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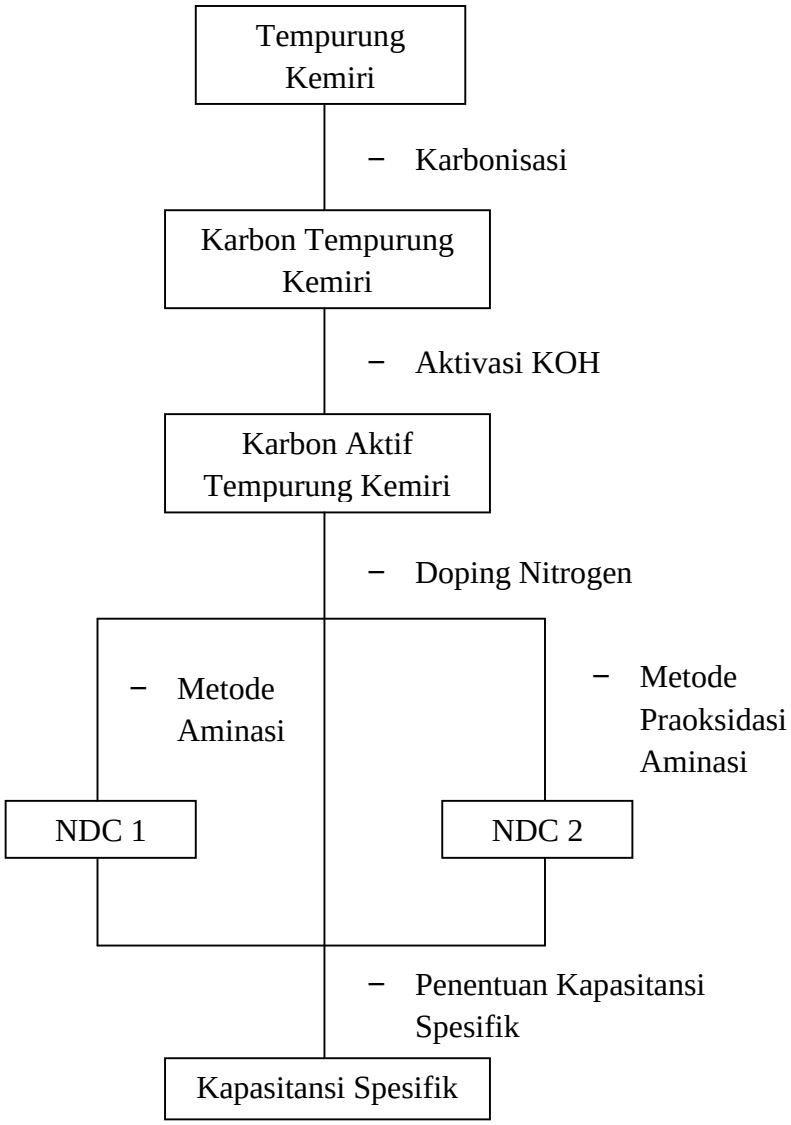
Lampiran 1. Diagram Alir Penelitian



Lampiran 2. Skema Kerja Preparasi Sampel, Karbonisasi dan Aktivasi

a. Preparasi Sampel

Tempurung Kemiri

- dicuci sampai bersih
- dikeringkan di bawah sinar matahari

Tempurung kemiri bersih dan kering

b. Karbonisasi

TK bersih dan kering

- dipanaskan di dalam tanur pada suhu 600 ºC selama 2 jam
- didinginkan lalu digerus
- diayak dengan ayakan ukuran 100 mesh

KTK

c. Aktivasi

KTK

- ditambahkan larutan KOH 10% dengan perbandingan 1:10 (g/mL)
- diaduk dengan menggunakan *magnetic stirrer hotplate* selama 2 jam pada suhu 80 ºC
- disaring menggunakan corong Buchner lalu dicuci dengan HCl 0,1 M dan kemudian akuades hingga pH netral
- dikeringkan selama 24 jam pada suhu 110 ºC
- dipanaskan dalam tanur selama 45 menit pada suhu 800 ºC
- didinginkan dalam desikator

K

Lampiran 3. Skema Kerja Sintesis NDC

a) Metode Aminasi

KATK

- ditambahkan larutan NH_4OH 25% dengan perbandingan 1:10 (g/mL)
- didiamkan selama 48 jam
- disaring menggunakan corong Buchner
- dicuci dengan akuades secara hingga pH netral
- dikeringkan dalam oven selama 24 jam pada suhu 110 ºC

NDC 1

b) Metode Praoksidasi Aminasi

KATK

- ditambahkan larutan HNO_3 6 N dengan perbandingan 1:10 (g/mL)
- diaduk dengan menggunakan *magnetic stirrer hotplate* selama 8 jam pada suhu 80 ºC
- disaring menggunakan corong Buchner
- dicuci dengan akuades hingga pH netral
- dikeringkan dalam oven selama 2 jam pada suhu 110 ºC
- dilanjutkan dengan metode aminasi

NDC 2

Lampiran 4. Skema Kerja Pembuatan Elektroda dan Karakterisasi Material

a. Pembuatan Elektroda

KATK

- dicampur dengan lilin paraffin dengan perbandingan 1:1
- dipanaskan di atas *hotplate* lalu diaduk hingga homogeny
- dicetak ke dalam badan elektroda

Elektroda pasta karbon

Catatan: diulangi prosedur yang sama untuk sampel NDC 1 dan NDC 2.

b. Karakterisasi Material

1) Penentuan Kadar Air

Tempurung Kemiri

- ditimbang sebanyak 0,5 gram pada cawan petri yang telah diketahui beratnya
- dikeringkan dalam oven pada suhu 105 ºC selama 3 jam
- didinginkan dalam desikator lalu ditimbang
- dimasukkan kembali ke dalam oven selama 30 menit dan dinginkan kembali dalam desikator
- diulangi sampai bobotnya tetap

Data

Catatan: diulangi prosedur yang sama untuk sampel KTK, KATK, NDC 1 dan NDC 2.

2) Penentuan Kadar Abu

Tempurung Kemiri

- ditimbang sebanyak 0,5 gram pada cawan porselin yang telah diketahui beratnya
- dipanaskan dalam tanur pada suhu 600 ºC selama 6 jam
- didinginkan dalam desikator lalu ditimbang
- dimasukkan kembali ke dalam tanur selama 30 menit dan dinginkan kembali dalam desikator
- diulangi sampai bobotnya tetap

Data

Catatan: diulangi prosedur yang sama untuk sampel KTK, KATK, NDC 1 dan NDC 2.

3) Penentuan Kadar Senyawa Volatil

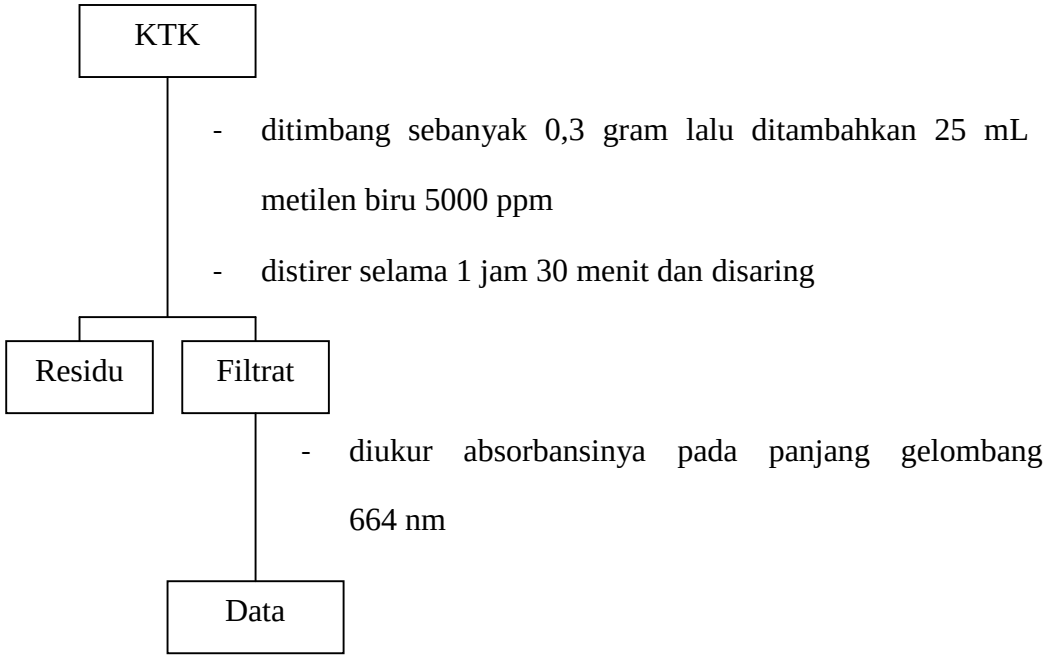
Tempurung Kemiri

- ditimbang sebanyak 0,5 gram pada cawan porselin yang telah diketahui beratnya
- dipanaskan dalam tanur pada suhu 800 ºC selama 7 menit
- didinginkan dalam desikator lalu ditimbang
- dimasukkan kembali ke dalam tanur selama 5 menit dan dinginkan kembali dalam desikator
- diulangi sampai bobotnya tetap

Data

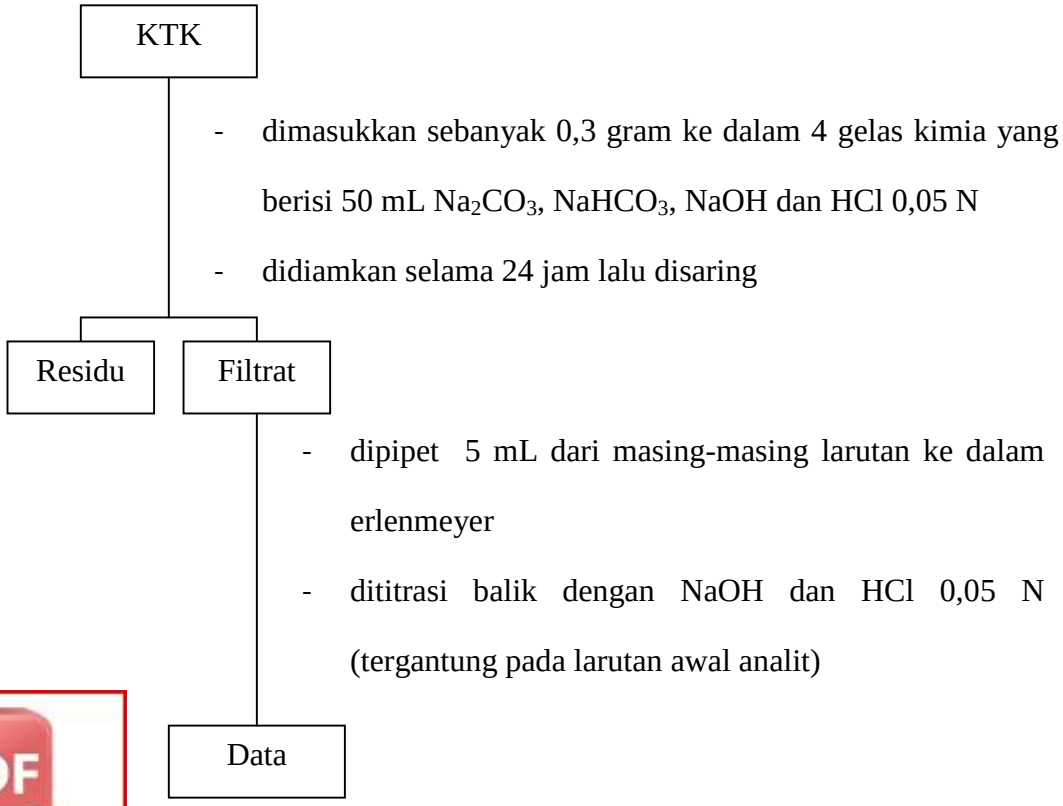
diulangi prosedur yang sama untuk sampel KTK, KATK, NDC 1 dan NDC 2.

4) Penentuan Luas Permukaan



Catatan: diulangi prosedur yang sama untuk sampel KATK, NDC 1 dan NDC 2.

5) Penentuan Gugus Fungsi dengan Titrasi Boehm



diulangi prosedur yang sama untuk sampel KATK, NDC 1 dan NDC 2.

6) Penentuan Kadar N dengan Titrasi Asidimetri

Filtrat hasil sintesis NDC

- dipipet sebanyak 1 mL lalu diencerkan hingga 250 mL
- dipipet sebanyak 25 mL ke dalam erlenmeyer dan ditambahkan indikator PP
- dititrasi dengan HCl 0,1 M dan dicatat volume HCl yang digunakan saat titik ekuivalen.
- mmol NH_4OH sebagai N yang terdeposisi pada permukaan karbon aktif adalah selisih antara NH_4OH awal dan NH_4OH sisa.

Data

7) Penentuan Gugus Fungsi dengan FTIR

Sampel

- dicampur dengan KBr
- dicetak menjadi cakram tipis/pelet
- dianalisis

Data

8) Penentuan Kapasitansi Spesifik

Elektroda pasta karbon | Elektroda Ag/AgCl | Elektroda Pt

- dihubungkan dengan alat potensiostat
- dilakukan pengujian dengan laju scan 25, 50 dan 100 mV/s menggunakan larutan elektrolit KOH 1 M

Data

Lampiran 5. Dokumentasi Kegiatan Penelitian

Sampel tempurung kemiri.

Karbon tempurung kemiri.

KTK ukuran 100 mesh.

Proses aktivasi KTK.

ses penyaringan KATK.

KATK yang telah dipanaskan dalam tanur.

Proses penyaringan NDC 1.

Proses pembuatan NDC 2.

Filtrat hasil penyaringan NDC.

NDC 1 dan NDC 2.

Larutan standar metilen biru.

Hasil karakterisasi dengan metilen biru.

Proses penentuan kadar air.

Proses penentuan kadar abu.

Hasil titrasi Boehm asam total.

Hasil titrasi Boehm basa total.

Elektroda pasta karbon.

Proses pengukuran kapasitansi spesifik menggunakan alat Potensiostat.

Lampiran 6. Perhitungan Pembuatan Larutan Pereaksi

a) Pembuatan Larutan Na_2CO_3 0,05 N

gram = L × N × BE

gram = 0,25 L × 0,05 N × 106 g/eq

gram = 1,3250 gram

b) Pembuatan Larutan $NaHCO_3$ 0,05 N

gram = L × N × BE

gram = 0,25 L × 0,05 N × 106 g/eq

gram = 1,0500 gram

c) Pembuatan Larutan NaOH 0,05 N

gram = L × N × BE

gram = 0,25 L × 0,05 N × 40 g/eq

gram = 0,5000 gram

d) Pembuatan Larutan HCl 0,05 N

$$N = \frac{\% \times bj \times 10}{BE}$$

$$N = \frac{37 \times 1{,}19 \text{ g/mL} \times 10}{36{,}5 \text{ g/eq}}$$

$$N = 12{,}06 \text{ N}$$

$V_1 \times N_1 = V_2 \times N_2$

$V_1 \times 12{,}06 \text{ N} = 250 \text{ mL} \times 0{,}05 \text{ N}$

$V_1 = 1{,}03 \text{ mL}$

e) Pembuatan Larutan $Na_2B_4O_7$ 0,05 N

gram = L × N × BE

gram = 0,1 L × 0,05 N × 190,6 g/eq

gram = 0,9530 gram

f) Pembuatan Larutan $H_2C_2O_4$ 0,05 N

gram = L × N × BE

gram = 0,1 L × 0,05 N × 63 g/eq

gram = 0,3150 gram

g) Pembuatan Larutan NH_4OH 5%, 10% dan 15%

$V_1 \times C_1 = V_2 \times C_2$

$V_1 \times 25\% = 50\ mL \times 5\%$

$V_1 = 10\ mL$

$V_1 \times C_1 = V_2 \times C_2$

$V_1 \times 25\% = 50\ mL \times 10\%$

$V_1 = 20\ mL$

$V_1 \times C_1 = V_2 \times C_2$

$V_1 \times 25\% = 50\ mL \times 15\%$

$V_1 = 30\ mL$

h) Pembuatan Larutan KOH 1 M

gram = L × M × BM

= 0,1 L × 1 M × 56 g/mol

= 5,6000 gram

i) Pembuatan Larutan Metilen Biru 5000 ppm

mg metilen biru = ppm x L

mg metilen biru = 500 ppm x 0,25 L

mg metilen biru = 1,25 g

j) Pembuatan Larutan Metilen Biru 50 ppm

$V_1 \times C_1 = V_2 \times C_2$

$V_1 \times 500 \text{ ppm} = 50 \text{ mL} \times 50 \text{ ppm}$

$V_1 = 1{,}03 \text{ mL}$

k) Pembuatan Larutan Standar Metilen Biru 0,5; 1; 2; 4 dan 8 ppm

$V_1 \times C_1 = V_2 \times C_2$

$V_1 \times 50 \text{ ppm} = 25 \text{ mL} \times 0{,}5 \text{ ppm}$

$V_1 = 0{,}25 \text{ mL}$

$V_1 \times C_1 = V_2 \times C_2$

$V_1 \times 50 \text{ ppm} = 25 \text{ mL} \times 1 \text{ ppm}$

$V_1 = 0{,}5 \text{ mL}$

$V_1 \times C_1 = V_2 \times C_2$

$V_1 \times 50 \text{ ppm} = 25 \text{ mL} \times 2 \text{ ppm}$

$V_1 = 1 \text{ mL}$

$V_1 \times C_1 = V_2 \times C_2$

$V_1 \times 50 \text{ ppm} = 25 \text{ mL} \times 4 \text{ ppm}$

$V_1 = 2 \text{ mL}$

$\times C_1 = V_2 \times C_2$

$\times 50 \text{ ppm} = 25 \text{ mL} \times 8 \text{ ppm}$

$V_1 = 4 \text{ mL}$

Lampiran 7. Hasil Analisis Proksimat

A. Penentuan Kadar Air

1) Tempurung Kemiri

No.	Bobot Kosong Cawan (A)	Bobot Cawan + Sampel (B)	Bobot I	Bobot II	Bobot III	Bobot Rata-rata (C)	Bobot Akhir Sampel (B-C)	Bobot Awal Sampel (B-A)	Kadar Air (%)
1.	46,6336	47,2386	47,2165	47,2147	47,2141	47,2151	0,0235	0,6050	3,88
2.	45,7371	46,2374	46,2205	46,2077	46,2229	46,2170	0,0204	0,5003	4,07
3.	45,2477	45,7479	45,7296	45,7286	45,7268	45,7283	0,0196	0,5002	3,91
Rata-rata									3,96

$$\text{Kadar air (\%)} = \frac{\text{B-C}}{\text{B-A}} \times 100\ \% = \frac{0{,}0235}{0{,}6050} \times 100\ \% = 3{,}88\%$$

2) Karbon Tempurung Kemiri

No.	Bobot Kosong Cawan (A)	Bobot Cawan + Sampel (B)	Bobot I	Bobot II	Bobot III	Bobot Rata-rata (C)	Bobot Akhir Sampel (B-C)	Bobot Awal Sampel (B-A)	Kadar Air (%)
	44,3417	44,8417	44,8337	44,8247	44,8221	44,8268	0,0149	0,5000	2,97
	42,7444	43,2446	43,2302	43,2295	43,2295	43,2297	0,0149	0,5002	2,97
	45,7466	46,2469	46,2335	46,2332	46,2315	46,2327	0,0142	0,5003	2,83
Rata-rata									2,93

$$\text{Kadar air (\%)} = \frac{\text{B-C}}{\text{B-A}} \times 100\ \% = \frac{0{,}0149}{0{,}5000} \times 100\ \% = 2{,}97\%$$

3) Karbon Aktif Tempurung Kemiri

No.	Bobot Kosong Cawan (A)	Bobot Cawan + Sampel (B)	Bobot I	Bobot II	Bobot III	Bobot Rata-rata (C)	Bobot Akhir Sampel (B-C)	Bobot Awal Sampel (B-A)	Kadar Air (%)
1.	43,5452	44,0458	44,0370	44,0360	44,0350	44,0360	0,0098	0,5006	1,96
2.	35,4869	35,9987	35,9922	35,9922	35,9902	35,9915	0,0072	0,5118	1,40
3.	44,3415	44,8424	44,8335	44,8322	44,8321	44,8326	0,0098	0,5009	1,96
Rata-rata									1,77

$$\text{Kadar air (\%)} = \frac{\text{B-C}}{\text{B-A}} \times 100\ \% = \frac{0{,}0098}{0{,}5006} \times 100\ \% = 1{,}96\%$$

4) NDC 1

No.	Bobot Kosong Cawan (A)	Bobot Cawan + Sampel (B)	Bobot I	Bobot II	Bobot III	Bobot Rata-rata (C)	Bobot Akhir Sampel (B-C)	Bobot Awal Sampel (B-A)	Kadar Air (%)
1.	42,7438	42,8439	42,8428	42,8426	42,8404	42,8419	0,0020	0,1001	1,96
	46,6602	46,7606	46,7589	46,7582	46,7581	46,7584	0,0022	0,1004	2,19
	43,5781	43,6793	43,6778	43,6774	43,6771	43,6774	0,0019	0,1012	1,84
Rata-rata									2,00

Kadar air (%) = $\frac{\text{B-C}}{\text{B-A}}$ x 100 % = $\frac{0,0020}{0,1001}$ x 100 % = 1,96%

5) NDC 2

No.	Bobot Kosong Cawan (A)	Bobot Cawan + Sampel (B)	Bobot I	Bobot II	Bobot III	Bobot Rata-rata (C)	Bobot Akhir Sampel (B-C)	Bobot Awal Sampel (B-A)	Kadar Air (%)
1.	49,9681	50,0710	50,0708	50,0703	50,0687	50,0699	0,0011	0,1029	1,04
2.	34,8975	34,9990	34,9988	34,9985	34,9977	34,9983	0,0007	0,1015	0,66
3.	44,3395	44,4427	44,4426	44,4417	44,4412	44,4418	0,0009	0,1032	0,84
Rata-rata									0,84

Kadar air (%) = $\frac{\text{B-C}}{\text{B-A}}$ x 100 % = $\frac{0,0011}{0,1029}$ x 100 % = 1,04%

B. Penentuan Kadar Abu

1) Tempurung Kemiri

No.	Bobot Kosong Cawan (A)	Bobot Cawan + Sampel (B)	Bobot I	Bobot II	Bobot III	Bobot Rata-rata (C)	Bobot Abu (C-A)	Bobot Awal Sampel (B-A)	Kadar Abu (%)
	22,3061	22,8322	22,3389	22,3363	22,3349	22,3367	0,0306	0,5261	5,82
	21,1317	21,6364	21,1662	21,1645	21,1640	21,1649	0,0332	0,5047	6,58
	26,7030	27,2060	26,7386	26,7357	26,7335	26,7359	0,0329	0,5030	6,55
Rata-rata									6,31

Kadar abu (%) = $\frac{\text{C-A}}{\text{B-A}}$ x 100 % = $\frac{0{,}0306}{0{,}5261}$ x 100 % = 5,82%

2) Karbon Tempurung Kemiri

No.	Bobot Kosong Cawan (A)	Bobot Cawan + Sampel (B)	Bobot I	Bobot II	Bobot III	Bobot Rata-rata (C)	Bobot Abu (C-A)	Bobot Awal Sampel (B-A)	Kadar Abu (%)
1.	26,6982	27,1988	26,7518	26,7410	26,7404	26,7444	0,0462	0,5006	9,23
2.	21,1326	21,6429	21,1888	21,1789	21,1777	21,1818	0,0492	0,5103	9,64
3.	21,4555	21,9560	21,5092	21,5003	21,4999	21,5031	0,0476	0,5005	9,52
Rata-rata									9,46

Kadar abu (%) = $\frac{\text{C-A}}{\text{B-A}}$ x 100 % = $\frac{0{,}0462}{0{,}5006}$ x 100 % = 9,23%

3) Karbon Aktif Tempurung Kemiri

No.	Bobot Kosong Cawan (A)	Bobot Cawan + Sampel (B)	Bobot I	Bobot II	Bobot III	Bobot Rata-rata (C)	Bobot Abu (C-A)	Bobot Awal Sampel (B-A)	Kadar Abu (%)
1	21,4557	21,9558	21,5488	21,5458	21,5443	21,5463	0,0906	0,5001	18,12
	21,0699	21,5701	21,1624	21,1591	21,1572	21,1596	0,0897	0,5002	17,93
	21,1334	21,6345	21,2341	21,2303	21,2272	21,2305	0,0971	0,5011	19,38
Rata-rata									18,48

Kadar abu (%) = $\frac{\text{C-A}}{\text{B-A}}$ x 100 % = $\frac{0,0906}{0,5001}$ x 100 % = 18,12%

4) NDC 1

No.	Bobot Kosong Cawan (A)	Bobot Cawan + Sampel (B)	Bobot I	Bobot II	Bobot III	Bobot Rata-rata (C)	Bobot Abu (C-A)	Bobot Awal Sampel (B-A)	Kadar Abu (%)
1.	26,6738	26,7792	26,6887	26,6876	26,6866	26,6876	0,0138	0,1054	13,12
2.	26,0530	26,1561	26,0652	26,0667	26,0665	26,0661	0,0131	0,1031	12,74
3.	25,5052	25,6066	25,5184	25,5177	25,5174	25,5178	0,0126	0,1014	12,46
Rata-rata									12,77

Kadar abu (%) = $\frac{\text{C-A}}{\text{B-A}}$ x 100 % = $\frac{0,0138}{0,1054}$ x 100 % = 13,12%

5) NDC 2

No.	Bobot Kosong Cawan (A)	Bobot Cawan + Sampel (B)	Bobot I	Bobot II	Bobot III	Bobot Rata-rata (C)	Bobot Abu (C-A)	Bobot Awal Sampel (B-A)	Kadar Abu (%)
1.	26,0532	26,1536	26,0549	26,0543	26,0537	26,0543	0,0011	0,1004	1,10
[illegible]	25,5057	25,6077	25,5068	25,5067	25,5061	25,5065	0,0008	0,1020	0,82
[illegible]	25,4042	25,5049	25,4054	25,4053	25,4047	25,4051	0,0009	0,1007	0,93
Rata-rata									0,95

$$\text{Kadar abu (\%)} = \frac{\text{C-A}}{\text{B-A}} \times 100\ \% = \frac{0{,}0011}{0{,}1004} \times 100\ \% = 1{,}10\%$$

C. Penentuan Kadar Senyawa Volatil

1) Tempurung Kemiri

No.	Bobot Kosong Cawan (A)	Bobot Cawan + Sampel (B)	Bobot I	Bobot II	Bobot III	Bobot Rata-rata (C)	Bobot Volatil (C-A)	Bobot Awal Sampel (B-A)	Kadar Abu (%)
1.	22,3071	22,8098	22,4213	22,3538	22,3415	22,3722	0,0651	0,5027	12,95
2.	21,0691	21,5701	21,1688	21,1221	21,1118	21,1342	0,0651	0,5010	13,00
3.	22,3480	22,8497	22,4412	22,3977	22,3815	22,4068	0,0588	0,5017	11,72
Rata-rata									12,56

$$\text{Kadar volatil (\%)} = \frac{\text{C-A}}{\text{B-A}} \times 100\ \% = \frac{0{,}0651}{0{,}5027} \times 100\ \% = 12{,}95\%$$

2) Karbon Tempurung Kemiri

No.	Bobot Kosong Cawan (A)	Bobot Cawan + Sampel (B)	Bobot I	Bobot II	Bobot III	Bobot Rata-rata (C)	Bobot Volatil (C-A)	Bobot Awal Sampel (B-A)	Kadar Abu (%)
	22,3124	22,8140	22,5322	22,3938	22,3510	22,4257	0,1133	0,5016	22,58
	21,0678	21,5681	21,3068	21,1632	21,1048	21,1916	0,1238	0,5003	24,75
	21,1359	21,6367	21,3717	21,2226	21,1720	21,2554	0,1195	0,5008	23,87
Rata-rata									23,73

Kadar volatil (%) = $\frac{\text{C-A}}{\text{B-A}}$ x 100 % = $\frac{0{,}1133}{0{,}5016}$ x 100 % = 22,58%

3) Karbon Aktif Tempurung Kemiri

No.	Bobot Kosong Cawan (A)	Bobot Cawan + Sampel (B)	Bobot I	Bobot II	Bobot III	Bobot Rata-rata (C)	Bobot Volatil (C-A)	Bobot Awal Sampel (B-A)	Kadar Abu (%)
1.	31,4756	31,9759	31,6920	31,6371	31,6060	31,6450	0,1694	0,5003	33,87
2.	31,8404	32,3414	32,0371	31,9856	31,9603	31,9943	0,1539	0,5010	30,73
3.	32,3713	32,8721	32,5864	32,5313	32,5018	32,5398	0,1685	0,5008	33,65
Rata-rata									32,75

Kadar volatil (%) = $\frac{\text{C-A}}{\text{B-A}}$ x 100 % = $\frac{0{,}1694}{0{,}5003}$ x 100 % = 33,87%

4) NDC 1

No.	Bobot Kosong Cawan (A)	Bobot Cawan + Sampel (B)	Bobot I	Bobot II	Bobot III	Bobot Rata-rata (C)	Bobot Volatil (C-A)	Bobot Awal Sampel (B-A)	Kadar Abu (%)
1.	26,0526	26,1547	26,0632	26,0628	26,0628	26,0629	0,0103	0,1021	10,12
[illegible]	25,4036	25,5038	25,4141	25,4137	25,4136	25,4138	0,0102	0,1002	10,18
[illegible]	26,6736	26,7748	26,6846	26,6843	26,6842	26,6844	0,0108	0,1012	10,64
Rata-rata									10,31

Kadar volatil (%) = $\frac{\text{C-A}}{\text{B-A}}$ x 100 % = $\frac{0{,}0103}{0{,}1021}$ x 100 % = 10,12%

5) NDC 2

No.	Bobot Kosong Cawan (A)	Bobot Cawan + Sampel (B)	Bobot I	Bobot II	Bobot III	Bobot Rata-rata (C)	Bobot Volatil (C-A)	Bobot Awal Sampel (B-A)	Kadar Abu (%)
1.	25,4041	25,5049	25,4052	25,4050	25,4047	25,4050	0,0009	0,1008	0,86
2.	26,0533	26,1537	26,0545	26,0540	26,0538	26,0541	0,0008	0,1004	0,80
3.	25,5052	25,6063	25,5064	25,5058	25,5053	25,5058	0,0006	0,1011	0,63
Rata-rata									0,76

Kadar volatil (%) = $\frac{\text{C-A}}{\text{B-A}}$ x 100 % = $\frac{0{,}0009}{0{,}1008}$ x 100 % = 0,86%

D. Penentuan Kadar Karbon Tetap

No.	Sampel	Kadar Air	Kadar Abu	Kadar Senyawa Volatil	Kadar Karbon Tetap
1.	TK	3,96	6,31	12,56	77,17
2.	KTK	2,93	9,46	23,73	63,88
3.	KATK	1,77	18,48	32,75	47,00
4.	NDC21	2,00	12,77	10,31	74,91
	NDC 2	0,84	0,95	0,76	97,45

rbon tetap (%) = 100 % - (kadar air + kadar abu + kadar senyawa volatil)%

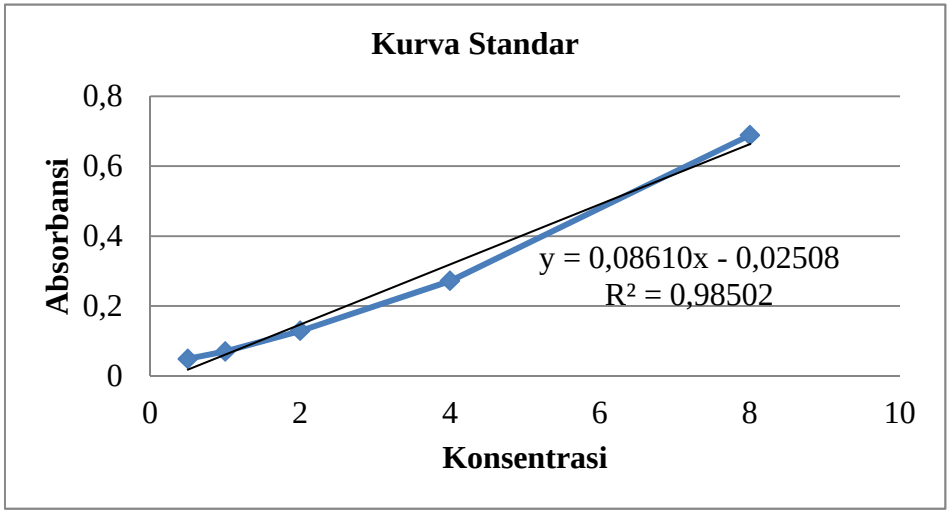
rbon tetap (%) = 100 % - (3,96 + 6,31 + 12,56)% = 77,17%

Lampiran 8. Hasil Analisis Luas Permukaan

Nilai absorbansi deret standar metilen biru

Konsentrasi (ppm)	Absorbansi
0,5	0,049
1	0,07
2	0,129
4	0,272
8	0,689

Kurva kalibrasi deret standar metilen biru



Konsentrasi metilen biru (C_0)

y = 0,08610x - 0,02508

1,62 = 0,08610x - 0,02508

6550

1) Karbon Tempurung Kemiri

No.	Absorbansi	Pengenceran	C_e (mg/L)	C_o (mg/L)	Volume (L)	Massa (g)	Xm (mg/g)	S (m^2/g)
1.	1,74	100	2050,0348	4776,6550	0,0250	0,4007	170,1161	629,4772
2.	1,74	100	2050,0348	4776,6550	0,0250	0,3004	226,9158	839,6522
3.	1,74	100	2050,0348	4776,6550	0.,0250	0,3223	211,4971	782,5985
Rata-rata								750,5760

$$X_m = \frac{(C_o - C_e) \text{ x volume larutan}}{\text{massa karbon aktif}} = \frac{(4776,6550-2050,0348) \text{ x } 0,0250}{0,4007} = 170,1161 \text{ mg/g}$$

$$S = \frac{X_m \,.\, N \,.\, a}{Mr} = \frac{170,1161 \text{ mg/g x } (6,02 \text{ x } 10^{23} \text{ mol}^{-1}) \text{ x } (197 \text{ x } 10^{-20} \text{ m}^2)}{320,5 \text{ g/mol}} = 629,4772 \text{ m}^2/\text{g}$$

2) Karbon Aktif Tempurung Kemiri

No.	Absorbansi	Pengenceran	C_e (mg/L)	C_o (mg/L)	Volume (L)	Massa (g)	Xm (mg/g)	S (m^2/g)
1.	1,74	100	2050,0348	4776,6550	0,0250	0,3000	227,2183	840,7717
2.	1,74	100	2050,0348	4776,6550	0,0250	0,3005	226,8403	839,3727
Rata-rata								840,0722

$$X_m = \frac{(C_o - C_e) \text{ x volume larutan}}{\text{massa karbon aktif}} = \frac{(4776,6550-2050,0348) \text{ x } 0,0250}{0,3000} = 227,2183 \text{ mg/g}$$

$$\frac{N \,.\, a}{Mr} = \frac{227,2183 \text{ mg/g x } (6,02 \text{ x } 10^{23} \text{ mol}^{-1}) \text{ x } (197 \text{ x } 10^{-20} \text{ m}^2)}{320,5 \text{ g/mol}} = 840,7717 \text{ m}^2/\text{g}$$

3) NDC 1

No.	Absorbansi	Pengenceran	C_e (mg/L)	C_o (mg/L)	Volume (L)	Massa (g)	Xm (mg/g)	S (m^2/g)
1.	1,76	100	2073,2636	4776,6550	0,0250	0,3005	224,9078	832,2219
2.	1,74	100	2050,0348	4776,6550	0,0250	0,3201	212,9507	787,9772
Rata-rata								810,0996

$$X_m = \frac{(C_o - C_e) \text{ x volume larutan}}{\text{massa karbon aktif}} = \frac{(4776,6550-2073,2636) \text{ x } 0,0250}{0,3005} = 224,9078 \text{ mg/g}$$

$$S = \frac{X_m \,.\, N \,.\, a}{Mr} = \frac{224,9078 \text{ mg/g x } (6,02 \text{ x } 10^{23} \text{ mol}^{-1}) \text{ x } (197 \text{ x } 10^{-20} \text{ m}^2)}{320,5 \text{ g/mol}} = 832,2219 \text{ m}^2/\text{g}$$

4) NDC 2

No.	Absorbansi	Pengenceran	C_e (mg/L)	C_o (mg/L)	Volume (L)	Massa (g)	Xm (mg/g)	S (m^2/g)
1.	1,74	100	2050,0348	4776,6550	0,0250	0,3053	223,2738	826,1759
2.	1,74	100	2050,0348	4776,6550	0,0250	0,3021	225,6389	834,9272
Rata-rata								830,5516

$$X_m = \frac{(C_o - C_e) \text{ x volume larutan}}{\text{massa karbon aktif}} = \frac{(4776,6550-2050,0348) \text{ x } 0,0250}{0,3053} = 223,2738 \text{ mg/g}$$

$$\frac{N \,.\, a}{Mr} = \frac{223,2738 \text{ mg/g x } (6,02 \text{ x } 10^{23} \text{ mol}^{-1}) \text{ x } (197 \text{ x } 10^{-20} \text{ m}^2)}{320,5 \text{ g/mol}} = 826,1759 \text{ m}^2/\text{g}$$

Lampiran 9. Hasil Analisis Gugus Fungsi dengan Titrasi Boehm

A. Karbon Tempurung Kemiri

1) Kadar Karboksilat

No	V. Sampel (Vs) (mL)	V. Titran $NaHCO_3$ (Vp) (mL)	Normal $NaHCO_3$	Normal HCl	V. HCl (mL)	Normal NaOH	V. NaOH (mL)	Massa Karbon (g)	n Karboksilat (meq/g)
1.	25	5	0,0504	0,0516	10	0,0456	8,2	0,3018	1,8178
2.	25	5	0,0504	0,0516	10	0,0456	8,2	0,3018	1,8178
3.	25	5	0,0504	0,0516	10	0,0456	8,1	0,3018	1,7423
4.	25	5	0,0504	0,0516	10	0,0456	8,1	0,3018	1,7423
Rata - rata									1,7801

$$n_{karboksilat} = \frac{V_{NaHCO_3}N_{NaHCO_3} - (N_{HCl}V_{HCl} - N_{NaOH}V_{NaOH})]\frac{V_p}{V_s}}{w}$$

$$n_{karboksilat} = \frac{[5 \text{ x } 0{,}0504 - ((0{,}0516 \text{ x } 10) - (0{,}0456 \text{ x } 8{,}2))]\frac{25}{5}}{0{,}3018} = 1{,}8178 \text{ meq/g}$$

2) Kadar Lakton

No	V. Sampel (Vs) (mL)	V. Titran Na_2CO_3 (Vp) (mL)	Normal Na_2CO_3	Normal HCl	V. HCl (mL)	Normal NaOH	V. NaOH (mL)	Massa Karbon (g)	n Lakton (meq/g)
1.	25	5	0,0501	0,0516	10	0,0456	4,4	0,3012	-2.8884
2.	25	5	0,0501	0,0516	10	0,0456	4,4	0,3012	-2.8884
3.	25	5	0,0501	0,0516	10	0,0456	4,4	0,3012	-2.8129
4.	25	5	0,0501	0,0516	10	0,0456	4,4	0,3012	-2.8129
Rata - rata									-2,8507

$$n_{lakton} = \frac{\left[V_{Na_2CO_3} N_{Na_2CO_3} - (N_{HCl} V_{HCl} - N_{NaOH} V_{NaOH})\right] \frac{V_p}{V_s}}{w} - n_{karboksilat}$$

$$n_{lakton} = \frac{[5 \text{ x } 0{,}0501 - ((0{,}0516 \text{ x } 10) - (0{,}0456 \text{ x } 4{,}4))] \frac{25}{5}}{0{,}3012} - 1{,}8178 = \text{-2,8884 meq/g}$$

3) Kadar Fenol

No	V. Sampel (Vs) (mL)	V. Titran NaOH (Vp) (mL)	Normal NaOH	Normal HCl	V. HCl (mL)	Normal NaOH	V. NaOH (mL)	Massa Karbon (g)	n Fenol (meq/g)
1	25	5	0,0456	0,0516	10	0,0456	8,0	0,3010	2,3448
	25	5	0,0456	0,0516	10	0,0456	8,0	0,3010	2,3448
	25	5	0,0456	0,0516	10	0,0456	8,0	0,3010	2,3448
	25	5	0,0456	0,0516	10	0,0456	7,9	0,3010	2,2691
Rata - rata									2,3259

$$n_{fenol} = \frac{[V_{NaOH}N_{NaOH} - (N_{HCl}V_{HCl} - N_{NaOH}V_{NaOH})]\frac{V_p}{V_s}}{w} - n_{karboksilat} - n_{lakton}$$

$$n_{fenol} = \frac{[5 \times 0{,}0456 - ((0{,}0516 \times 10) - (0{,}0456 \times 8{,}0))]\frac{25}{5}}{0{,}3012} - 1{,}8178 - (-2{,}8884) = 2{,}3448 \text{ meq/g}$$

4) Kadar Basa Total

No	V. Sampel (Vs) (mL)	V. Titran HCl (Vp) (mL)	Normal HCl	Normal NaOH	V. NaOH (mL)	Normal HCl	V. HCl (mL)	Massa Karbon (g)	n basa total (meq/g)
1.	25	5	0,0516	0,0456	10	0,0516	4,4	0,3067	0,4737
2.	25	5	0,0516	0,0456	10	0,0516	4,5	0,3067	0,5578
3.	25	5	0,0516	0,0456	10	0,0516	4,4	0,3067	0,4737
4.	25	5	0,0516	0,0456	10	0,0516	4,5	0,3067	0,5578
Rata - rata									0,5158

$$n_{basa\ total} = \frac{[V_{HCl}N_{HCl} - (N_{NaOH}V_{NaOH} - N_{HCl}V_{HCl})]\frac{V_p}{V_s}}{w}$$

$$n_{basa\ total} = \frac{[5 \times 0{,}0516 - ((0{,}0456 \times 10) - (0{,}0516 \times 4{,}4))]\frac{25}{5}}{0{,}3067} = 0{,}4737 \text{ meq/g}$$

B. Karbon Aktif Tempurung Kemiri

1) Kadar Karboksilat

No	V. Sampel (Vs) (mL)	V. Titran $NaHCO_3$ (Vp) (mL)	Normal $NaHCO_3$	Normal HCl	V. HCl (mL)	Normal NaOH	V. NaOH (mL)	Massa Karbon (g)	n Karboksilat (meq/g)
1.	25	5	0,0501	0,0532	10	0,0458	7,8	0,2006	1,8878
2.	25	5	0,0501	0,0532	10	0,0458	7,8	0,2006	1,8878
3.	25	5	0,0501	0,0532	10	0,0458	7,9	0,2006	2,0020
4.	25	5	0,0501	0,0532	10	0,0458	7,8	0,2006	1,8878
Rata - rata									1,9164

$$n_{karboksilat} = \frac{V_{NaHCO_3}N_{NaHCO_3} - (N_{HCl}V_{HCl} - N_{NaOH}V_{NaOH})]\frac{V_p}{V_s}}{w}$$

$$n_{karboksilat} = \frac{[5 \text{ x } 0{,}0501 - ((0{,}0532 \text{ x } 10) - (0{,}0458 \text{ x } 7{,}8))]\frac{25}{5}}{0{,}2006} = 1{,}8878 \text{ meq/g}$$

2) Kadar Lakton

No	V. Sampel (Vs) (mL)	V. Titran Na_2CO_3 (Vp) (mL)	Normal Na_2CO_3	Normal HCl	V. HCl (mL)	Normal NaOH	V. NaOH (mL)	Massa Karbon (g)	n Lakton (meq/g)
1.	25	5	0,05	0,0532	10	0,0458	4	0,2013	-4,3419
2.	25	5	0,05	0,0532	10	0,0458	4,1	0,2013	-4,2281
3.	25	5	0,05	0,0532	10	0,0458	4,1	0,2013	-4,3423
4.	25	5	0,05	0,0532	10	0,0458	4	0,2013	-4,3419
Rata - rata									-4,3135

$$n_{lakton} = \frac{\left[V_{Na_2CO_3} N_{Na_2CO_3} - (N_{HCl} V_{HCl} - N_{NaOH} V_{NaOH})\right] \frac{V_p}{V_s}}{w} - n_{karboksilat}$$

$$n_{lakton} = \frac{[5 \times 0{,}05 - ((0{,}0532 \times 10) - (0{,}0458 \times 4))] \frac{25}{5}}{0{,}2013} - 1{,}8878 = -4{,}3419 \text{ meq/g}$$

3) Kadar Fenol

No	V. Sampel (Vs) (mL)	V. Titran NaOH (Vp) (mL)	Normal NaOH	Normal HCl	V. HCl (mL)	Normal NaOH	V. NaOH (mL)	Massa Karbon (g)	n Fenol (meq/g)
1.	25	5	0,0458	0,0532	10	0,0458	6,9	0,2002	2,7792
2.	25	5	0,0458	0,0532	10	0,0458	6,9	0,2002	2,6655
3.	25	5	0,0458	0,0532	10	0,0458	6,9	0,2002	2,6655
4.	25	5	0,0458	0,0532	10	0,0458	6,9	0,2002	2,7792
Rata - rata									2,7223

$$n_{fenol} = \frac{[V_{NaOH}N_{NaOH} - (N_{HCl}V_{HCl} - N_{NaOH}V_{NaOH})]\frac{V_p}{V_s}}{w} - n_{karboksilat} - n_{lakton}$$

$$n_{fenol} = \frac{[5 \times 0{,}0458 - ((0{,}0532 \times 10) - (0{,}0458 \times 6{,}9))]\frac{25}{5}}{0{,}2002} - 1{,}8878 - (-4{,}3419) = 2{,}7792 \text{ meq/g}$$

4) Kadar Basa Total

No	V. Sampel (Vs) (mL)	V. Titran HCl (Vp) (mL)	Normal HCl	Normal NaOH	V. NaOH (mL)	Normal HCl	V. HCl (mL)	Massa Karbon (g)	n basa total (meq/g)
1.	25	5	0,0532	0,0458	10	0,0532	5,9	0,2038	2,9902
2.	25	5	0,0532	0,0458	10	0,0532	5,8	0,2038	2,8597
3.	25	5	0,0532	0,0458	10	0,0532	5,9	0,2038	2,9902
4.	25	5	0,0532	0,0458	10	0,0532	5,9	0,2038	2,9902
Rata - rata									2,9576

$$n_{basa\ total} = \frac{[V_{HCl}N_{HCl} - (N_{NaOH}V_{NaOH} - N_{HCl}V_{HCl})]\frac{V_p}{V_s}}{w}$$

$$n_{basa\ total} = \frac{[5 \times 0{,}0532 - ((0{,}0458 \times 10) - (0{,}0532 \times 5{,}9))]\frac{25}{5}}{0{,}2038} = 2{,}9902 \text{ meq/g}$$

C. NDC 1

1) Kadar Karboksilat

No	V. Sampel (Vs) (mL)	V. Titran $NaHCO_3$ (Vp) (mL)	Normal $NaHCO_3$	Normal HCl	V. HCl (mL)	Normal NaOH	V. NaOH (mL)	Massa Karbon (g)	n Karboksilat (meq/g)
1.	50	5	0,0501	0,0547	10	0,0528	7	0,3031	2,4117
2.	50	5	0,0501	0,0547	10	0,0528	6,5	0,3031	1,5407
3.	50	5	0,0501	0,0547	10	0,0528	6,3	0,3031	1,1923
4.	50	5	0,0501	0,0547	10	0,0528	6,5	0,3031	1,5407
Rata - rata									1,6714

$$n_{karboksilat} = \frac{V_{NaHCO_3}N_{NaHCO_3} - (N_{HCl}V_{HCl} - N_{NaOH}V_{NaOH})]\frac{V_p}{V_s}}{w}$$

$$n_{karboksilat} = \frac{[5 \text{ x } 0{,}0501 - ((0{,}0547 \text{ x } 10) - (0{,}0528 \text{ x } 7))]\frac{50}{5}}{0{,}3031} = 2{,}4117 \text{ meq/g}$$

2) Kadar Lakton

No	V. Sampel (Vs) (mL)	V. Titran Na_2CO_3 (Vp) (mL)	Normal Na_2CO_3	Normal HCl	V. HCl (mL)	Normal NaOH	V. NaOH (mL)	Massa Karbon (g)	n Lakton (meq/g)
1.	50	5	0,05	0,0547	15	0,0528	8,5	0,3022	-6,4389
2.	50	5	0,05	0,0547	15	0,0528	8,8	0,3022	-5,0437
3.	50	5	0,05	0,0547	15	0,0528	9	0,3022	-4,3459
4.	50	5	0,05	0,0547	15	0,0528	8,8	0,3022	-5,0437
Rata – rata									-5,2181

$$n_{lakton} = \frac{\left[V_{Na_2CO_3} N_{Na_2CO_3} - (N_{HCl} V_{HCl} - N_{NaOH} V_{NaOH})\right] \frac{V_p}{V_s}}{w} - n_{karboksilat}$$

$$n_{lakton} = \frac{[5 \times 0{,}05 - ((0{,}0547 \times 15) - (0{,}0528 \times 8{,}5))] \frac{50}{5}}{0{,}3022} - 2{,}4117 = -6{,}4389 \text{ meq/g}$$

3) Kadar Fenol

No	V. Sampel (Vs) (mL)	V. Titran NaOH (Vp) (mL)	Normal NaOH	Normal HCl	V. HCl (mL)	Normal NaOH	V. NaOH (mL)	Massa Karbon (g)	n Fenol (meq/g)
1	50	5	0,0528	0,0547	10	0,0528	5,2	0,3012	3,7469
	50	5	0,0528	0,0547	10	0,0528	5,4	0,3012	3,5734
	50	5	0,0528	0,0547	10	0,0528	5,5	0,3012	3,3992
	50	5	0,0528	0,0547	10	0,0528	5,4	0,3012	3,5734
Rata – rata									3,5732

$$n_{fenol} = \frac{[V_{NaOH}N_{NaOH} - (N_{HCl}V_{HCl} - N_{NaOH}V_{NaOH})]\frac{V_p}{V_s}}{w} - n_{karboksilat} - n_{lakton}$$

$$n_{fenol} = \frac{[5 \text{ x } 0{,}0528 - ((0{,}0547 \text{ x } 10) - (0{,}0528 \text{ x } 5{,}2))]\frac{50}{5}}{0{,}3012} - 2{,}4117 - (-6{,}4389) = 3{,}7469 \text{ meq/g}$$

4) Kadar Basa Total

No	V. Sampel (Vs) (mL)	V. Titran HCl (Vp) (mL)	Normal HCl	Normal NaOH	V. NaOH (mL)	Normal HCl	V. HCl (mL)	Massa Karbon (g)	n basa total (meq/g)
1.	50	5	0,0547	0,0528	10	0,0547	6,2	0,3007	2,8148
2.	50	5	0,0547	0,0528	10	0,0547	6,3	0,3007	2,9967
3.	50	5	0,0547	0,0528	10	0,0547	6,2	0,3007	2,8148
4.	50	5	0,0547	0,0528	10	0,0547	6,2	0,3007	2,8148
Rata – rata									2,8602

$$n_{basa\ total} = \frac{[V_{HCl}N_{HCl} - (N_{NaOH}V_{NaOH} - N_{HCl}V_{HCl})]\frac{V_p}{V_s}}{w}$$

$$= \frac{[5 \text{ x } 0{,}0547 - ((0{,}0528 \text{ x } 10) - (0{,}0547 \text{ x } 6{,}2))]\frac{50}{5}}{0{,}3007} = 2{,}8148 \text{ meq/g}$$

D. NDC 2

1) Kadar Karboksilat

No	V. Sampel (Vs) (mL)	V. Titran $NaHCO_3$ (Vp) (mL)	Normal $NaHCO_3$	Normal HCl	V. HCl (mL)	Normal NaOH	V. NaOH (mL)	Massa Karbon (g)	n Karboksilat (meq/g)
1.	50	5	0,0501	0,0528	10	0,0491	8,7	0,3031	4,9495
2.	50	5	0,0501	0,0528	10	0,0491	8,6	0,3031	4,7873
3.	50	5	0,0501	0,0528	10	0,0491	8,6	0,3031	4,7873
4.	50	5	0,0501	0,0528	10	0,0491	8,6	0,3031	4,7873
Rata – rata									4,8279

$$n_{karboksilat} = \frac{V_{NaHCO_3}N_{NaHCO_3} - (N_{HCl}V_{HCl} - N_{NaOH}V_{NaOH})]\frac{V_p}{V_s}}{w}$$

$$n_{karboksilat} = \frac{[5 \text{ x } 0{,}0501 - ((0{,}0528 \text{ x } 10) - (0{,}0419 \text{ x } 8{,}7))]\frac{50}{5}}{0{,}3031} = 4{,}9495 \text{ meq/g}$$

2) Kadar Lakton

No	V. Sampel (Vs) (mL)	V. Titran Na_2CO_3 (Vp) (mL)	Normal Na_2CO_3	Normal HCl	V. HCl (mL)	Normal NaOH	V. NaOH (mL)	Massa Karbon (g)	n Lakton (meq/g)
1.	50	5	0,0501	0,0528	15	0,0491	5,2	0,3081	-5,6561
2.	50	5	0,0501	0,0528	15	0,0491	5,2	0,3081	-5,4940
3.	50	5	0,0501	0,0528	15	0,0491	5,2	0,3081	-5,4940
Rata – rata									-5,5480

$$n_{lakton} = \frac{\left[V_{Na_2CO_3}N_{Na_2CO_3} - (N_{HCl}V_{HCl} - N_{NaOH}V_{NaOH})\right]\frac{V_p}{V_s}}{w} - n_{karboksilat}$$

$$n_{lakton} = \frac{[5 \times 0{,}0501 - ((0{,}0528 \times 15) - (0{,}0491 \times 5{,}2))]\frac{50}{5}}{0{,}3081} - 4{,}9495 = -5{,}6561 \text{ meq/g}$$

3) Kadar Fenol

No	V. Sampel (Vs) (mL)	V. Titran NaOH (Vp) (mL)	Normal NaOH	Normal HCl	V. HCl (mL)	Normal NaOH	V. NaOH (mL)	Massa Karbon (g)	n Fenol (meq/g)
1	50	5	0,0528	0,0528	10	0,0491	6,4	0,3010	2,3758
	50	5	0,0528	0,0528	10	0,0491	6,4	0,3010	2,3758
	50	5	0,0528	0,0528	10	0,0491	6,4	0,3010	2,3758
Rata – rata									2,3758

$$n_{fenol} = \frac{[V_{NaOH}N_{NaOH} - (N_{HCl}V_{HCl} - N_{NaOH}V_{NaOH})]\frac{V_p}{V_s}}{w} - n_{karboksilat} - n_{lakton}$$

$$n_{fenol} = \frac{[5 \times 0{,}0528 - ((0{,}0528 \times 10) - (0{,}0491 \times 6{,}4))]\frac{50}{5}}{0{,}3010} - 4{,}9495 - (-5{,}6561) = 2{,}3758 \text{ meq/g}$$

4) Kadar Basa Total

No	V. Sampel (Vs) (mL)	V. Titran HCl (Vp) (mL)	Normal HCl	Normal NaOH	V. NaOH (mL)	Normal HCl	V. HCl (mL)	Massa Karbon (g)	n basa total (meq/g)
1.	50	5	0,0528	0,0491	10	0,0528	4,1	0,3056	-0,3573
2.	50	5	0,0528	0,0491	10	0,0528	4,1	0,3056	-0,3573
3.	50	5	0,0528	0,0491	10	0,0528	4,1	0,3056	-0,3573
4.	50	5	0,0528	0,0491	10	0,0528	4,1	0,3056	-0,3573
Rata – rata									-0,3573

$$n_{basa\ total} = \frac{[V_{HCl}N_{HCl} - (N_{NaOH}V_{NaOH} - N_{HCl}V_{HCl})]\frac{V_p}{V_s}}{w}$$

$$= \frac{[5 \times 0{,}0528 - ((0{,}0491 \times 10) - (0{,}0528 \times 4{,}1))]\frac{50}{5}}{0{,}3056} = -0{,}3573 \text{ meq/g}$$

Lampiran 10. Hasil Analisis Kadar N yang Terdeposisi pada Permukaan KATK

A. Standarisasi NH_4OH dengan HCl 0,0532 N

No.	V NH_3 (mL)	V HCl (mL)
1.	5	3,5
2.	5	3,5
3.	5	3,4
Rata-rata	5	3,47

$$N_{NH_4OH} = \frac{V_{HCl} \times N_{HCl}}{V_{NH_3}} \times \frac{250\ mL}{1\ mL}$$

$$N_{NH_4OH} = \frac{3,47\ mL \times 0,0532\ N}{5\ mL} \times \frac{250\ mL}{1\ mL}$$

$$N_{NH_4OH} = 9,2302\ N$$

mmol NH_4OH awal = $N_{NH_4OH} \times V_{NH_4OH} \times$ Valensi

mmol NH_4OH awal = 9,2302 N x 5 mL x 1 = 46,1510 mmol

B. Penentuan kadar NH_4OH yang bereaksi dengan KATK

1) NDC 1

$$V_{HCl} = \frac{6,4\ mL + 6,4\ mL + 6,4\ mL + 6,5\ mL}{4} = 6,43\ mL$$

$$\text{mmol } NH_4OH \text{ sisa} = V_{HCl} \times N_{HCl} \times \frac{500\ mL}{110\ mL} \times \frac{100\ mL}{5\ mL}$$

$$\text{mmol } NH_4OH \text{ sisa} = 6,43\ mL \times 0,0532\ N \times \frac{500\ mL}{110\ mL} \times \frac{100\ mL}{5\ mL}$$

mmol NH_4OH sisa = 31,0978 mmol

mmol NH_4OH yang bereaksi = 46,1510 mmol – 31,0978 mmol = 15,0532 mmol

$$\frac{\text{mol } NH_4OH_{awal} - \text{mol } NH_4OH_{akhir}) \times Mr}{\text{massa karbon aktif}}$$

$$\% \text{ N} = \frac{15{,}0532 \text{ mmol x } 14\frac{\text{mg}}{\text{mmol}} \text{ x } 100\%}{10306{,}3 \text{ mg}} = 2{,}04\%$$

2) NDC 2

$$V_{HCl} = \frac{6 \text{ mL} + 6{,}1 \text{ mL} + 6 \text{ mL}}{3} = 6{,}03 \text{ mL}$$

$$\text{mmol } NH_4OH \text{ sisa} = V_{HCl} \text{ x } N_{HCl} \text{ x } \frac{500 \text{ mL}}{110 \text{ mL}} \text{ x } \frac{100 \text{ mL}}{5 \text{ mL}}$$

$$\text{mmol } NH_4OH \text{ sisa} = 6{,}03 \text{ mL x } 0{,}0532 \text{ N x } \frac{500 \text{ mL}}{110 \text{ mL}} \text{ x } \frac{100 \text{ mL}}{5 \text{ mL}}$$

mmol NH_4OH sisa = 29,1633 mmol

mmol NH_4OH yang bereaksi = 46,1510 mmol – 29,1633 mmol = 16,9877 mmol

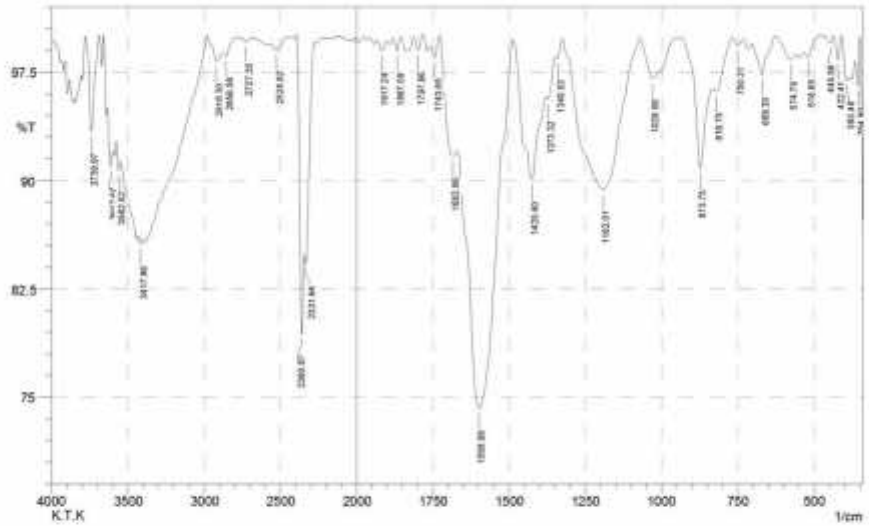
$$\% \text{ N} = \frac{16{,}9877 \text{ mmol x } 14\frac{\text{mg}}{\text{mmol}} \text{ x } 100\%}{10301{,}4 \text{ mg}} = 2{,}31\%$$

Lampiran 11. Hasil Analisis Kapasitansi Spesifik

Sampel	Laju Scan (V/s)	Ic (A)	I_d (A)	Massa Sampel	Kapasitansi Spesifik (F/g)
KATK	$2,5 \times 10^{-2}$	$8,94 \times 10^{-5}$	$-3,16 \times 10^{-5}$	0,0324	0,1494
	$5,0 \times 10^{-2}$	$1,04 \times 10^{-4}$	$-2,57 \times 10^{-5}$	0,0324	0,0801
	10×10^{-2}	$1,07 \times 10^{-4}$	$-3,65 \times 10^{-5}$	0,0324	0,0443
NDC 1	**$2,5 \times 10^{-2}$**	**$5,12 \times 10^{-3}$**	**$-4,87 \times 10^{-3}$**	**0,0310**	**12,8903**
	$5,0 \times 10^{-2}$	$5,12 \times 10^{-3}$	$-5,12 \times 10^{-3}$	0,0310	6,6065
	10×10^{-2}	$8,98 \times 10^{-3}$	$-9,16 \times 10^{-3}$	0,0310	5,8516
NDC 2	$2,5 \times 10^{-2}$	$1,95 \times 10^{-3}$	$-2,23 \times 10^{-3}$	0,0338	4,9467
	$5,0 \times 10^{-2}$	$2,01 \times 10^{-3}$	$-2,61 \times 10^{-3}$	0,0338	2,7337
	10×10^{-2}	$3,14 \times 10^{-3}$	$-1,97 \times 10^{-3}$	0,0338	1,5118

$$Cs = \frac{Ic - Id}{v \times m} = \frac{5,12 \times 10^{-3} - (-4,87 \times 10^{-3})}{2,5 \times 10^{-2} \times 0,0310} = 12,8903 \text{ F/g}$$

Lampiran 12. Hasil Analisis FTIR



No.	Peak	Intensity	Corr. Intensity	Base (H)	Base (L)	Area	Corr. Area
1	354.9	96.561	2.933	364.55	351.04	0.137	0.085
2	393.48	96.949	0.709	410.84	389.62	0.167	0.034
3	422.41	98.362	1.659	437.84	410.84	0.089	0.091
4	445.56	99.5	0.516	462.92	437.84	0.03	0.032
5	518.85	98.542	0.679	534.28	489.92	0.173	0.053
6	574.79	98.354	0.656	626.87	559.36	0.282	0.093
7	669.3	97.307	2.403	704.02	626.87	0.439	0.351
8	750.31	99.364	0.493	769.6	732.95	0.064	0.041
9	819.75	96.155	0.832	831.32	769.6	0.606	0.111
10	873.75	90.83	6.89	937.4	833.25	1.889	1.015
11	1028.06	97.041	2.828	1070.49	950.91	0.838	0.772
12	1192.01	89.388	10.458	1325.1	1072.42	7.007	6.837
13	1340.53	98.461	0.46	1346.31	1325.1	0.092	0.018
14	1373.32	95.639	0.624	1379.1	1346.31	0.451	0.042
15	1425.4	90.079	7.364	1485.19	1381.03	2.959	1.908
16	1598.99	74.224	20.716	1666.5	1487.12	13.344	10.052
17	1683.86	91.687	2.477	1726.29	1668.43	1.596	0.516
18	1743.65	98.516	1.149	1759.08	1728.22	0.119	0.074
19	1797.66	99.024	0.993	1811.16	1782.23	0.058	0.061
20	1867.09	98.988	0.91	1880.6	1855.52	0.059	0.047
21	1917.24	98.988	0.886	1932.67	1901.81	0.088	0.044
22	2331.94	84.241	2.887	2341.58	2277.93	2.391	0.302
23	2380.87	79.389	10.801	2393.66	2343.51	2.906	1.108
24	2524.82	99.053	0.864	2677.2	2449.6	0.482	0.401
25	2727.35	99.611	0.314	2769.07	2677.2	0.106	0.069
26	2856.58	98.607	0.475	2877.79	2789.07	0.288	0.045
27	2916.3	98.229	0.869	2949.16	2877.79	0.418	0.127
28	3417.86	85.605	0.453	3431.36	3402.43	1.922	0.033
29	3562.52	90.706	1.221	3576.02	3550.95	0.989	0.072
30	3612.67	90.982	2.294	3633.89	3597.24	1.323	0.239
31	3739.97	93.395	5.409	3778.55	3712.97	1.015	0.712

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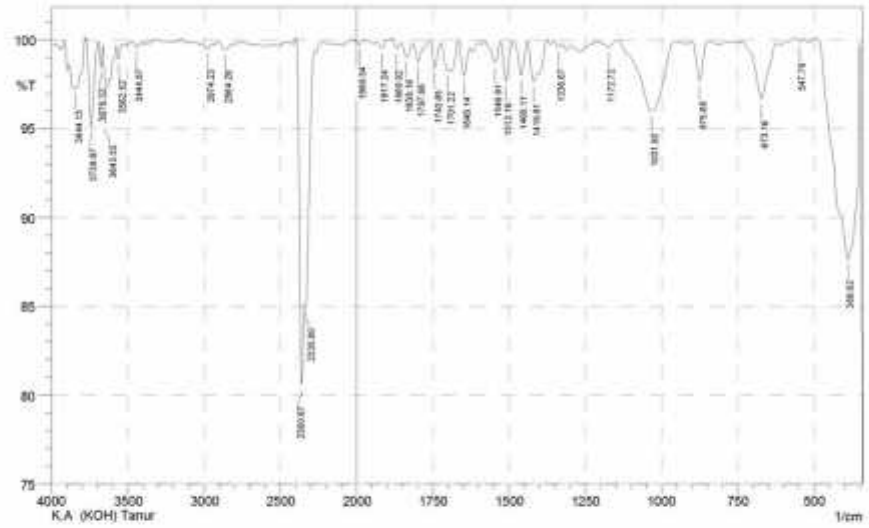

No.	Peak	Intensity	Corr. Intensity	Base (H)	Base (L)	Area	Corr. Area
1	389.62	87.644	12.318	491.85	351.04	4.632	4.628
2	547.78	99.91	0.181	561.29	536.21	-0.001	0.01
3	673.16	96.693	3.144	738.81	624.94	0.704	0.626
4	875.68	97.716	2.195	900.76	848.68	0.241	0.222
5	1031.92	95.997	3.974	1141.86	954.76	1.561	1.543
6	1172.72	99.585	0.391	1215.15	1141.86	0.062	0.062
7	1336.67	99.603	0.287	1354.03	1327.03	0.029	0.019
8	1419.61	97.667	2.335	1438.9	1375.25	0.39	0.393
9	1460.11	98.008	1.92	1483.26	1438.9	0.186	0.172
10	1512.19	97.672	2.21	1527.62	1483.26	0.206	0.183
11	1546.91	98.698	1.232	1577.77	1527.62	0.145	0.132
12	1649.14	97.987	1.803	1666.5	1629.85	0.177	0.141
13	1701.22	98.28	0.359	1724.36	1695.43	0.144	0.027
14	1743.65	98.405	1.534	1761.01	1724.36	0.122	0.111
15	1797.66	98.789	0.901	1815.02	1780.3	0.112	0.062
16	1838.16	99.032	0.791	1855.52	1815.02	0.103	0.071
17	1869.02	99.515	0.454	1884.45	1855.52	0.033	0.03
18	1917.24	99.525	0.431	1932.67	1901.81	0.035	0.029
19	1990.54	99.758	0.237	2005.97	1977.04	0.016	0.015
20	2335.8	84.965	0.958	2339.65	2276	2.147	0.149
21	2360.87	80.585	9.857	2395.59	2341.58	3.035	1.121
22	2864.29	99.464	0.02	2908.65	2862.36	0.066	0.006
23	2974.23	99.532	0.23	3022.45	2941.44	0.12	0.035
24	3444.87	99.549	0.276	3486.08	3427.51	0.051	0.023
25	3562.52	98.903	0.798	3577.95	3543.23	0.105	0.061
26	3643.53	95.307	3.368	3664.75	3624.25	0.5	0.272
27	3676.32	98.449	1.309	3695.61	3664.75	0.115	0.087
28	3739.97	95.113	4.934	3778.55	3697.54	0.766	0.78
29	3844.13	97.291	0.186	3853.77	3813.27	0.446	0.031

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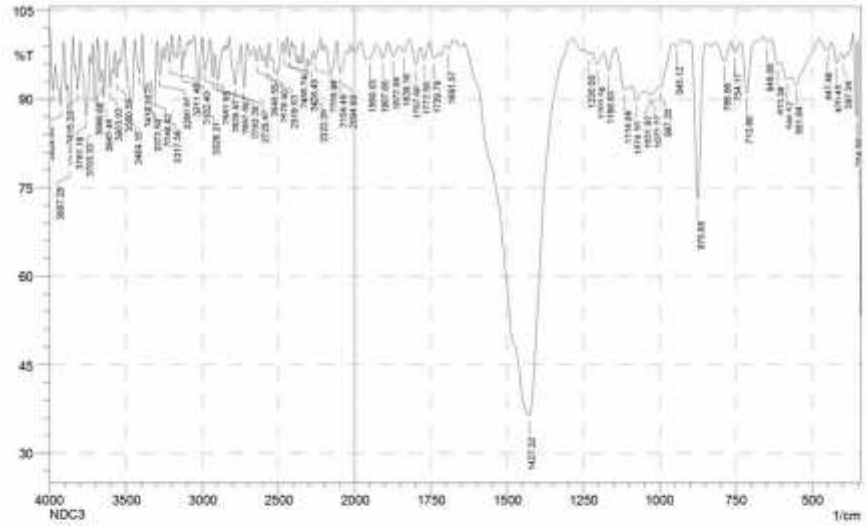

	Peak	Intensity	Corr. Intensity	Base (H)	Base (L)	Area	Corr. Area
1	354.9	86.8822	13.4448	366.48	351.04	0.3862	0.4271
2	397.34	96.727	0.9183	405.05	387.69	0.2115	0.0311
3	420.48	96.0789	2.5506	435.91	405.05	0.332	0.1465
4	447.49	96.2656	1.4678	478.35	435.91	0.1801	0.1618
5	551.64	92.4789	2.3225	567.07	478.35	1.6801	0.4767
6	580.57	93.3151	1.1913	603.72	569	0.9061	0.1095
7	613.36	95.807	1.5808	636.51	603.72	0.3505	0.0887
8	648.08	99.5804	0.7931	659.66	636.51	0.003	0.0385
9	713.66	90.8744	8.7982	734.88	682.8	0.8483	0.78
10	754.17	97.9138	1.7946	767.67	734.88	0.1722	0.1271
11	786.96	96.3813	3.3566	813.96	767.67	0.4283	0.3721
12	875.65	73.0072	26.5215	898.83	850.61	2.7416	2.6393
13	945.12	99.0109	0.5606	958.62	923.9	0.0984	0.0461
14	997.2	92.0082	0.7078	1001.06	958.62	0.8624	0.0773
15	1022.27	90.9049	0.1165	1024.2	1002.98	0.823	0.0093
16	1031.92	90.7194	0.301	1045.42	1026.13	0.7991	0.016
17	1074.35	89.6395	1.9938	1089.78	1060.85	1.2389	0.1408
18	1114.86	91.5721	1.407	1143.79	1109.07	0.9104	0.1386
19	1166.93	94.9044	3.2785	1184.29	1145.72	0.5492	0.2482
20	1203.58	95.8311	2.0874	1220.94	1184.29	0.5044	0.1691
21	1230.58	97.5872	0.4088	1246.02	1220.94	0.2344	0.0274
22	1427.32	36.4161	63.4737	1639.49	1284.59	55.2612	54.9905
23	1691.57	98.487	0.9424	1701.22	1676.14	0.1034	0.0532
24	1739.79	96.8586	1.9106	1757.15	1724.36	0.3192	0.1506
25	1772.58	96.6066	2.5821	1784.15	1757.15	0.2995	0.1732
26	1797.66	95.72	3.5573	1818.87	1784.15	0.3648	0.2795
27	1838.16	97.8662	1.677	1855.52	1818.87	0.1778	0.1096
28	1872.88	97.2926	2.0281	1890.24	1855.52	0.2819	0.1791
29	1907.6	96.8744	2.5884	1930.74	1890.24	0.3048	0.2039
30	1950.03	96.8002	0.6921	1955.82	1930.74	0.258	0.0472
31	2094.69	94.3552	4.9609	2115.91	2050.33	1.0414	0.7563
32	2154.49	94.4345	5.1062	2194.99	2117.84	1.1181	0.961
33	2258.64	96.7819	1.895	2272.15	2223.92	0.4121	0.2361

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34	2322.29	91.8055	6.3424	2337.72	2304.94	0.7258	0.435
35	2426.45	97.148	2.9016	2443.81	2412.95	0.1868	0.1982
36	2459.24	97.5612	2.4237	2472.74	2443.81	0.1469	0.148
37	2519.03	94.2363	1.1724	2540.25	2509.39	0.6747	0.0913
38	2576.9	95.2726	3.2431	2592.33	2561.47	0.4169	0.2158
39	2640.55	96.3249	2.4721	2659.84	2621.26	0.4148	0.212
40	2725.42	91.9122	7.3848	2744.71	2704.2	0.8361	0.7135
41	2783.26	92.3768	3.1772	2796.78	2765.92	0.8096	0.2187
42	2897.08	93.1563	4.7686	2916.37	2862.38	0.9932	0.5536
43	2929.87	93.5866	5.0577	2947.23	2916.37	0.4864	0.3346
44	2981.95	94.9494	5.3792	2999.31	2949.16	0.6313	0.67
45	3026.31	89.6473	10.8925	3051.38	3001.24	0.8885	1.1047
46	3132.4	94.8334	4.4445	3147.83	3118.9	0.3702	0.2894
47	3211.48	96.1855	3.9747	3228.91	3197.98	0.2372	0.2516
48	3280.92	94.1109	5.1658	3296.35	3257.77	0.5799	0.4383
49	3317.06	88.3911	7.5838	3334.92	3296.35	1.2924	0.6834
50	3348.42	91.0299	1.7756	3361.93	3336.85	0.9182	0.1051
51	3373.5	90.1876	5.1288	3392.79	3363.86	0.8282	0.3648
52	3410.15	94.461	5.9921	3441.01	3394.72	0.7041	0.7767
53	3484.15	88.0084	12.1893	3512.37	3442.94	2.0368	2.123
54	3560.59	93.4987	3.9345	3572.17	3549.02	0.4653	0.2037
55	3603.03	92.0803	4.6516	3628.1	3589.53	0.78	0.3219
56	3645.46	90.3138	6.3711	3665.11	3630.03	0.6712	0.3869
57	3668.68	92.9313	3.7307	3685.97	3657.04	0.5663	0.2491
58	3703.33	86.0249	13.5032	3716.83	3687.9	0.984	0.9333
59	3761.19	87.1703	10.9418	3797.84	3739.05	2.1347	1.7029
60	3815.2	91.6857	8.1054	3832.56	3799.77	0.7507	0.4265
61	3867.28	78.6528	17.3097	3884.64	3849.92	1.9671	1.4459
62	3929	88.881	5.3367	3938.64	3907.78	0.9514	0.3901
63	3979.15	91.5038	6.9881	4000.36	3963.72	0.6665	0.6686

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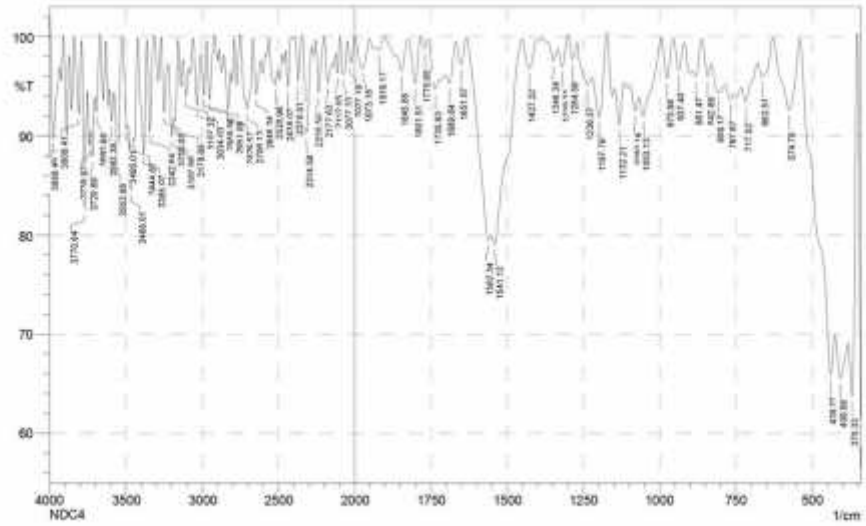
Resolution;
Apodization;
User; FTIR



	Peak	Intensity	Corr. Intensity	Base (H)	Base (L)	Area	Corr. Area
1	370.33	83.762502	17.7784	381.91	352.97	3.90198	1.749055
2	406.98	85.518923	4.0063	424.34	383.83	6.97824	0.565604
3	439.77	85.914899	7.423725	538.14	426.27	10.787289	1.79611
4	574.79	92.593355	7.235937	626.79	540.07	1.687174	1.626049
5	663.51	95.940109	2.18438	678.94	630.72	0.625346	0.335834
6	717.52	93.422053	2.17526	732.95	680.87	1.15175	0.256994
7	767.67	93.666231	0.840746	785.03	758.02	0.70817	0.05835
8	808.17	94.378092	1.774978	831.32	786.96	0.968458	0.211595
9	842.89	95.982936	2.297329	860.25	831.32	0.345761	0.159182
10	881.47	95.986014	1.664103	893.04	860.25	0.376135	0.106903
11	937.4	96.55021	3.053194	954.76	920.05	0.306301	0.248337
12	975.98	95.804532	4.116192	993.34	954.76	0.365647	0.35126
13	1053.13	91.954759	3.095306	1066.64	995.27	1.568827	0.605426
14	1080.14	92.472976	1.929438	1097.5	1068.56	0.843196	0.130355
15	1132.21	91.123376	3.859926	1145.72	1116.78	0.898524	0.257928
16	1197.79	91.861399	6.18451	1220.94	1174.65	1.096766	0.709447
17	1236.37	95.081407	1.831461	1269.16	1222.87	0.793215	0.296811
18	1284.59	97.663855	2.123511	1300.02	1269.16	0.172312	0.143693
19	1319.31	96.964907	2.405905	1334.74	1300.02	0.256642	0.172952
20	1348.24	97.603257	1.43802	1367.53	1334.74	0.225016	0.096848
21	1427.32	96.860914	2.834511	1450.47	1402.25	0.387916	0.323675
22	1541.12	79.029508	2.875859	1550.77	1452.4	5.311495	0.642257
23	1562.34	79.455457	2.991495	1631.78	1552.7	4.260361	0.417198
24	1651.07	97.143748	2.571303	1668.43	1633.71	0.245533	0.202468
25	1689.84	95.3029	2.017986	1701.22	1668.43	0.4704	0.153578
26	1735.93	94.694121	3.578103	1759.08	1703.14	0.976283	0.455196
27	1770.65	98.828144	1.075237	1782.23	1759.08	0.065015	0.055291
28	1801.51	95.255173	4.639497	1824.66	1782.23	0.422467	0.400628
29	1845.88	98.523444	2.287359	1883.24	1824.66	0.364931	0.178191
30	1919.17	98.656077	0.670343	1928.82	1901.81	0.096931	0.036792
31	1973.18	96.793854	3.096797	2000.18	1951.96	0.399828	0.380166
32	2027.19	97.344383	2.389892	2046.47	2000.18	0.327681	0.282811
33	2077.33	96.156167	3.729572	2096.62	2046.47	0.52995	0.490293

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34	2112.05	96.322266	2.788064	2125.56	2096.62	0.267348	0.182475
35	2177.83	95.36182	3.48827	2198.85	2148.7	0.713006	0.399189
36	2235.5	94.385219	5.442038	2254.79	2200.78	0.647238	0.620089
37	2314.58	90.297273	9.294859	2341.58	2281.79	1.347248	1.223213
38	2370.51	95.569781	4.387758	2391.73	2343.51	0.380356	0.374348
39	2438.02	94.824724	4.276864	2453.45	2416.74	0.418335	0.398324
40	2520.96	95.121464	3.290281	2561.47	2505.53	0.932437	0.46156
41	2846.34	94.152781	4.74754	2865.62	2819.33	0.816697	0.543127
42	2706.13	92.741392	2.436011	2717.7	2687.55	1.157961	0.469611
43	2829.57	92.616583	4.462311	2856.58	2814.14	0.934393	0.421419
44	2951.09	93.703477	6.152055	2970.38	2920.23	0.675764	0.663777
45	2989.66	94.037864	4.944545	3008.95	2972.31	0.588529	0.40931
46	3034.03	93.013418	5.976432	3099.1	3010.88	0.833702	0.620386
47	3107.32	93.994088	3.22377	3126.61	3089.96	0.733145	0.283899
48	3178.69	91.414286	2.004537	3184.48	3157.47	0.631147	0.149208
49	3197.96	90.059351	3.483628	3221.12	3186.4	1.1764	0.287973
50	3250.05	92.35963	6.47605	3269.34	3223.05	0.933977	0.638643
51	3342.84	90.451602	9.392128	3361.93	3315.63	0.940273	0.918284
52	3385.07	88.308015	11.351058	3421.72	3363.86	1.751194	1.667461
53	3444.87	89.49626	2.41736	3450.65	3423.65	0.753655	0.172355
54	3466.01	84.507672	5.820799	3485.37	3452.58	1.931255	0.482389
55	3496.01	90.76851	2.132428	3525.88	3487.3	0.950352	0.188307
56	3552.88	87.370415	9.80922	3577.95	3527.8	1.701924	1.093661
57	3593.38	91.449373	3.098118	3604.96	3579.88	0.801929	0.189063
58	3693.88	90.420009	3.311456	3703.33	3670.54	0.648695	0.243815
59	3720.69	87.904242	3.822663	3730.33	3705.26	1.120399	0.243663
60	3736.97	89.074582	2.81256	3753.46	3732.26	0.9185	0.171521
61	3770.84	82.528291	14.224432	3790.12	3755.4	1.699227	1.218035
62	3809.41	92.240038	7.591879	3840.27	3792.05	0.970293	0.644155
63	3858.49	89.895857	8.953772	3909.71	3873.06	0.927105	0.759459
64	3977.22	89.70626	10.676664	4000.36	3936.71	1.734678	1.571661

Comment;
NDC4

Resolution;
Apodization;
User; FTIR

Lampiran 13. Hasil Analisis SEM

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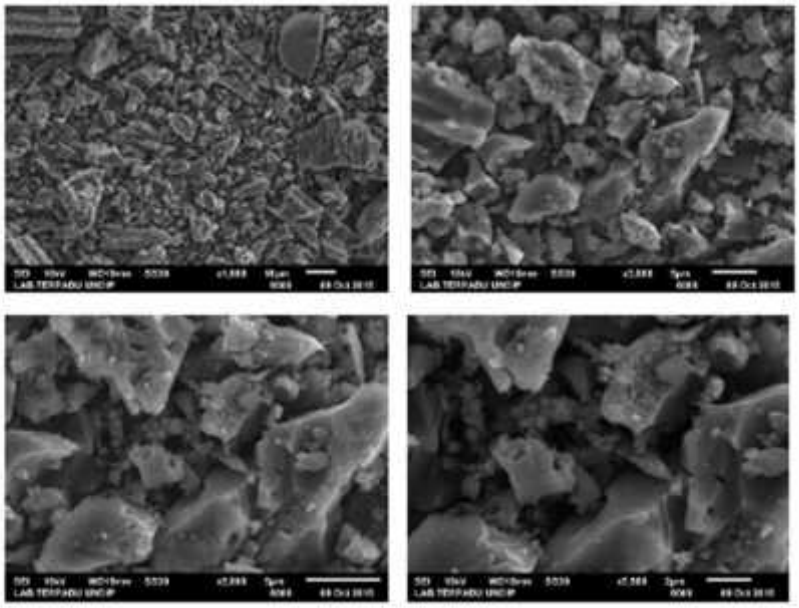
Hasil Uji Citra SEM sbb:
NDC 3



Hasil Uji Citra SEM sbb:
NDC 4