

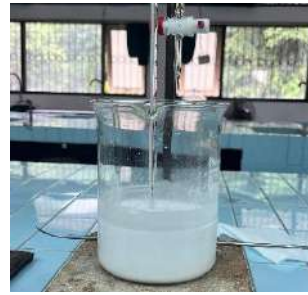
Lampiran 1. Dokumentasi Penelitian



Proses pencucian
cangkang telur



Proses kalsinasi



Proses sintesis



pH larutan yang dijaga
selama sintesis



Proses penyaringan dan
pencucian setelah proses
sintesis



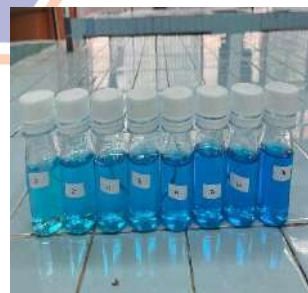
Proses pengeringan
endapan hidroksiapatit
setelah sintesis



Hidroksiapatit yang
dihasilkan



Karakterisasi HAp



Larutan konsentrasi
penentuan lamda maks



Proses menimbang
HAp



Proses menimbang zat
warna



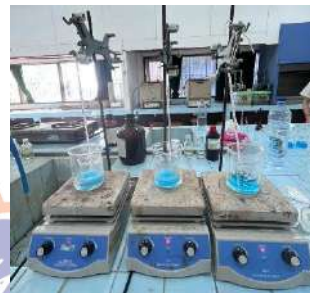
Proses penyaringan zat
warna



Proses uji adsorpsi
pada variasi waktu
kontak



Proses uji adsorpsi pada
vaariasi pH



Proses uji adsorpsi
terhadap variasi suhu



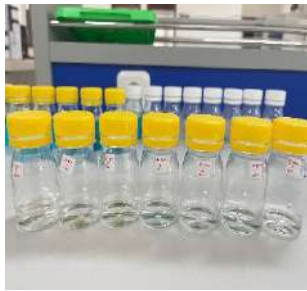
Hasil larutan setelah
melakukan uji



Larutan hasil uji adsorpsi
variasi waktu kontak



Larutan hasil uji
adsorpsi variasi pH



Larutan hasil uji variasi konsentrasi



Larutan hasil uji adsorpsi variasi suhu



Pengukuran absorbansi

Lampiran 2. Tabel Konsentrasi dan Adsorbansi Penentuan Panjang Gelombang Maksimum.

Konsentrasi (mg/L)	Absorbansi
0	0
10	0,2506
20	0,4879
30	0,7052
40	0,9218

Lampiran 3. Hasil Uji Adsorpsi Pada setiap Variabel.

1. Hasil Uji Adsorpsi Terhadap Pengaruh Waktu Kontak

Waktu (Menit)	Abs A	Abs B	Abs C	Mean Abs	SD Abs	Abs Induk A	Abs Induk B	Abs Induk C
15	0,0638	0,0649	0,0636	0,0641	0,00070	0,7753	0,7749	0,7751
30	0,0717	0,0716	0,0716	0,0716	0,00040	0,7753	0,7749	0,7751
45	0,1207	0,1199	0,1201	0,1202	0,00040	0,7753	0,7749	0,7751
60	0,1607	0,1601	0,1606	0,1605	0,00030	0,7753	0,7749	0,7751
75	0,1260	0,1254	0,1258	0,1257	0,00030	0,7753	0,7749	0,7751
90	0,1682	0,1694	0,1691	0,1689	0,00060	0,7753	0,7749	0,7751
105	0,0981	0,0980	0,0978	0,0979	0,00015	0,7753	0,7749	0,7751
120	0,1358	0,1356	0,1356	0,1357	0,00012	0,7753	0,7749	0,7751

Waktu Kontak (Menit)	Co	Ce	Co-Ce	%E
15	33,5926	0,67593	32,9167	97,9879
30	33,5926	1,02469	32,5679	96,9497
45	33,5926	3,27469	30,3179	90,2517
60	33,5926	5,13735	28,4552	84,7069
75	33,5926	3,52932	30,0648	89,4938
90	33,5926	5,52778	28,0648	83,5447
105	33,5926	2,24383	31,3488	93,3205
120	33,5926	3,98920	29,6034	88,1248

2. Hasil Uji Adsorpsi Terhadap Pengaruh pH

pH	Abs A	Abs B	Abs C	Mean	SD Abs	Abs	Abs	Abs
				Abs		Induk A	Induk B	Induk C
3	0,0927	0,0928	0,0928	0,09277	0,00006	0,8261	0,8266	0,8263
4	0,0852	0,0854	0,0854	0,08533	0,00012	0,8261	0,8266	0,8263
5	0,0657	0,0652	0,0653	0,06540	0,00026	0,8261	0,8266	0,8263
6	0,0897	0,0897	0,0895	0,08963	0,00012	0,8261	0,8266	0,8263
7	0,0817	0,0816	0,0817	0,08167	0,00006	0,8261	0,8266	0,8263
8	0,0876	0,0872	0,0874	0,08740	0,00020	0,8261	0,8266	0,8263
9	0,1986	0,1983	0,1984	0,19843	0,00015	0,8261	0,8266	0,8263
10	0,1925	0,1925	0,1926	0,19253	0,00006	0,8261	0,8266	0,8263

pH	Co	Ce	Co-Ce	%E
3	35,9645	2,00309	33,9614	94,4304
4	35,9645	1,65895	34,3056	95,3873
5	35,9645	0,736111	35,2284	97,9532
6	35,9645	1,85802	34,1065	94,8337
7	35,9645	1,4892	34,4753	95,8593
8	35,9645	1,75463	34,2099	95,1212
9	35,9645	6,89506	29,0694	80,8281
10	35,9645	6,62191	29,3429	81,5876

3. Hasil Uji Adsorpsi Terhadap Pengaruh Konsentrasi

Konsentrasi (Mg/L)	Abs A	Abs B	Abs C	Mean Abs	SD Abs	Abs Induk A	Abs Induk B	Abs Induk C
40	0,0642	0,0643	0,0647	0,0644	0,00025	0,7801	0,7799	0,7798
50	0,0761	0,0761	0,0762	0,0761	0,00005	0,9075	0,9076	0,9075
60	0,0861	0,0869	0,0865	0,0865	0,00040	1,0963	1,0966	1,0973
70	0,0919	0,0917	0,0915	0,0915	0,00020	1,3939	1,3946	1,3947
80	0,0951	0,0947	0,0949	0,0949	0,00020	1,5768	1,5777	1,5773
90	0,1036	0,1037	0,1035	0,1035	0,00010	1,7442	1,7448	1,7448
100	0,1030	0,1034	0,1035	0,1033	0,00025	1,8293	1,8289	1,8289

Konsentrasi (mg/L)	Co	Ce	Co-Ce	%E
40	33,8164	0,68981	33,1265	97,9601
50	39,7238	1,23302	38,4907	96,8960
60	48,4830	1,71296	46,7701	96,4669
70	62,2639	1,96370	60,3102	96,8622

80	70,7299	2,10185	68,6281	97,0283
90	78,4769	2,50463	75,9722	96,8084
100	82,3827	2,49074	79,892	96,9766

4. Hasil Uji Adsorpsi HAp Terhadap Zat Warna Serta Pemodelan Kinetika Adsorpsi.

Waktu (Menit)	C ₀	C _t	C ₀ -C _t	Q _t	Q _e	T/Q _t	Q _e -Q _t	Log (Q _e -Q _t)
15	33,5926	0,67593	32,9167	2,30417	2,35148	6,50995	0,04731	-1,325
30	33,5926	1,02469	32,5679	2,27975	2,35148	13,1593	0,07173	-1,14431
45	33,5926	3,27469	30,3179	2,12225	2,35148	21,2039	0,22923	-0,63973
60	33,5926	5,13735	28,4552	1,99187	2,35148	30,1225	0,35961	-0,44416
75	33,5926	3,52932	30,0633	2,10443	2,35148	35,6391	0,24705	-0,60721
90	33,5926	5,52778	28,0648	1,96454	2,35148	45,8123	0,38694	-0,41235
105	33,5926	2,24383	31,3488	2,19441	2,35148	47,8488	0,15707	-0,80391
120	33,5926	3,98920	29,6034	2,07224	2,35148	57,9084	0,27924	-0,55402

5. Hasil Uji Adsorpsi HAp Terhadap Zat Warna Serta Pemodelan Isoterm Adsorpsi.

C ₀	C _e	C ₀ -C _e	Q _e	C _e /q _e	Log C _e	Log q _e
39,7238	1,23302	38,4907	2,69435	0,45763	0,090972	0,43045
48,4830	1,71296	46,7701	3,27390	0,52322	0,233748	0,51507
62,2639	1,95370	60,3102	4,22171	0,46278	0,290859	0,62549

70,7299	2,10185	68,6281	4,80397	0,43752	0,322602	0,68160
78,4769	2,50463	75,9722	5,31806	0,47097	0,398744	0,72575
82,3827	2,49074	79,8920	5,59244	0,44538	0,396330	0,74760

6. Absorbansi Serta Hasil Uji Adsorpsi HAp Terhadap Pengaruh

a. Absorbansi Hasil Uji Adsorpsi Pengaruh Termodinamika

Suhu (°C)	Abs A	Abs B	Abs C	Mean Abs	SD Abs	Abs Induk A	Abs Induk B	Abs Induk C
30	0,0620	0,0620	0,0616	0,06187	0,00023	0,7924	0,7929	0,7928
40	0,0739	0,0738	0,0734	0,07370	0,00026	0,7924	0,7929	0,7928
50	0,0848	0,0839	0,0843	0,08433	0,00045	0,7924	0,7929	0,7928
60	0,0891	0,0890	0,0891	0,08907	0,00006	0,7924	0,7929	0,7928
70	0,0917	0,0912	0,0912	0,09137	0,00029	0,7924	0,7929	0,7928
80	0,0996	0,0995	0,0992	0,09943	0,00021	0,7924	0,7929	0,7928

b. Hasil Uji Adsorpsi dan Efisiensi Pengaruh Termodinamika

Suhu (°C)	Co	Ce	Co-Ce (mg/L)	Kc	In Kc	1/T (K)	Delta G	%E
40	34,4074	1,12037	33,28704	29,7107	3,39151	0,00319	-8,82566	96,74381
50	34,4074	1,61265	32,79475	20,3359	3,01239	0,00310	-8,08953	95,31306
60	34,4074	1,83179	32,57562	17,7835	2,87827	0,00300	-7,96867	94,67618
70	34,4074	1,93827	32,46914	16,7516	2,81849	0,00292	-8,03750	94,36670

80	34,4074	2,31173	32,09568	13,8838	2,63073	0,00283	-7,72076	93,28131
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Lampiran 4. Perhitungan

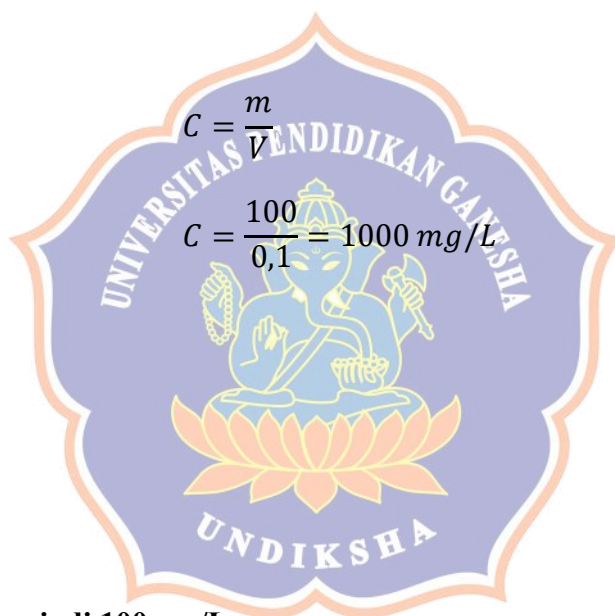
1. Pembuatan Larutan Standar Zat Warna Remazol Blue Turkish

a. Larutan induk 1000 mg/L

Diketahui:

Massa zat warna= 0,1 g = 100 mg

Volume larutan = 100 mL = 0,1 L



b. Pengenceran menjadi 100 mg/L

Diketahui:

$C_1 = 1000 \text{ mg/L}$

$V_1 = 10 \text{ mL}$

$V_2 = 100 \text{ mL}$

$$C_1 V_1 = C_2 V_2$$

$$(1000)(10) = C_2(100)$$

$$C_2 = 100 \text{ mg/L}$$

c. Pengenceran menjadi 50 mg/L

Diketahui:

$$C_1 = 100 \text{ mg/L}$$

$$V_1 = 50 \text{ mL}$$

$$V_2 = 100 \text{ mL}$$

$$C_1 V_1 = C_2 V_2$$

$$(100)(50) = C_2(100)$$

$$C_2 = 50 \text{ mg/L}$$



2. Perhitungan Efisiensi Adsorpsi Hidroksiapatit

Rumus:

$$\%E = \frac{C_0 - C_e}{C_0} \times 100\%$$

a. Waktu kontak 15 menit

$$C_0 = 33,5926 \text{ mg/L}$$

$$C_e = 0,67593 \text{ mg/L}$$

$$\%E = \frac{33,5926 - 0,67593}{33,5926} \times 100$$

$$\%E = 97,98\%$$

b. pH 5

$$C_0 = 35,9645 \text{ mg/L}$$

$$C_e = 0,736111 \text{ mg/L}$$

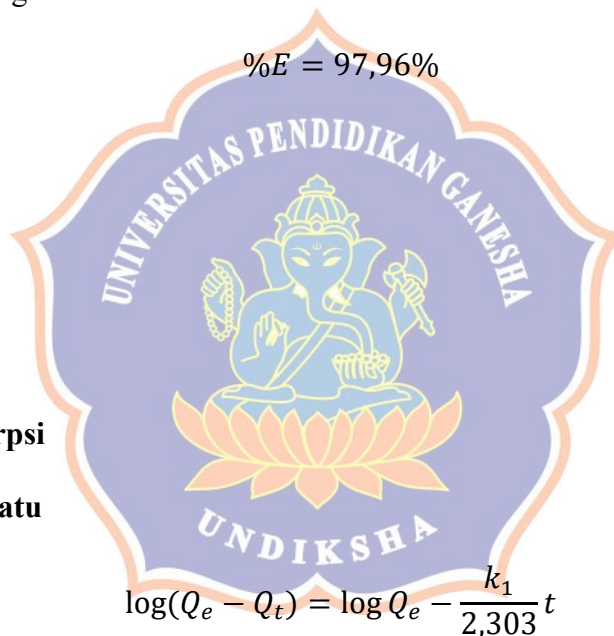
$$\%E = 97,95\%$$

c. Konsentrasi 40 mg/L

$$C_0 = 33,8164 \text{ mg/L}$$

$$C_e = 0,68981 \text{ mg/L}$$

$$\%E = 97,96\%$$



3. Kinetika Adsorpsi

a. Pseudo Orde Satu

$$\log(Q_e - Q_t) = \log Q_e - \frac{k_1}{2,303} t$$

Diketahui:

$$y = 0,00006x + 1,1523$$

Perhitungan Q_e

$$\log Q_e = 1,1523$$

$$Q_e = 10^{1,1523}$$

$$Q_e = 14,21 \text{ mg/g}$$

Perhitungan k_1

$$k_1 = 0,00006 \times 2,303$$

$$k_1 = 0,0001382 \text{ min}^{-1}$$

$$R^2 = 0,3324$$

b. Pseudo Orde Dua



Diketahui:

$$y = 0,4862x - 0,5412$$

Perhitungan Q_e

$$\frac{1}{q_e} = 0,4862$$

$$q_e = 2,0567 \text{ mg/g}$$

Perhitungan k_2

$$\frac{1}{k_2 q_e^2} = 0,5412$$

$$k_2 = 0,4368 \text{ g mg}^{-1} \text{ min}^{-1}$$

$$R^2 = 0,9924$$

4. Isoterm Adsorpsi

a. Langmuir



$$y = 0,2518x + 1,1183$$

Q_m

$$Q_m = \frac{1}{0,2518}$$

$$Q_m = 3,97 \text{ mg/g}$$

K_L

$$K_L = \frac{1}{(1,1183 \times 3,97)}$$

$$K_L = 0,225 \text{ L/mg}$$

$$R^2 = 0,9411$$

b. Freundlich

$$y = 0,904x - 0,2725$$

1/n dan n

$$1/n = 0,904$$

$$n = 1,106$$

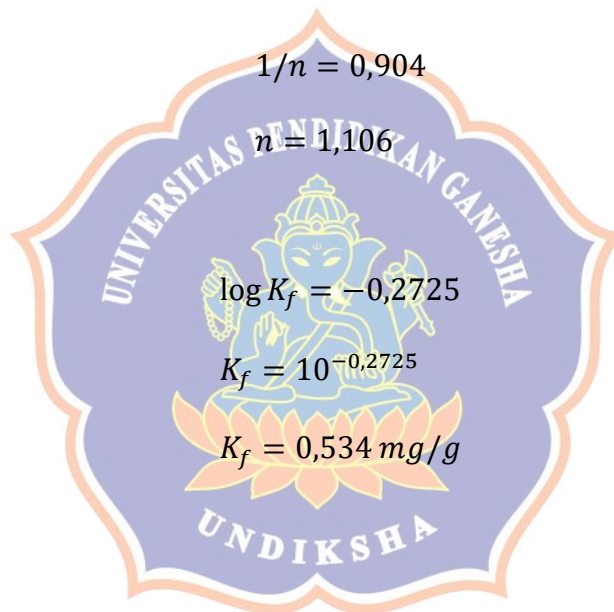
Kf

$$\log K_f = -0,2725$$

$$K_f = 10^{-0,2725}$$

$$K_f = 0,534 \text{ mg/g}$$

$$R^2 = 0,9547$$



5. Termodinamika Adsorpsi

Van't Hoff

$$\text{Slope} = 1909,6$$

$$\text{Intercept} = -2,7987$$

ΔH°

$$\Delta H^\circ = -(1909,6 \times 8,314)$$

$$\Delta H^{\circ} = -15,88 \text{ kJ/mol}$$

$$\Delta S^{\circ}$$

$$\Delta S^{\circ} = (-2,7987 \times 8,314)$$

$$\Delta S^{\circ} = -23,27 \text{ J/mol.K}$$

$$\Delta G^{\circ} (40^{\circ}\text{C})$$

$$T = 313 \text{ K}$$

$$\ln K_c = 3,3915$$

$$\Delta G^{\circ} = -RT \ln K_c$$

$$\Delta G^{\circ} = -8,83 \text{ kJ/mol.}$$

