79.25)^2 + (79.07)^2\right]}{5} - 4467.3594$

$= 585.4798$

5. $JKG = JKT - JKU - JKP$

$= 1033.5364 - 115.6696 - 585.4798$

$= 332.3870$

6. $KTU = \frac{JKU}{db\ Ulangan} = \frac{115.6696}{4} = 28.9174$

7. $KTP = \frac{JKP}{db\ Perlakuan} = \frac{585.4798}{3} = 195.1599$

8. $KTG = \frac{JKG}{db\ Galat} = \frac{332.3870}{12} = 27.6989$

9. $F_{hit} = \frac{KTP}{KTG} = \frac{195.1599}{27.6989} = 7.0458$

$F_{tabel\ (5\%)} = 3.24$ dan $F_{tabel\ (1\%)} = 5.29$

$F_{hit} < F_{tabel(5\%)} \rightarrow$ perlakuan tidak berbeda nyata

$F_{hit} < F_{tabel(5\%)} \leq F_{tabel(1\%)} \rightarrow$ perlakuan berbeda nyata

$F_{hit} > F_{tabel(1\%)} \rightarrow$ perlakuan berbeda sangat nyata

Koefisien Keragaman :

$KK = \frac{\sqrt{KTG}}{\bar{y}} \times 100\ \%$ dimana $\bar{y} = \frac{T_{ij}}{rt} = \frac{\sum Y_{ij}}{r \cdot t}$

Tabel 27. Hasil perhitungan analisis sidik ragam (Anova) pigmen total *R. mucilaginosa* UICC Y-18 pada inkubasi 24 jam

Sb. Keragaman	d.b	JK	KT	F_{hit}	$F_{0.05}$	$F_{0.01}$
Ulangan	4	72.19	18.0475	2.0816	3.26	5.41
Perlakuan	3	61.99	20.6633	2.3833	3.49	5.95
Galat	12	104.04	8.6700			
Total	19	238.22				

Tabel 28. Hasil perhitungan analisis sidik ragam (Anova) pigmen total *R. mucilaginosa* UICC Y-18 pada inkubasi 36 jam

Sb. Keragaman	d.b	JK	KT	F_{hit}	$F_{0.05}$	$F_{0.01}$
Ulangan	4	50.13	12.5325	1.1453	3.26	5.41
Perlakuan	3	179.80	59.9333	5.4771**	3.49	5.95
Galat	12	131.31	10.9425			
Total	19	361.24				

Keterangan:

** = berbeda sangat nyata

$$KK = \frac{\sqrt{10.9425}}{5.825} \times 100\,\% = 56.789\,\%$$

Tabel 29. Hasil perhitungan analisis sidik ragam (Anova) pigmen total *R. mucilaginosa* UICC Y-18 pada inkubasi 48 jam

Sb. Keragaman	d.b	JK	KT	F_{hit}	$F_{0.05}$	$F_{0.01}$
Ulangan	4	115.67	28.9175	1.0440	3.26	5.41
Perlakuan	3	585.48	195.1600	7.0457**	3.49	5.95
Galat	12	332.39	27.6992			
Total	19	1033.54				

$$KK = \frac{\sqrt{27.6992}}{14.945} \times 100\,\% = 35.216\,\%$$

Tabel 30. Hasil perhitungan analisis sidik ragam (Anova) pigmen total *R. mucilaginosa* UICC Y-18 pada inkubasi 60 jam

Sb. Keragaman	d.b	JK	KT	F_{hit}	$F_{0.05}$	$F_{0.01}$
Ulangan	4	410.73	102.6825	1.4500	3.26	5.41
Perlakuan	3	3591.01	1197.0033	16.9032**	3.49	5.95
Galat	12	849.78	70.8150			
Total	19	4851.52				

$$KK = \frac{\sqrt{70.8150}}{27.630} \times 100\,\% = 30.457\,\%$$

Tabel 31. Hasil perhitungan analisis sidik ragam (Anova) pigmen total *R. mucilaginosa* UICC Y-18 pada inkubasi 72 jam

Sb. Keragaman	d.b	JK	KT	F_{hit}	$F_{0.05}$	$F_{0.01}$
Ulangan	4	1048.63	262.1575	0.8627	3.26	5.41
Perlakuan	3	5046.85	1682.2833	5.5360**	3.49	5.95
Galat	12	3646.54	303.8783			
Total	19	9742.02				

$$KK = \frac{\sqrt{303.8783}}{57.490} \times 100\,\% = 30.322\,\%$$

Tabel 32. Hasil perhitungan analisis sidik ragam (Anova) pigmen total *R. mucilaginosa* UICC Y-18 pada inkubasi 84 jam

Sb. Keragaman	d.b	JK	KT	F_{hit}	$F_{0.05}$	$F_{0.01}$
Ulangan	4	417.49	104.3725	0.3311	3.26	5.41
Perlakuan	3	11835.08	3945.0267	12.5152**	3.49	5.95
Galat	12	3782.62	315.2183			
Total	19	16035.19				

$$KK = \frac{\sqrt{315.2183}}{77.363} \times 100\,\% = 22.950\,\%$$

Tabel 33. Hasil perhitungan analisis sidik ragam (Anova) pigmen total *R. mucilaginosa* UICC Y-18 pada inkubasi 96 jam

Sb. Keragaman	d.b	JK	KT	F_{hit}	$F_{0.05}$	$F_{0.01}$
Ulangan	4	3740.53	935.1325	2.8112	3.26	5.41
Perlakuan	3	13444.65	4481.5500	13.4722**	3.49	5.95
Galat	12	3991.81	332.6508			
Total	19	21176.99				

$$KK = \frac{\sqrt{332.6508}}{96.058} \times 100\,\% = 18.987\,\%$$

Tabel 34. Hasil perhitungan analisis sidik ragam (Anova) pigmen total *R. mucilaginosa* UICC Y-18 pada inkubasi 108 jam

Sb. Keragaman	d.b	JK	KT	F_{hit}	$F_{0.05}$	$F_{0.01}$
Ulangan	4	655.72	163.9300	0.2577	3.26	5.41
Perlakuan	3	26321.42	8773.8067	13.7943**	3.49	5.95
Galat	12	7632.56	636.0467			
Total	19	34609.70				

$$KK = \frac{\sqrt{636.0467}}{97.575} \times 100\,\% = 25.847\,\%$$

Tabel 35. Hasil perhitungan analisis sidik ragam (Anova) pigmen total *R. mucilaginosa* UICC Y-18 pada inkubasi 120 jam

Sb. Keragaman	d.b	JK	KT	F_{hit}	$F_{0.05}$	$F_{0.01}$
Ulangan	4	526.27	131.5675	0.3155	3.26	5.41
Perlakuan	3	34295.48	11431.8267	27.4121**	3.49	5.95
Galat	12	5004.43	417.0358			
Total	19	39826.18				

$$KK = \frac{\sqrt{417.0358}}{93.395} \times 100\,\% = 21.866\,\%$$

Lampiran 12. Uji Duncan rata-rata pigmen total *Rhodotorula mucilaginosa* UICC Y-18 pada medium standar dengan sumber nitrogen yang berbeda (Hanafiah, 1991; Gomez dan Gomez,1995)

1. Waktu inkubasi 36 jam

$$S_{\bar{d}} = \sqrt{\frac{2(KTG)}{r}} = \sqrt{\frac{2(10.9425)}{5}} = 2.0921$$

$$R_p = \frac{r_p \cdot S_{\bar{d}}}{\sqrt{2}}$$

Perlakuan	Nilai Tengah	P_2	P_4	P_3	P_1
P_2	2.15	-	1.65^{tn}	5.50^{*}	7.55^{**}
P_4	3.80		-	3.85^{tn}	5.90^{*}
P_3	7.68			-	2.05^{tn}
P_1	9.70				-
P			2	3	4
$r_{p(0.05)}$			3.08	3.23	4.33
$r_{p(0.01)}$			4.32	4.55	4.68
$R_{p(0.05)}$			4.55636	4.77826	4.92620
$R_{p(0.01)}$			6.39074	6.73099	6.92330

Keterangan: tn = berbeda tidak nyata
* = berbeda nyata
** = berbeda sangat nyata

2. Waktu inkubasi 48.jam

$$S_{\bar{d}} = \sqrt{\frac{2(KTG)}{r}} = \sqrt{\frac{2(27.6992)}{5}} = 3.3286$$

$$R_p = \frac{r_p \cdot S_{\bar{d}}}{\sqrt{2}}$$

Perlakuan	Nilai Tengah	P_2	P_4	P_3	P_1
P_2	6.51	-	9.34^{*}	9.31^{*}	15.10^{**}
P_4	15.82		-	0.03^{tn}	5.76^{tn}
P_3	15.85			-	5.79^{tn}
P_1	21.61				-
P			2	3	4
$r_{p(0.05)}$			3.08	3.23	4.33
$r_{p(0.01)}$			4.32	4.55	4.68
$R_{p(0.05)}$			7.24933	7.60237	7.83774
$R_{p(0.01)}$			10.16788	10.70922	11.05120

Keterangan: tn = berbeda tidak nyata
* = berbeda nyata
** = berbeda sangat nyata

3. Waktu inkubasi 60 jam

$$S_{\bar{d}} = \sqrt{\frac{2(KTG)}{r}} = \sqrt{\frac{2(70.8150)}{5}} = 5.3222$$

$$R_p = \frac{r_p \cdot S_{\bar{d}}}{\sqrt{2}}$$

Perlakuan	Nilai Tengah	P_2	P_1	P_3	P_4
P_2	7.48	-	20.68^{**}	22.24^{**}	37.68^{**}
P_1	28.16		-	1.52^{tn}	17.00^{*}
P_3	29.72			-	15.44^{*}
P_4	45.16				-
P			2	3	4
$r_{p(0.05)}$			3.08	3.23	4.33
$r_{p(0.01)}$			4.32	4.55	4.68
$R_{p(0.05)}$			11.59116	12.15566	12.53200
$R_{p(0.01)}$			16.25773	17.12330	17.61254

Keterangan: tn = berbeda tidak nyata
* = berbeda nyata
** = berbeda sangat nyata

4. Waktu inkubasi 72 jam

$$S_{\bar{d}} = \sqrt{\frac{2(KTG)}{r}} = \sqrt{\frac{2(303.8783)}{5}} = 11.0250$$

$$R_p = \frac{r_p \cdot S_{\bar{d}}}{\sqrt{2}}$$

Perlakuan	Nilai Tengah	P_2	P_4	P_3	P_1
P_2	34.10	-	19.81^{tn}	30.33^{*}	43.42^{**}
P_4	53.91		-	10.52^{tn}	23.62^{tn}
P_3	64.43			-	13.10^{tn}
P_1	77.53				-
P			2	3	4
$r_{p(0.05)}$			3.08	3.23	4.33
$r_{p(0.01)}$			4.32	4.55	4.68
$R_{p(0.05)}$			24.01122	25.18060	25.96019
$R_{p(0.01)}$			33.67808	35.47113	36.48459

Keterangan: tn = berbeda tidak nyata
* = berbeda nyata
** = berbeda sangat nyata

5. Waktu inkubasi 84 jam

$$S_{\bar{d}} = \sqrt{\frac{2(KTG)}{r}} = \sqrt{\frac{2(315.2183)}{5}} = 11.2289$$

$$R_p = \frac{r_p \cdot S_{\bar{d}}}{\sqrt{2}}$$

Perlakuan	Nilai Tengah	P_4	P_2	P_1	P_3
P_4	2.34	-	0.26^{tn}	1.94^{**}	2.00^{**}
P_2	2.60		-	1.68^{**}	1.74^{**}
P_1	4.28			-	0.06^{tn}
P_3	4.34				-
P			2	3	4
$r_{p(0.05)}$			3.08	3.23	4.33
$r_{p(0.01)}$			4.32	4.55	4.68
$R_{p(0.05)}$			0.49656	0.52074	0.53686
$R_{p(0.01)}$			0.69647	0.73355	0.75451

Keterangan: tn = berbeda tidak nyata
** = berbeda sangat nyata

6. Waktu inkubasi 96 jam

$$S_{\bar{d}} = \sqrt{\frac{2(KTG)}{r}} = \sqrt{\frac{2(332.6508)}{5}} = 11.5352$$

$$R_p = \frac{r_p \cdot S_{\bar{d}}}{\sqrt{2}}$$

Perlakuan	Nilai Tengah	P_4	P_2	P_3	P_1
P_4	**62.61**	-	16.77^{tn}	54.44**	62.61**
P_2	**79.36**		-	37.69*	45.86**
P_3	**117.05**			-	8.17^{tn}
P_1	**125.22**				-
P			**2**	**3**	**4**
$r_{p(0.05)}$			3.08	3.23	4.33
$r_{p(0.01)}$			4.32	4.55	4.68
$R_{p(0.05)}$			25.12238	26.34588	27.16154
$R_{p(0.01)}$			35.23659	37.11261	38.17297

Keterangan: tn = berbeda tidak nyata
* = berbeda nyata
** = berbeda sangat nyata

7. Waktu inkubasi 108 jam

$$S_{\bar{d}} = \sqrt{\frac{2(KTG)}{r}} = \sqrt{\frac{2(636.0467)}{5}} = 15.9505$$

$$R_p = \frac{r_p \cdot S_{\bar{d}}}{\sqrt{2}}$$

Perlakuan	Nilai Tengah	P_4	P_2	P_3	P_1
P_4	**43.91**	-	50.99*	61.96**	101.71**
P_2	**94.90**		-	10.97^{tn}	47.72*
P_3	**105.87**			-	39.75*
P_1	**145.62**				-
P			**2**	**3**	**4**
$r_{p(0.05)}$			3.08	3.23	4.33
$r_{p(0.01)}$			4.32	4.55	4.68
$R_{p(0.05)}$			34.73842	36.43022	37.55809
$R_{p(0.01)}$			48.72401	51.31812	52.74835

Keterangan: tn = berbeda tidak nyata
** = berbeda sangat nyata

8. Waktu inkubasi 120 jam

$$S_{\bar{d}} = \sqrt{\frac{2(KTG)}{r}} = \sqrt{\frac{2(417.0358)}{5}} = 12.9157$$

$$R_p = \frac{r_p \cdot S_{\bar{d}}}{\sqrt{2}}$$

Perlakuan	Nilai Tengah	P_4	P_2	P_3	P_1
P_4	40.36	-	37.51*	60.34**	114.29**
P_2	77.65		-	22.83tn	76.78**
P_3	100.70			-	53.97**
P_1	154.65				-
P			2	3	4
$r_{p(0.05)}$			3.08	3.23	4.33
$r_{p(0.01)}$			4.32	4.55	4.68
$R_{p(0.05)}$			28.12896	29.49888	30.41215
$R_{p(0.01)}$			39.45361	41.55414	42.74141

Keterangan: tn = berbeda tidak nyata
* = berbeda nyata
** = berbeda sangat nyata

Lampiran 13. Uji Kesamaan Rata-rata Perlakuan (Usman dan Akbar, 1995)

Tabel 36. Uji kesamaan rata-rata perlakuan ammonium sulfat

Waktu Inkubasi (jam)					
36	60	72	84	96	
3.20	4.30	4.70	3.90	3.70	
3.50	4.10	4.50	4.30	4.30	
3.50	3.30	4.60	4.70	4.10	
4.50	4.00	4.00	4.70	3.80	
3.80	3.00	3.60	4.00	3.80	
$n_1 = 5$ $\Sigma X_1 = 18.50$	$n_2 = 5$ $\Sigma X_2 = 18.70$	$n_3 = 5$ $\Sigma X_3 = 21.40$	$n_4 = 5$ $\Sigma X_4 = 21.60$	$n_5 = 5$ $\Sigma X_5 = 19.70$	$N = 25$ $\Sigma X = 99.90$
$\overline{X}_1 = 3.70$ $S_1^2 = 0.25$	$\overline{X}_2 = 3.70$ $S_2^2 = 0.25$	$\overline{X}_3 = 3.70$ $S_3^2 = 0.25$	$\overline{X}_4 = 3.70$ $S_4^2 = 0.25$	$\overline{X}_5 = 3.70$ $S_5^2 = 0.25$	

Perhitungan :

$$JK_R = \frac{\left(\sum X_1 + \sum X_2 + \ldots + \sum X_5\right)}{n_1 + n_2 + \ldots + n_5} = 399.2004 \qquad dk_R = 1$$

$$JK_A = \frac{(\sum X_1)^2}{n_1} + \frac{(\sum X_2)^2}{n_2} + \ldots + \frac{(\sum X_5)^2}{n_5} - JK_R = 1.7096 \qquad dk_A = k - 1 = 4$$

$$JK_D = \sum X_i^2 - JK_R - JK_A = 3.92 \qquad dk_D = N - k = 20$$

$$RK_R = \frac{JK_R}{dk_R} = 399.2004$$

$$RK_A = \frac{JK_A}{dk_A} = 0.4274$$

$$RK_D = \frac{JK_D}{dk_D} = 0.1960$$

$$F_{hit} = \frac{RK_A}{RK_D} = 2.1806$$

$F_{tabel} = F_{(0.05)(4.20)} = 2.87 \Rightarrow$ $F_{hit} < F_{tabel}$ maka H_0 diterima, tidak ada perbedaan rata-rata

Tabel 37. Uji kesamaan rata-rata perlakuan urea

Waktu Inkubasi (jam)					
72	84	96	108	120	
3.10	3.10	3.70	2.90	2.80	
2.40	2.60	3.10	2.40	3.20	
2.00	2.40	3.00	2.00	2.30	
3.10	3.10	3.00	2.70	3.00	
2.40	3.30	3.60	3.30	2.60	
$n_1 = 5$ $\Sigma X_1 = 13.00$	$n_2 = 5$ $\Sigma X_2 = 14.50$	$n_3 = 5$ $\Sigma X_3 = 16.40$	$n_4 = 5$ $\Sigma X_4 = 13.30$	$n_5 = 5$ $\Sigma X_5 = 13.90$	$N = 25$ $\Sigma X = 71.10$
$\overline{X}_1 = 2.60$ $S_1^2 = 0.24$	$\overline{X}_2 = 2.90$ $S_2^2 = 0.15$	$\overline{X}_3 = 3.28$ $S_3^2 = 0.12$	$\overline{X}_4 = 2.66$ $S_4^2 = 0.24$	$\overline{X}_5 = 2.78$ $S_5^2 = 0.12$	

Perhitungan :

$$JK_R = \frac{\left(\sum X_1 + \sum X_2 + \ldots + \sum X_5\right)}{n_1 + n_2 + \ldots + n_5} = 202.2084 \qquad dk_R = 1$$

$$JK_A = \frac{(\sum X_1)^2}{n_1} + \frac{(\sum X_2)^2}{n_2} + \ldots + \frac{(\sum X_5)^2}{n_5} - JK_R = 1.4536 \qquad dk_A = k - 1 = 4$$

$$JK_D = \sum X_i^2 - JK_R - JK_A = 3.45 \qquad dk_D = N - k = 20$$

$$RK_R = \frac{JK_R}{dk_R} = 202.2084$$

$$RK_A = \frac{JK_A}{dk_A} = 0.3634$$

$$RK_D = \frac{JK_D}{dk_D} = 0.1724$$

$$F_{hit} = \frac{RK_A}{RK_D} = 2.1079$$

$F_{tabel} = F_{(0.05)(4.20)} = 2.87 \Rightarrow$ $F_{hit} < F_{tabel}$ maka H_0 diterima, tidak ada perbedaan rata-rata

Tabel 38. Uji kesamaan rata-rata perlakuan pepton

Masa Inkubasi (jam)					
48	60	72	84	96	
4.80	4.50	4.40	3.20	4.30	
3.90	3.60	4.60	4.30	4.90	
4.20	4.00	4.60	3.30	5.00	
4.30	3.90	4.10	4.50	4.20	
4.10	2.70	4.00	4.60	4.40	
$n_1 = 5$ $\Sigma X_1 = 21.30$	$n_2 = 5$ $\Sigma X_2 = 18.70$	$n_3 = 5$ $\Sigma X_3 = 21.70$	$n_4 = 5$ $\Sigma X_4 = 19.90$	$n_5 = 5$ $\Sigma X_5 = 22.80$	$N = 25$ $\Sigma X = 104.40$
$\overline{X}_1 = 4.26$ $S_1^2 = 0.11$	$\overline{X}_2 = 3.74$ $S_2^2 = 0.44$	$\overline{X}_3 = 4.34$ $S_3^2 = 0.08$	$\overline{X}_4 = 3.98$ $S_4^2 = 0.46$	$\overline{X}_5 = 4.56$ $S_5^2 = 0.13$	

Perhitungan :

$$JK_R = \frac{\left(\sum X_1 + \sum X_2 + \ldots + \sum X_5\right)}{n_1 + n_2 + \ldots + n_5} = 435.9744 \qquad dk_R = 1$$

$$JK_A = \frac{(\sum X_1)^2}{n_1} + \frac{(\sum X_2)^2}{n_2} + \ldots + \frac{(\sum X_5)^2}{n_5} - JK_R = 2.0496 \qquad dk_A = k - 1 = 4$$

$$JK_D = \sum X_i^2 - JK_R - JK_A = 4.90 \qquad dk_D = N - k = 20$$

$$RK_R = \frac{JK_R}{dk_R} = 435.9744$$

$$RK_A = \frac{JK_A}{dk_A} = 0.5124$$

$$RK_D = \frac{JK_D}{dk_D} = 0.2448$$

$$F_{hit} = \frac{RK_A}{RK_D} = 2.0931$$

$F_{tabel} = F_{(0.05)(4.20)} = 2.87 \Rightarrow$ $F_{hit} < F_{tabel}$ maka H_0 diterima, tidak ada perbedaan rata-rata

Lampiran 14. Kadar nitrogen total medium biakan *R. mucilaginosa* UICC Y-18 dengan sumber nitrogen yang berbeda

Tabel 39. Perhitungan kadar nitrogen

Perlakuan	Ulangan	Kadar N Awal	Kadar N Akhir	Kadar N yang Dikonsumsi
Ammonium sulfat	1	2.144%	0.200%	1.944%
	2	2.563%	0.713%	1.850%
	3	2.407%	0.644%	1.763%
	4	2.570%	0.803%	1.767%
	5	2.122%	0.400%	1.722%
Urea	1	2.040%	1.532%	0.508%
	2	2.010%	1.230%	0.780%
	3	1.946%	1.089%	0.857%
	4	2.060%	1.703%	0.357%
	5	2.006%	1.462%	0.544%
Pepton	1	1.972%	1.510%	0.462%
	2	2.167%	0.920%	1.247%
	3	2.074%	0.735%	1.339%
	4	2.242%	1.650%	0.592%
	5	2.030%	1.580%	0.450%
Ammonium nitrat	1	2.940%	2.056%	0.884%
	2	2.570%	1.768%	0.802%
	3	2.568%	1.856%	0.712%
	4	2.043%	1.564%	0.479%
	5	2.580%	1.697%	0.883%

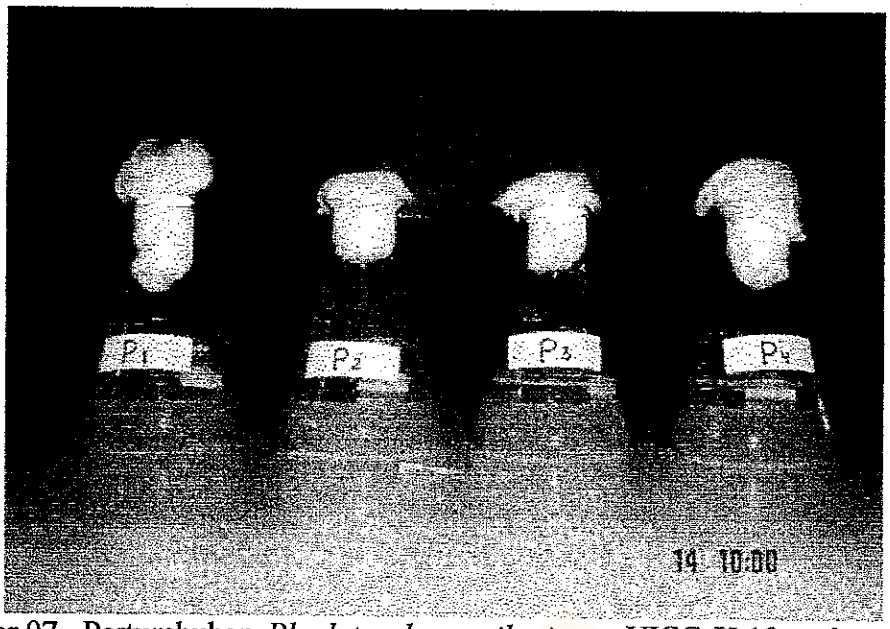
Sumber : Data primer Handayani (2004)

Lampiran 15. Perubahan pH medium biakan *R. mucilaginosa* UICC Y-18 dengan sumber nitrogen yang berbeda

Umur (Jam)	Perubahan pH Medium			
	Amm.sulfat	Urea	Pepton	Amm.nitrat
0	6.5	6.5	6.5	6.5
12	6.5	6.5	6.0	5.5
24	6.1	6.5	6.0	5.5
36	6.0	6.8	5.8	5.3
48	5.8	7.2	5.6	4.8
60	5.5	7.5	5.4	4.7
72	5.0	7.8	5.0	4.2
84	4.5	8.0	4.8	4.2
96	4.8	8.0	4.8	4.0
108	5.0	8.0	5.0	3.7
120	5.3	8.0	5.3	3.7

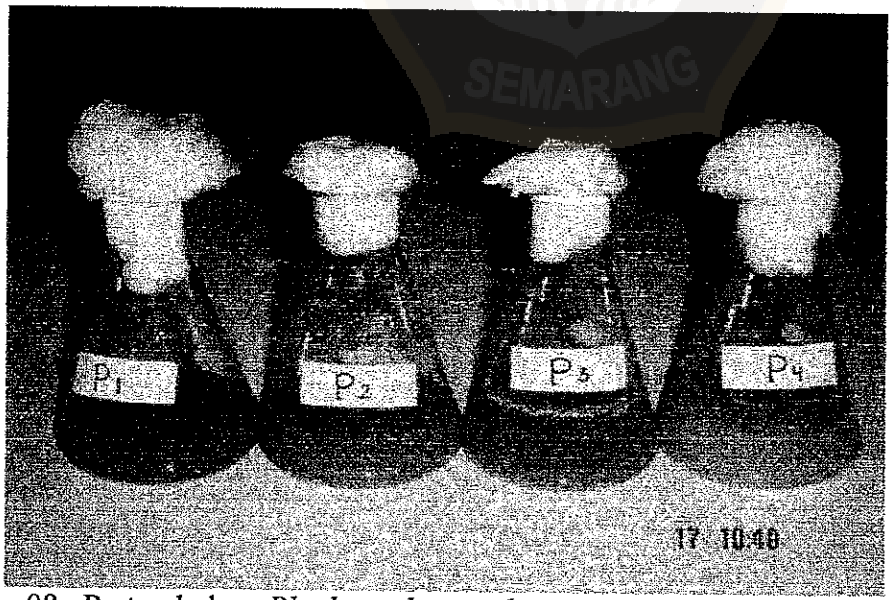
Sumber : Data primer Handayani (2004)

Lampiran 16. Pertumbuhan *Rhodotorula mucilaginosa* UICC Y-18

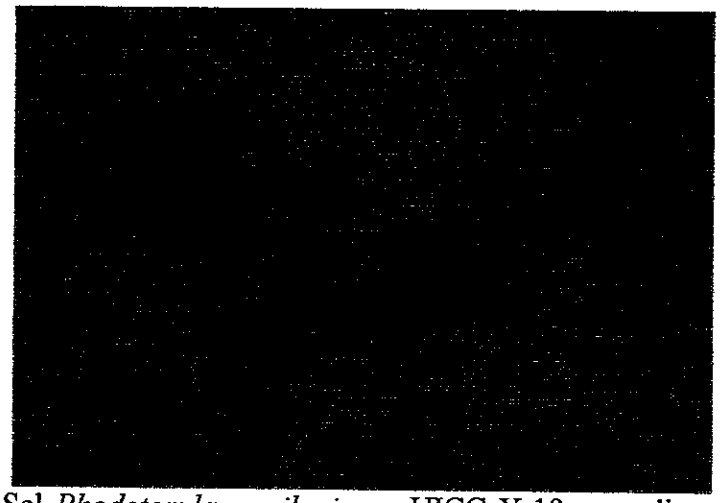


Gambar 07. Pertumbuhan *Rhodotorula mucilaginosa* UICC Y-18 pada medium standar dengan sumber nitrogen yang berbeda pada inkubasi 24 jam dengan agitasi 220 rpm, temperatur ruang, dan pH awal 6.5

Keterangan :
P_1 = Ammonium sulfat
P_2 = Urea
P_3 = Pepton
P_4 = Ammonium nitrat



Gambar 08. Pertumbuhan *Rhodotorula mucilaginosa* UICC Y-18 pada medium standar dengan sumber nitrogen yang berbeda pada inkubasi 96 jam dengan agitasi 220 rpm, temperatur ruang, dan pH awal 6.5



Gambar 09. Sel *Rhodotorula mucilaginosa* UICC Y-18 yang ditumbuhkan pada medium PDA (Perbesaran 1000x)

Keterangan :
a = sel vegetatif
b = budding/tunas