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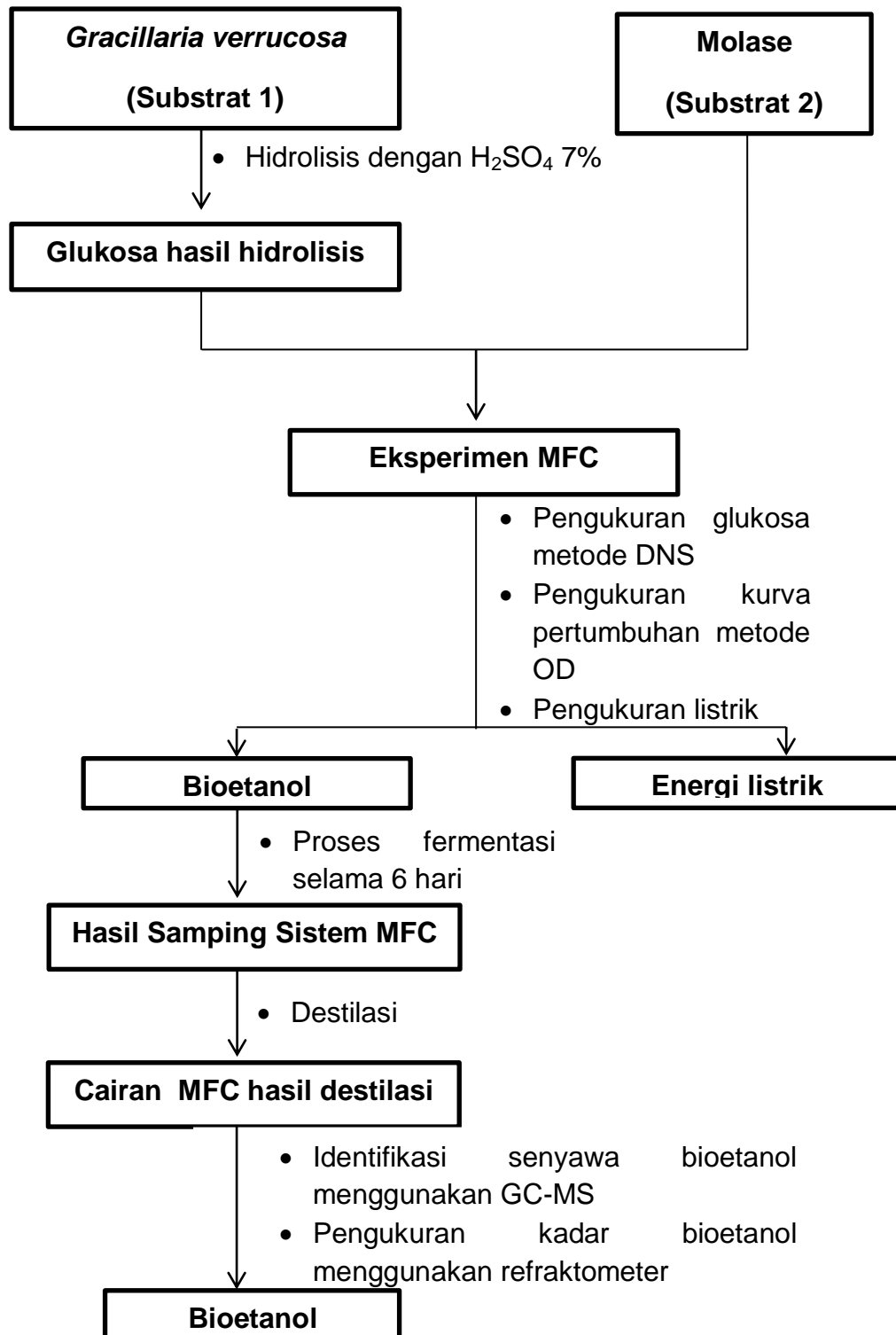
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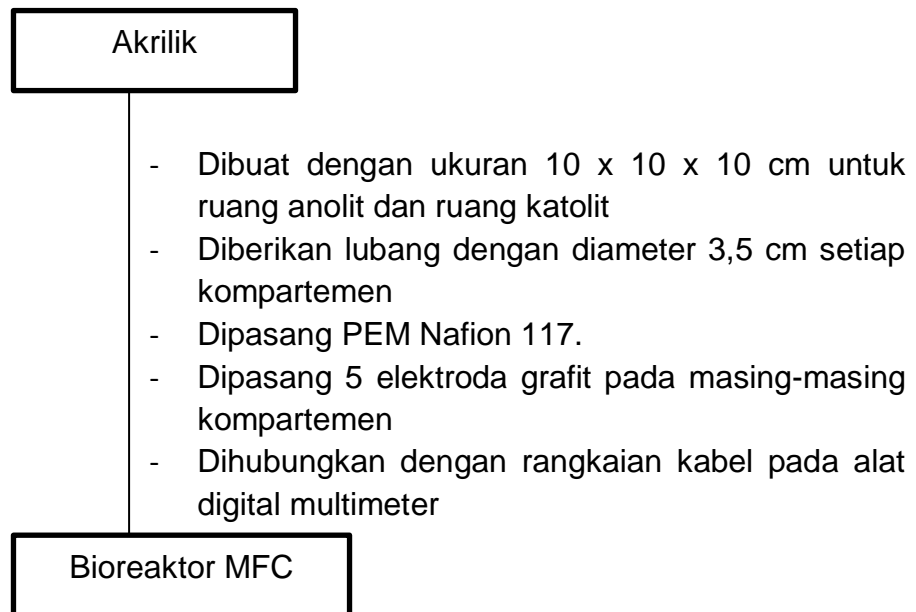
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## DIAGRAM KERJA

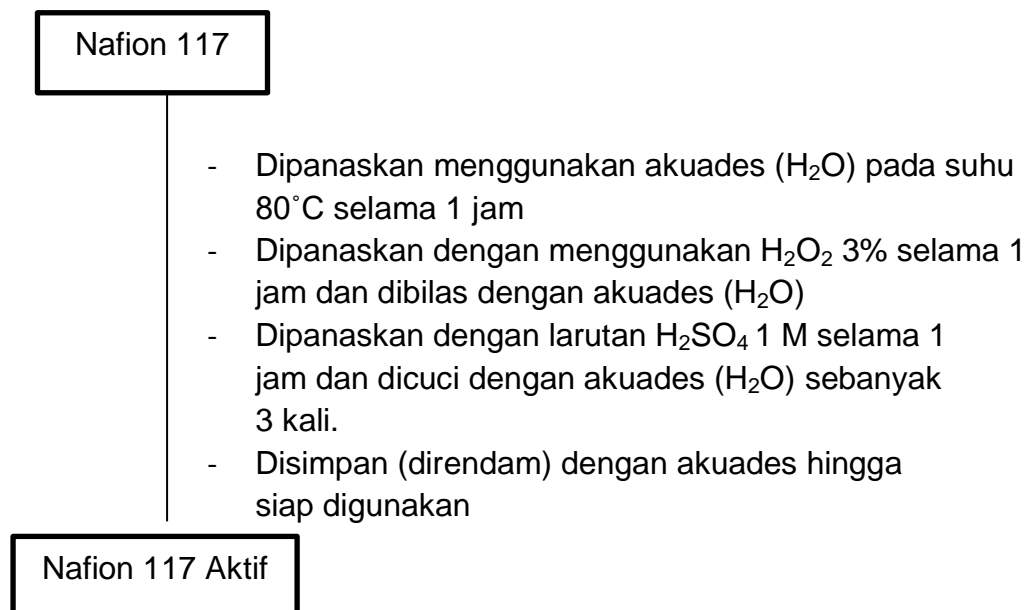
LAMPIRAN 1. Alur Penelitian



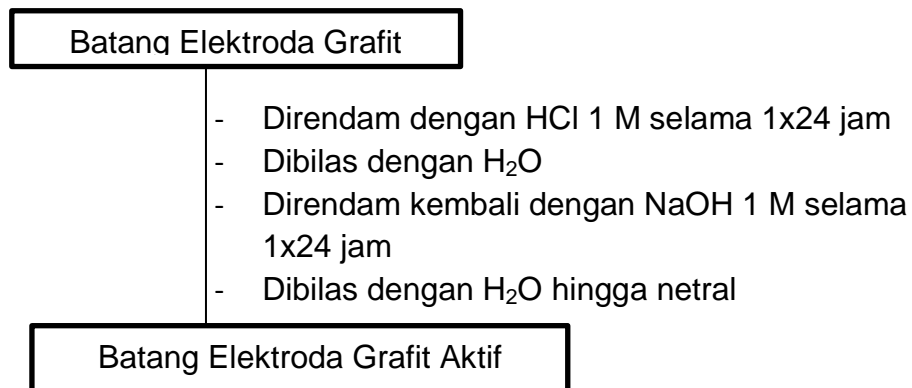
### Lampiran 2. Konstruksi MFC



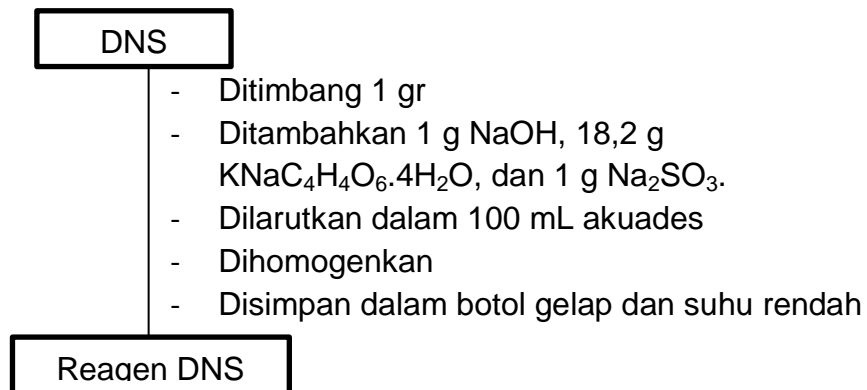
### Lampiran 3. Preparasi Membran Penukar Proton



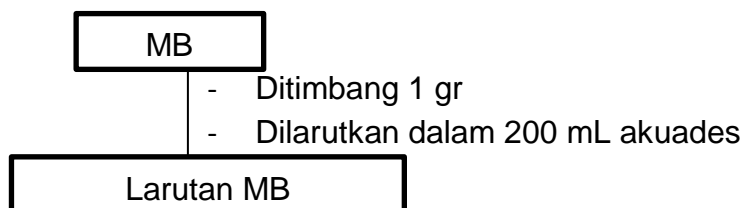
#### Lampiran 4. Preparasi Elektroda Grafit



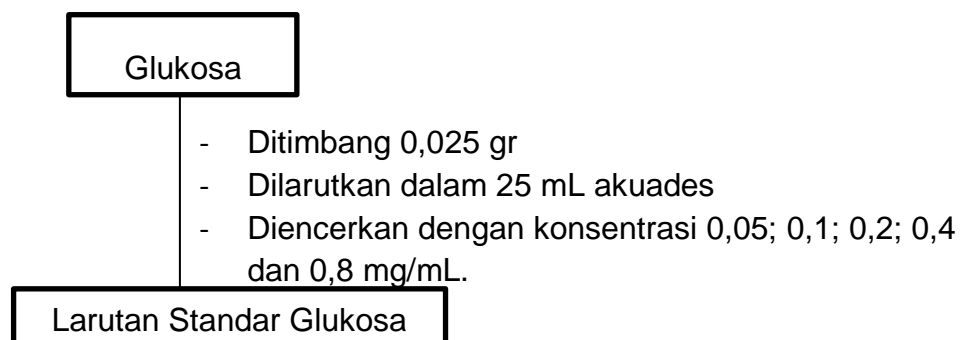
#### Lampiran 5. Pembuatan Larutan DNS

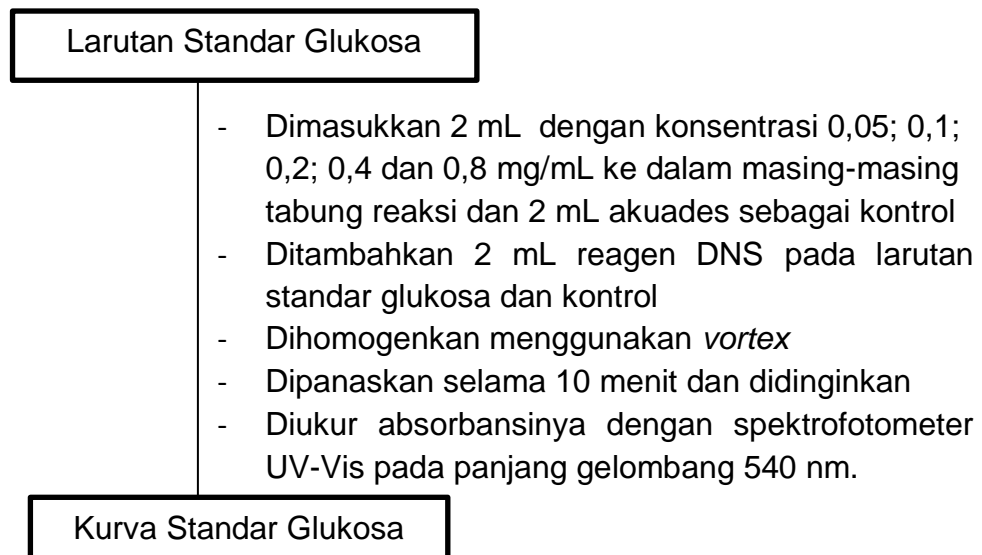
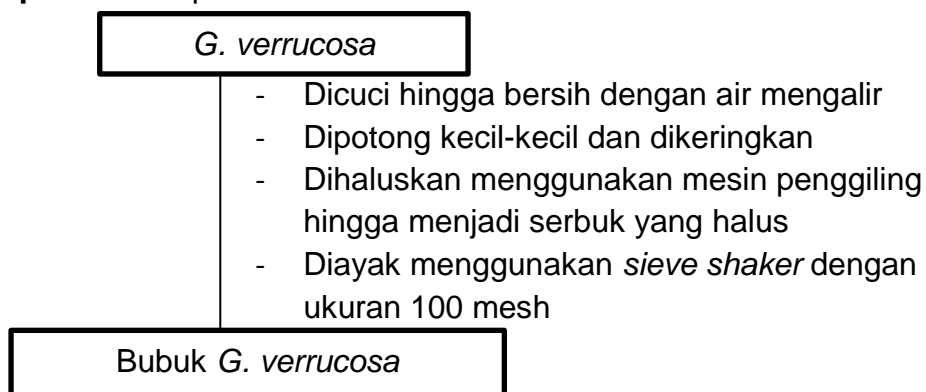


#### Lampiran 6. Pembuatan Larutan MB



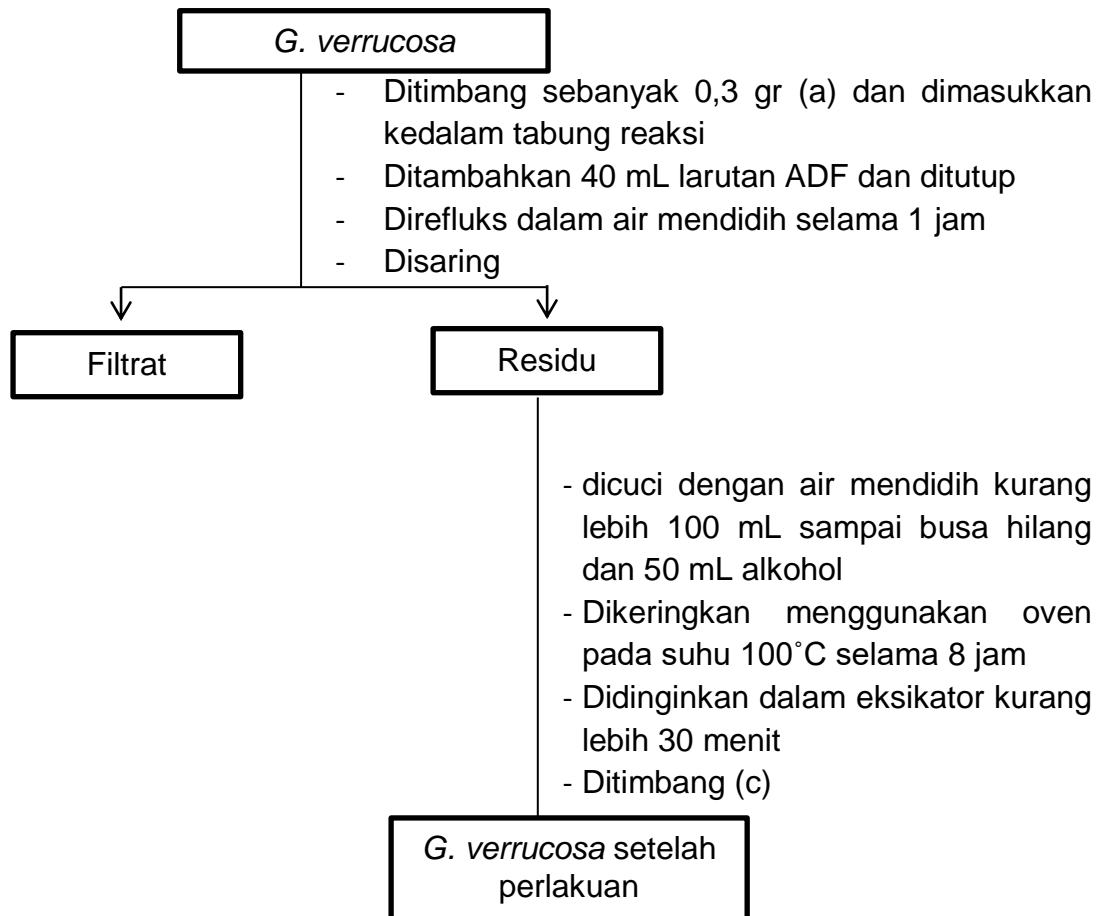
#### Lampiran 7. Pembuatan Larutan Standar Glukosa



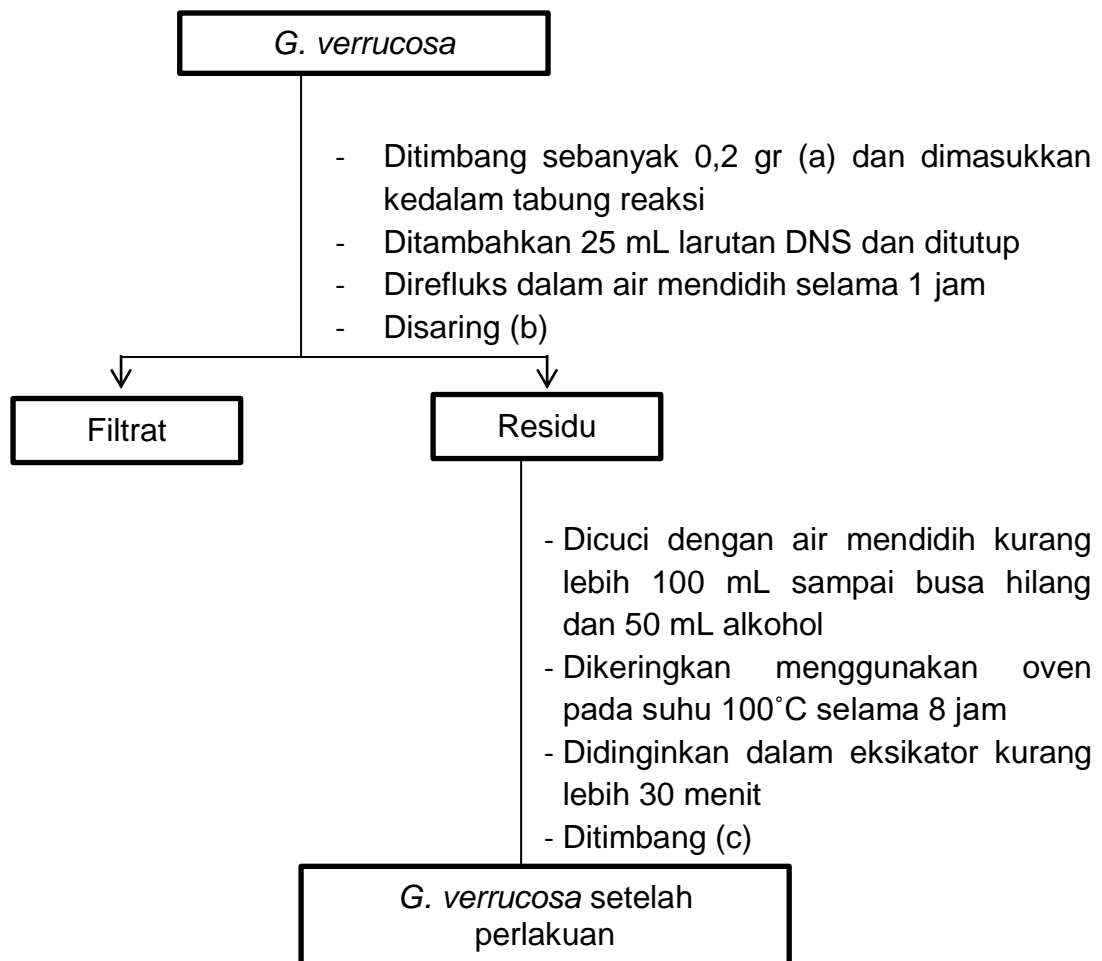
**Lampiran 8. Pembuatan Kurva Standar Glukosa****Lampiran 9. Preparasi Substrat *G. verrucosa***

**Lampiran 10.** Penentuan Kandungan ADF, NDF, Lignin, Selulosa dan Hemiselulosa pada *G. verrucosa*

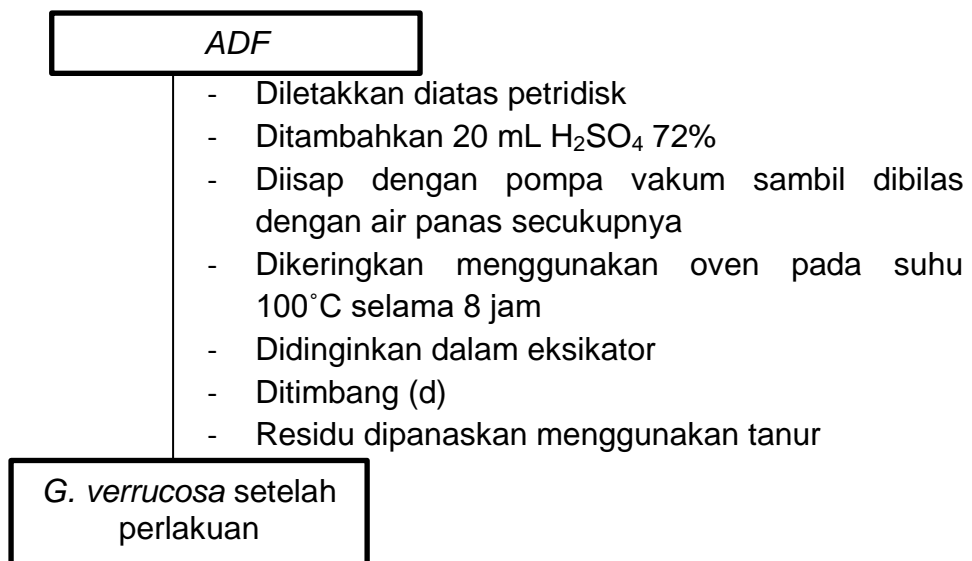
a. Penentuan Kadar ADF



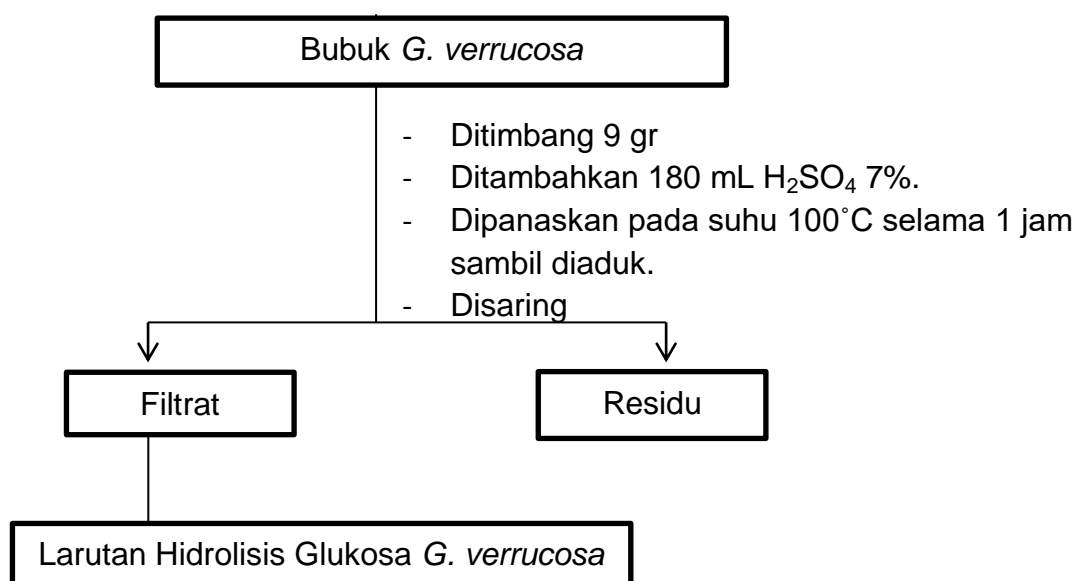
## b. Penentuan Kadar NDF



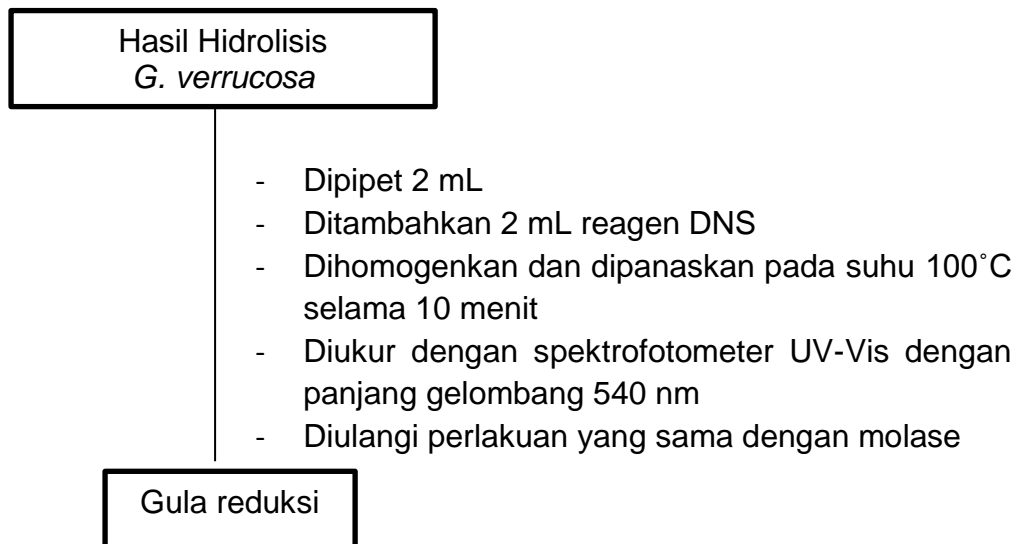
## c. Penentuan Kadar Selulosa dan Lignin



## Lampiran 11. Hidrolisis Selulosa

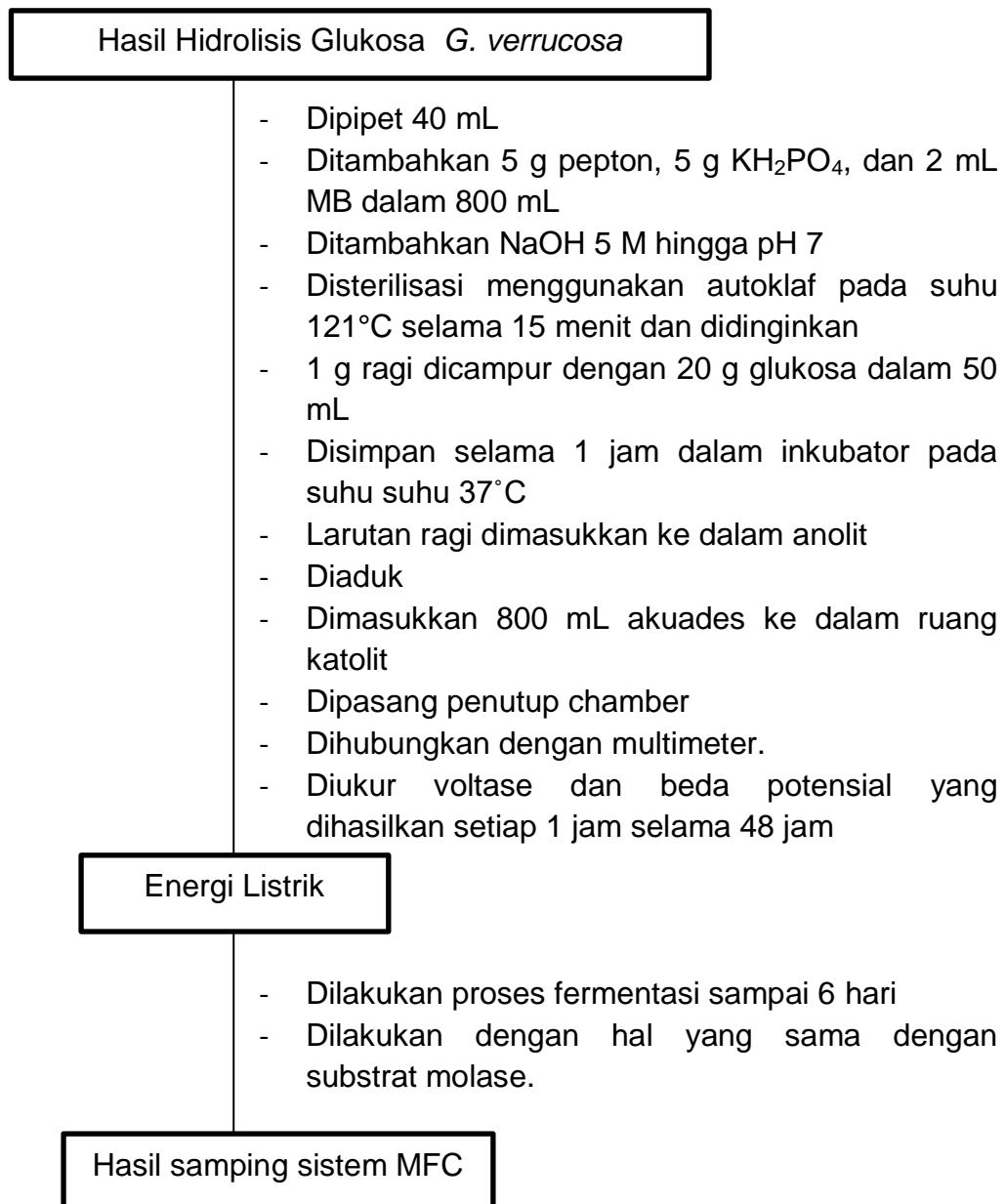




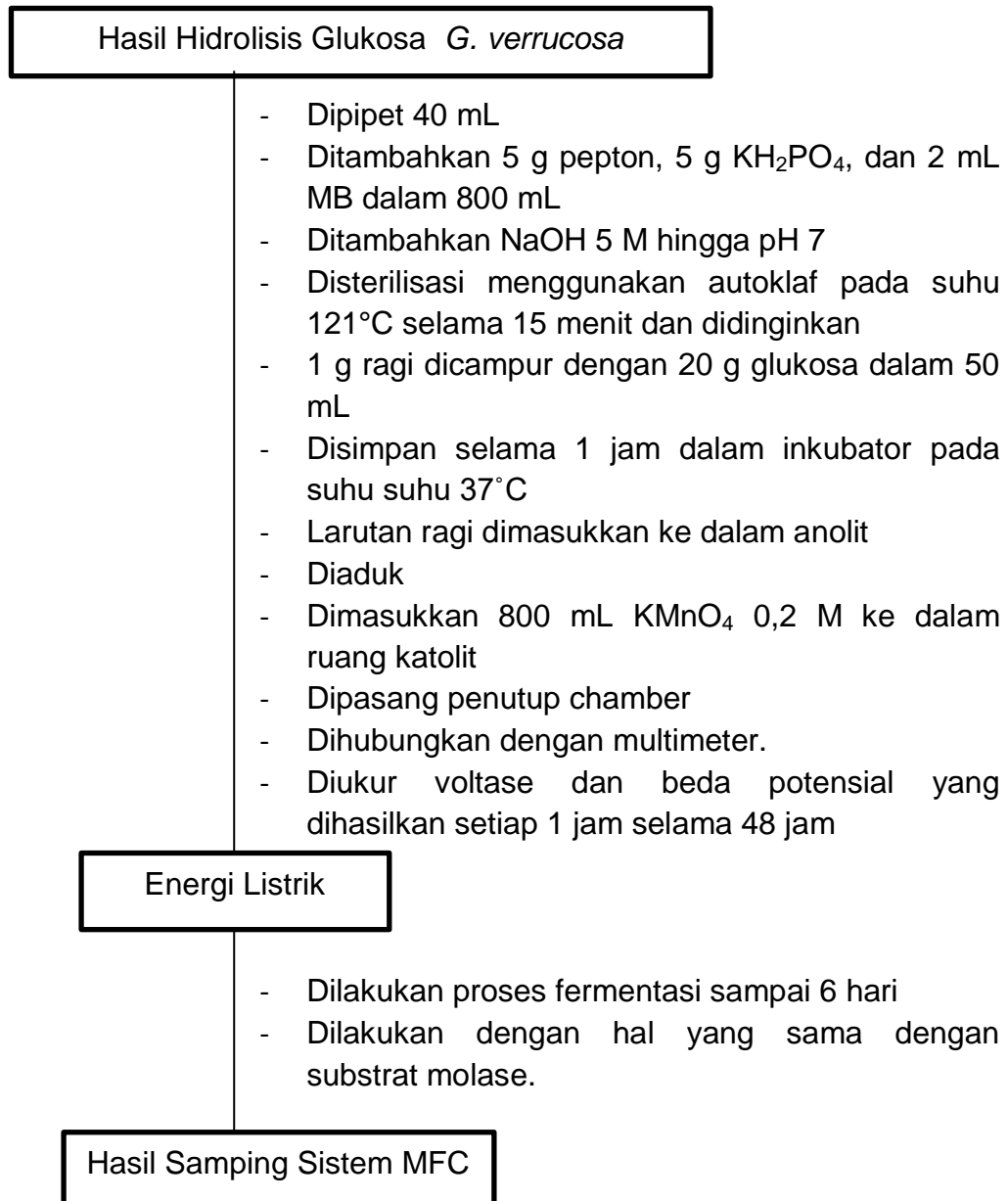
**Lampiran 12.** Pengukuran Gula Reduksi Hasil Hidrolisis *G. verrucosa*

**Lampiran 13. Eksperimen MFC**

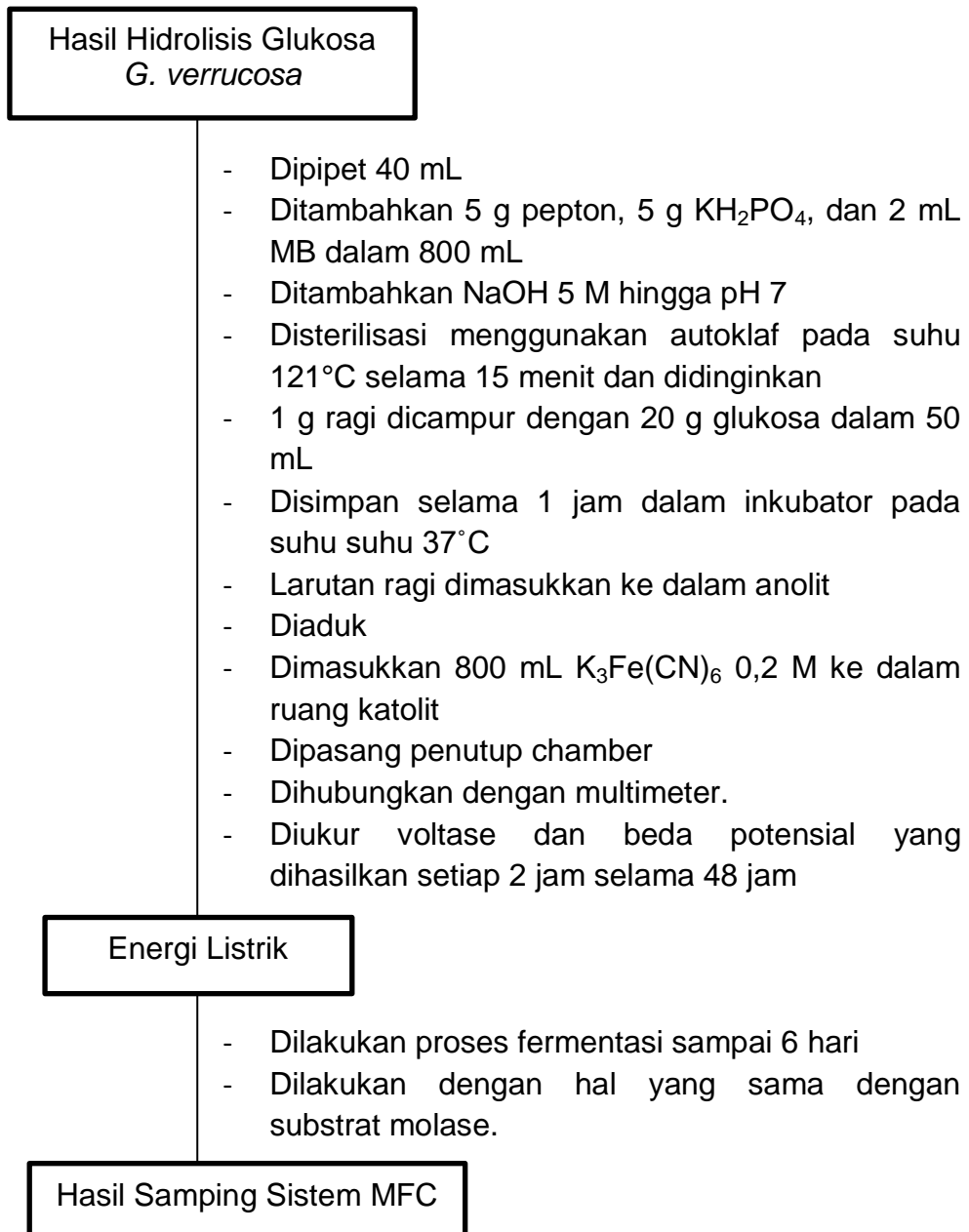
## a. Pengaruh perbedaan substrat tanpa kombinasi larutan elektrolit

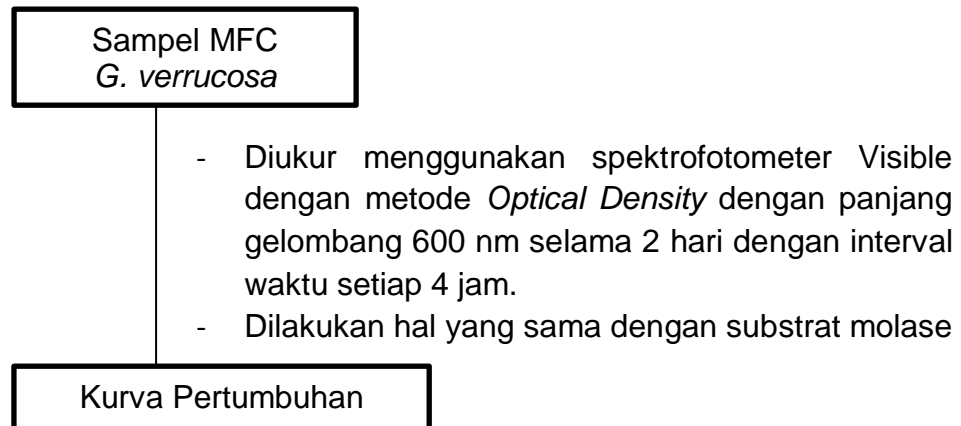
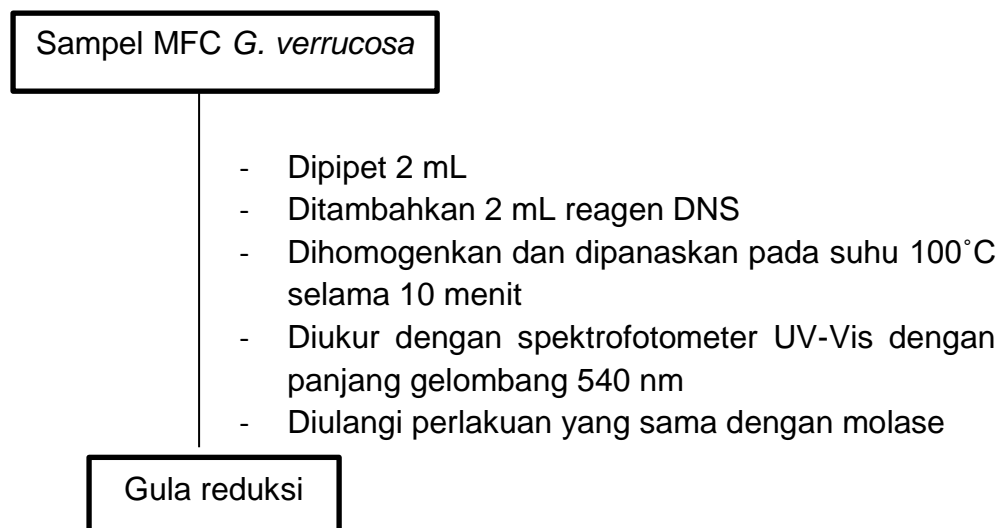
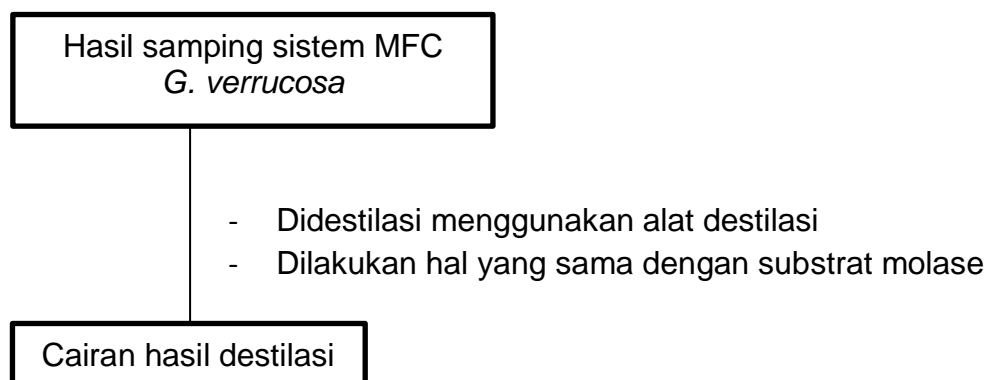


- b. Pengaruh perbedaan substrat dengan kombinasi larutan elektrolit  $\text{KMnO}_4$  0,2 M

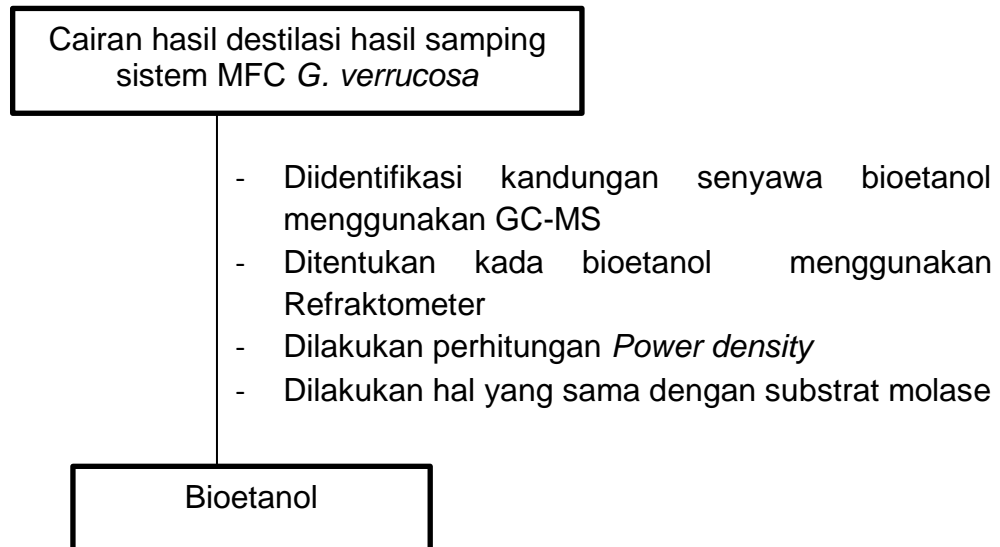


- c. Pengaruh perbedaan substrat dengan kombinasi larutan elektrolit  $K_3Fe(CN)_6$  0,2 M.



**Lampiran 14. Pengukuran Kurva Pertumbuhan *S. cerevisiae*****Lampiran 15. Pengukuran Gula Reduksi Sampel MFC****Lampiran 16. Proses Destilasi**

### Lampiran 17. Pengolahan dan Analisis Data



### Lampiran 18. Penentuan Kandungan ADF, NDF, Lignin, Selulosa dan

Hemiselulosa pada *G. verrucosa*

a. Penentuan Kandungan ADF pada *G. verrucosa*

Diketahui : a = 0,31 g

b = 52,3563 g

c = 52,4088 g

Ditanyakan: Kadar ADF?

$$\begin{aligned}
 \text{Kadar ADF} &= \frac{52,4088 - 52,3563}{0,31} \times 100\% \\
 &= \frac{0,0525}{0,31} \times 100\% \\
 &= 16,93\%
 \end{aligned}$$

b. Penentuan Kandungan NDF pada *G. verrucosa*

$$\begin{aligned} \text{Diketahui} : a &= 0,211 \text{ g} \\ b &= 53,8028 \text{ g} \\ c &= 53,8475 \text{ g} \end{aligned}$$

Ditanyakan: Kadar ADF?

$$\begin{aligned} \text{Kadar ADF} &= \frac{53,8475 - 53,8028}{0,211} \times 100\% \\ &= \frac{0,0447}{0,211} \times 100\% \\ &= 21,18\% \end{aligned}$$

c. Penentuan Kandungan Lignin pada *G. verrucosa*

$$\begin{aligned} \text{Diketahui} : a &= 0,31 \text{ g} \\ d &= 52,3984 \text{ g} \\ e &= 52,3926 \text{ g} \end{aligned}$$

Ditanyakan: Kadar ADF?

$$\begin{aligned} \text{Kadar ADF} &= \frac{52,3984 - 52,3926}{0,31} \times 100\% \\ &= \frac{0,0058}{0,31} \times 100\% \\ &= 1,87\% \end{aligned}$$

d. Penentuan Kandungan Abu tak larut pada  
*G. verrucosa*

$$\begin{aligned} \text{Diketahui : a (ADF)} &= 0,31 \text{ g} \\ \text{b (ADF)} &= 52,3563 \text{ g} \\ \text{e} &= 52,3926 \text{ g} \end{aligned}$$

Ditanyakan: Kadar Abu tak larut?

$$\begin{aligned} \text{Kadar ADF} &= \frac{52,3926 - 52,3563}{0,31} \times 100\% \\ &= \frac{0,0363}{0,31} \times 100\% \\ &= 11,70\% \end{aligned}$$

e. Penentuan Kandungan Selulosa dan Hemiselulosa  
pada *G. verrucosa*

$$\% \text{ Selulosa} = \% \text{ ADF} - \% \text{ Abu yang tak larut} - \text{lignin}$$

$$\begin{aligned} \% \text{ Selulosa} &= 16,93 - 11,70 - 1,87 \\ &= 3,36\% \end{aligned}$$

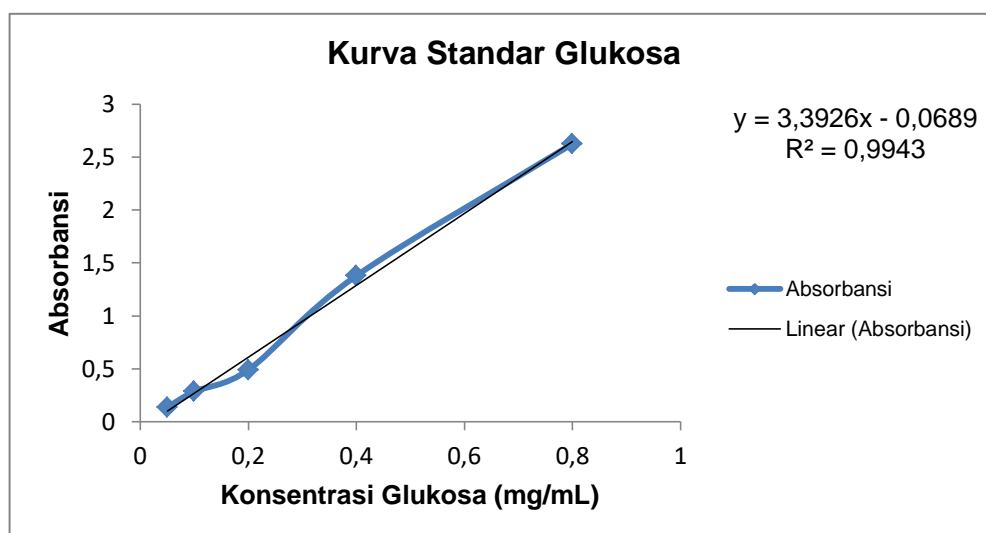
$$\% \text{ Hemiselulosa} = \% \text{ NDF} - \% \text{ ADF}$$

$$\begin{aligned} \% \text{ Hemiselulosa} &= 21,18 - 16,93 \\ &= 4,25\% \end{aligned}$$



**Lampiran 19. Kurva Standar Glukosa pada  $\lambda$  540 nm**

No	Konsentrasi Larutan Standar (mg/mL)	Absorbansi
1	0,05	0,136
2	0,1	0,284
3	0,2	0,489
4	0,4	1,379
5	0,8	2,626



**Lampiran 20.** Penentuan Kadar Glukosa pada Sampel MFC dari Molase  
pada  $\lambda$  540 nm

No	Waktu	Absorbansi
1	0	3.595
2	4	1.473
3	8	1.708
4	12	1.682

**Konsentrasi Glukosa pada Molase**

$$y = 3,3926x - 0,0689$$

$$x = \frac{y+0,0689}{3,3926}$$

Keterangan:

y = Absorbansi

x = Konsentrasi Glukosa (mg/mL)

1) Konsentrasi Glukosa pada Molase Tanpa Penambahan Mikroba

$$\begin{aligned} \text{(Glukosa)} &= \frac{y+0,0689}{3,3926} \\ &= \frac{2,784+0,0689}{3,3926} \\ &= \frac{2,8529}{3,3926} \\ &= 0,8409 \text{ mg/mL} \end{aligned}$$

2) Konsentrasi Glukosa pada 0 Jam

$$\text{(Glukosa)} = \frac{y+0,0689}{3,3926}$$

$$= \frac{3,595+0,0689}{3,3926}$$

$$= \frac{3,6639}{3,3926}$$

$$= 1,0799 \text{ mg/mL}$$

3) Konsentrasi Glukosa pada 4 Jam

$$\text{(Glukosa)} = \frac{y+0,0689}{3,3926}$$

$$= \frac{1,473+0,0689}{3,3926}$$

$$= \frac{1,5419}{3,3926}$$

$$= 0,4544 \text{ mg/mL}$$

4) Konsentrasi Glukosa pada 8 Jam

$$\text{(Glukosa)} = \frac{y+0,0689}{3,3926}$$

$$= \frac{1,708+0,0689}{3,3926}$$

$$= \frac{1,7769}{3,3926}$$

$$= 0,5237 \text{ mg/mL}$$

5) Konsentrasi Glukosa pada 12 Jam

$$\text{(Glukosa)} = \frac{y+0,0689}{3,3926}$$

$$= \frac{1,682+0,0689}{3,3926}$$

$$= \frac{1,7509}{3,3926}$$

$$= 0,5160 \text{ mg/mL}$$

**Lampiran 21.** Penentuan Kadar Glukosa pada Sampel MFC dari  
*G. verrucosa* pada  $\lambda$  540 nm

No	Waktu	Absorbansi
1	0	2,849
2	4	0,274
3	8	0,246
4	12	0,217

**Konsentrasi Glukosa pada *G. verrucosa***

$$y = 3,3926x - 0,0689$$

$$x = \frac{y+0,0689}{3,3926}$$

Keterangan:

y = Absorbansi

x = Konsentrasi Glukosa (mg/mL)

- 1) Konsentrasi Glukosa *G. verrucosa* tanpa Penambahan Mikroba

$$\begin{aligned}
 (\text{Glukosa}) &= \frac{y+0,0689}{3,3926} \\
 &= \frac{0,184+0,0689}{3,3926} \\
 &= \frac{0,2529}{3,3926} \\
 &= 0,0745 \text{ mg/mL}
 \end{aligned}$$

2) Konsentrasi Glukosa pada 0 Jam

$$\begin{aligned} \text{(Glukosa)} &= \frac{y+0,0689}{3,3926} \\ &= \frac{2,849+0,0689}{3,3926} \\ &= \frac{2,9179}{3,3926} \\ &= 0,86 \text{ mg/mL} \end{aligned}$$

3) Konsentrasi Glukosa pada 4 Jam

$$\begin{aligned} \text{(Glukosa)} &= \frac{y+0,0689}{3,3926} \\ &= \frac{0,274+0,0689}{3,3926} \\ &= \frac{0,3429}{3,3926} \\ &= 0,1010 \text{ mg/mL} \end{aligned}$$

4) Konsentrasi Glukosa pada 8 Jam

$$\begin{aligned} \text{(Glukosa)} &= \frac{y+0,0689}{3,3926} \\ &= \frac{0,246+0,0689}{3,3926} \\ &= \frac{0,3149}{3,3926} \\ &= 0,0928 \text{ mg/mL} \end{aligned}$$

5) Konsentrasi Glukosa pada 12 Jam

$$\begin{aligned} \text{(Glukosa)} &= \frac{y+0,0689}{3,3926} \\ &= \frac{0,217+0,0689}{3,3926} \\ &= \frac{0,2859}{3,3926} \\ &= 0,0842 \text{ mg/mL} \end{aligned}$$

**Lampiran 22.** Data Hasil Pengukuran Kurva Pertumbuhan dari *S. cerevisiae* dengan Substrat Molase pada  $\lambda$  600 nm

No	Waktu Fermentasi (jam)	OD
1	0	1,260
2	4	1,600
3	8	1,950
4	12	1,999
5	16	1,999
6	20	1,999
7	24	1,999
8	28	1,870
9	32	1,820
10	36	1,820
11	40	1,820
12	44	1,770
13	48	1,700

**Lampiran 23.** Data Hasil Pengukuran Kurva Pertumbuhan dari *S. cerevisiae* dengan Substrat *G. verrucosa* pada  $\lambda$  600 nm.

No	Waktu Fermentasi (jam)	OD
1	0	0,373
2	4	0,895
3	8	0,925
4	12	0,945
5	16	0,915
6	20	0,890
7	24	0,885
8	28	0,870
9	32	0,640
10	36	0,420
11	40	0,408
12	44	0,404
13	48	0,360

**Lampiran 24.** Data Hasil Pengukuran Arus Substrat *G. verrucosa* dan Molase Tanpa Penambahan Elektrolit

No	Jam	Arus (mA)	
		Molase	<i>G. verrucosa</i>
1	0	0,01	0,01
2	4	0,02	0,02
3	8	0,03	0,03
4	12	0,02	0,02
5	16	0,02	0,02
6	20	0,02	0,02
7	24	0,02	0,02
8	28	0,02	0,02
9	32	0,02	0,01
10	36	0,01	0,01
11	40	0,01	0,01
12	44	0,01	0,01
13	48	0,01	0,01



**Lampiran 25.** Data Hasil Pengukuran Tegangan Substrat *G. verrucosa* dan Molase Tanpa Penambahan Elektrolit

No	Jam	Tegangan (mV)	
		Molase	<i>G. verrucosa</i>
1	0	60	10
2	4	100	90
3	8	300	270
4	12	210	290
5	16	170	150
6	20	150	120
7	24	140	120
8	28	140	100
9	32	130	80
10	36	110	70
11	40	110	50
12	44	100	30
13	48	70	30

**Lampiran 26.** Data Hasil Pengukuran Arus Substrat *G. verrucosa* dan Molase Kombinasi Larutan Elektrolit  $\text{KMnO}_4$  0,2 M

No	Jam	Arus (mA)	
		Molase	<i>G. verrucosa</i>
1	0	0,75	0,63
2	4	1,20	0,68
3	8	0,77	0,74
4	12	0,80	0,69
5	16	0,80	0,54
6	20	0,83	0,52
7	24	0,55	0,45
8	28	0,54	0,42
9	32	0,54	0,37
10	36	0,52	0,30
11	40	0,47	0,28
12	44	0,44	0,27
13	48	0,42	0,24

**Lampiran 27.** Data Hasil Pengukuran Tegangan Substrat *G. verrucosa* dan Molase Kombinasi Larutan Elektrolit  $\text{KMnO}_4$  0,2 M

No	Jam	Tegangan (mV)	
		Molase	<i>G. verrucosa</i>
1	0	430	530
2	4	480	540
3	8	500	580
4	12	670	500
5	16	670	450
6	20	650	430
7	24	390	400
8	28	370	370
9	32	370	300
10	36	340	270
11	40	290	240
12	44	250	220
13	48	250	210

**Lampiran 28.** Data Hasil Pengukuran Arus Substrat *G. verrucosa* dan Molase Kombinasi Larutan Elektrolit  $K_3Fe(CN)_6$  0,2 M

No	Jam	Arus (mA)	
		Molase	<i>G. verrucosa</i>
1	0	1,65	0,27
2	4	0,71	0,67
3	8	0,84	0,69
4	12	0,53	0,66
5	16	0,65	0,64
6	20	0,60	0,61
7	24	0,47	0,58
8	28	0,44	0,43
9	32	0,39	0,37
10	36	0,35	0,30
11	40	0,32	0,28
12	44	0,24	0,24
13	48	0,16	0,16

**Lampiran 29.** Data Hasil Pengukuran Tegangan Substrat *G. verrucosa* dan Molase Kombinasi Larutan Elektrolit  $K_3Fe(CN)_6$  0,2 M

No	Jam	Tegangan (mV)	
		Molase	<i>G. verrucosa</i>
1	0	320	400
2	4	410	410
3	8	470	450
4	12	300	400
5	16	390	340
6	20	390	270
7	24	380	250
8	28	350	200
9	32	230	170
10	36	160	170
11	40	140	120
12	44	120	110
13	48	100	80

### Lampiran 30. Perhitungan Densitas Daya

#### A. Molase Tanpa Kombinasi Elektrolit

Dik: Arus = 0,03 mA

Tegangan = 300 mV

Luas Permukaan Elektroda = 0,19625 cm<sup>2</sup>

Dit: Densitas Daya (mW/cm<sup>2</sup>) = .....?

Jawab:

$$\text{Densitas Daya} = \frac{V \text{ (mV)} \times I \text{ (mA)}}{A}$$

$$\text{Densitas Daya} = \frac{300 \text{ mV} \times 0,03 \text{ mA}}{0,19625 \text{ cm}^2}$$

$$= \frac{9}{0,19625 \text{ cm}^2}$$

$$= 45,86 \text{ mW/cm}^2$$

#### B. *G. verrucosa* Tanpa Kombinasi Elektrolit

Dik: Arus = 0,03 mA

Tegangan = 290 mV

Luas Permukaan Elektroda = 0,19625 cm<sup>2</sup>

Dit: Nilai Densitas Daya (mW/cm<sup>2</sup>) = .....?

Jawab:

$$\text{Densitas Daya} = \frac{V \text{ (mV)} \times I \text{ (mA)}}{A}$$

$$\text{Densitas Daya} = \frac{290 \text{ mV} \times 0,03 \text{ mA}}{0,19625 \text{ cm}^2}$$

$$= \frac{8,7}{0,19625 \text{ cm}^2}$$

$$= 44,33 \text{ mW/cm}^2$$

**C. Molase dengan Kombinasi Elektrolit  $\text{KMnO}_4$  0,2 M**

$$\text{Dik: Arus} = 1,20 \text{ mA}$$

$$\text{Tegangan} = 670 \text{ mV}$$

$$\text{Luas Permukaan Elektroda} = 0,19625 \text{ cm}^2$$

$$\text{Dit: Nilai Densitas Daya (mW/cm}^2\text{)} = \dots\dots\dots?$$

Jawab:

$$\text{Densitas Daya} = \frac{V \text{ (mV)} \times I \text{ (mA)}}{A}$$

$$\text{Densitas Daya} = \frac{670 \text{ mV} \times 1,20 \text{ mA}}{0,19625 \text{ cm}^2}$$

$$= \frac{804}{0,19625 \text{ cm}^2}$$

$$= 4096,8152 \text{ mW/cm}^2$$

**D. Molase dengan Kombinasi Elektrolit  $\text{K}_3(\text{Fe}(\text{CN})_6)$  0,2 M**

$$\text{Dik: Arus} = 1,65 \text{ mA}$$

$$\text{Tegangan} = 470 \text{ mV}$$

$$\text{Luas Permukaan Elektroda} = 0,19625 \text{ cm}^2$$

$$\text{Dit: Nilai Densitas Daya (mW/cm}^2\text{)} = \dots\dots\dots?$$

Jawab:

$$\text{Densitas Daya} = \frac{V \text{ (mV)} \times I \text{ (mA)}}{A}$$

$$\text{Densitas Daya} = \frac{470 \text{ mV} \times 1,65 \text{ mA}}{0,19625 \text{ cm}^2}$$

$$= \frac{775,5}{0,19625 \text{ cm}^2}$$

$$= 3951,5923 \text{ mW/cm}^2$$

**E. *G. verrucosa* dengan Kombinasi Elektrolit  $\text{KMnO}_4$  0,2 M**

$$\text{Dik: Arus} = 0,74 \text{ mA}$$

$$\text{Tegangan} = 580 \text{ mV}$$

$$\text{Luas Permukaan Elektroda} = 0,19625 \text{ cm}^2$$

$$\text{Dit: Nilai Densitas Daya (mW/cm}^2\text{)} = \dots\dots\dots?$$

Jawab:

$$\text{Densitas Daya} = \frac{V \text{ (mV)} \times I \text{ (mA)}}{A}$$

$$\text{Densitas Daya} = \frac{580 \text{ mV} \times 0,74 \text{ mA}}{0,19625 \text{ cm}^2}$$

$$= \frac{429,2}{0,19625 \text{ cm}^2}$$

$$= 2187,0063 \text{ mW/cm}^2$$

**F. *G. verrucosa* dengan Kombinasi Elektrolit  $\text{K}_3(\text{Fe}(\text{CN})_6)$  0,2 M**

$$\text{Dik: Arus} = 0,69 \text{ mA}$$

$$\text{Tegangan} = 450 \text{ mV}$$

$$\text{Luas Permukaan Elektroda} = 0,19625 \text{ cm}^2$$

$$\text{Dit: Densitas Daya (mW/cm}^2\text{)} = \dots\dots\dots?$$

Jawab:

$$\text{Densitas Daya} = \frac{V \text{ (mV)} \times I \text{ (mA)}}{A}$$

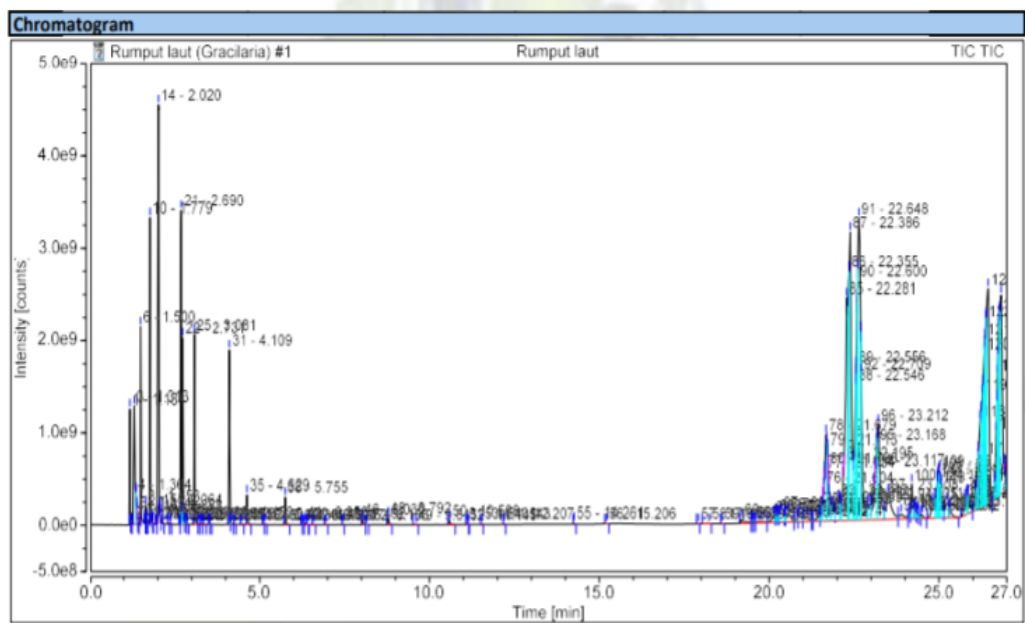
$$\text{Densitas Daya} = \frac{450 \text{ mV} \times 0,69 \text{ mA}}{0,19625 \text{ cm}^2}$$

$$= \frac{310,5}{0,19625 \text{ cm}^2}$$

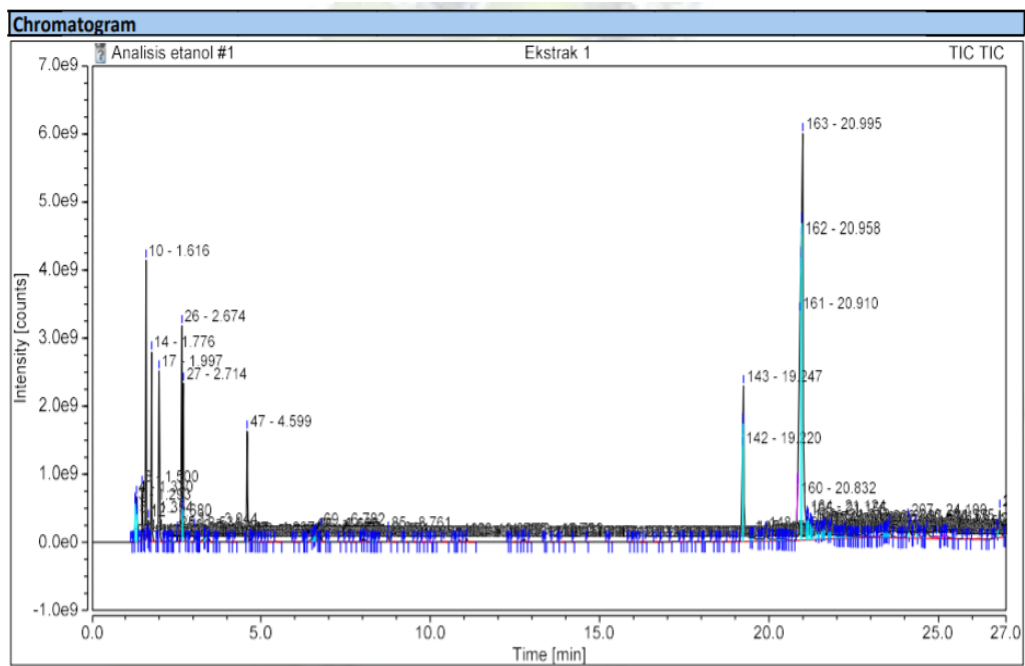
$$= 1.582,1656 \text{ mW/cm}^2$$



**Lampiran 31.** Data Hasil Analisis Fermentasi 6 Hari Hasil Samping Sistem MFC *G. verrucosa* setelah Destilasi dengan Alat GC-MS

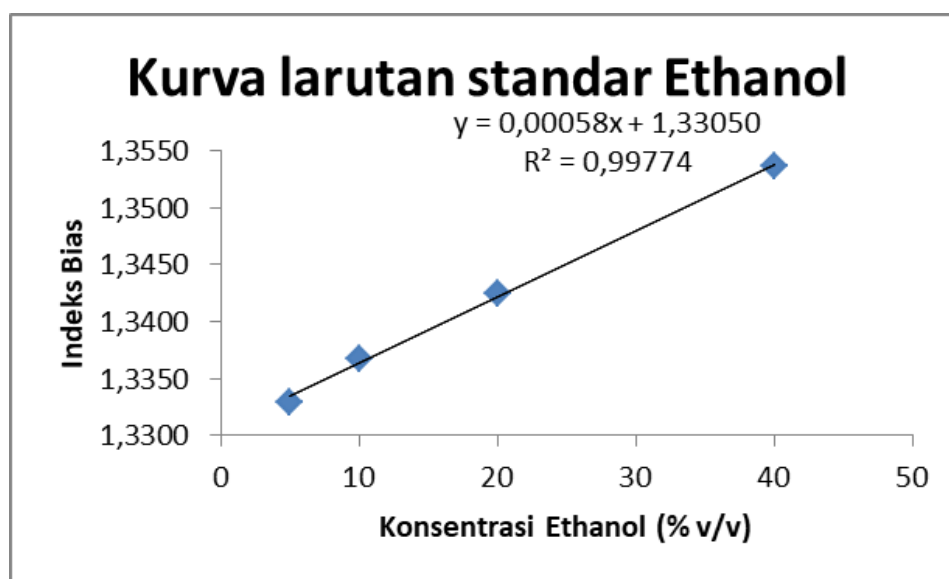


**Lampiran 32.** Data Hasil Analisis Fermentasi 6 Hari Hasil Samping Sistem MFC Molase setelah Destilasi dengan Alat GC-MS



**Lampiran 33.** Data Pengukuran Larutan Standar Bioetanol menggunakan Refraktometer

No	Konsentrasi Bioetanol (% v/v)	Indeks Bias
1	5	1,3329
2	10	1,3368
3	20	1,3424
4	40	1,3537



**Lampiran 34.** Data Perhitungan Konsentrasi Bioetanol (%) Hasil Samping Sistem MFC *G. verrucosa* dan Molase setelah Destilasi menggunakan Refraktometer

No	Indeks Bias	
	<i>G. verrucosa</i>	Molase
1	1,3373	1,3470

Perhitungan konsentrasi bioetanol dapat ditentukan sebagai berikut:

$$y = 0,00058x + 1,33050$$

$$x = \frac{y-1,33050}{0,00058}$$

Keterangan:

y = Absorbansi

x = Konsentrasi Bioetanol

1) Konsentrasi Bioetanol pada *G. verrucosa*

$$\begin{aligned} \text{(Bioetanol)} &= \frac{y-1,33050}{0,00058} \\ &= \frac{1,3373-1,33050}{0,00058} \\ &= \frac{0,0068}{0,00058} \\ &= 11,72 \% \end{aligned}$$

2) Konsentrasi Bioetanol pada Molase

$$\begin{aligned} \text{(Bioetanol)} &= \frac{y-1,33050}{0,00058} \\ &= \frac{1,3470-1,33050}{0,00058} \\ &= \frac{0,0165}{0,00058} \\ &= 28,44 \% \end{aligned}$$

**Lampiran 35. Dokumentasi**