

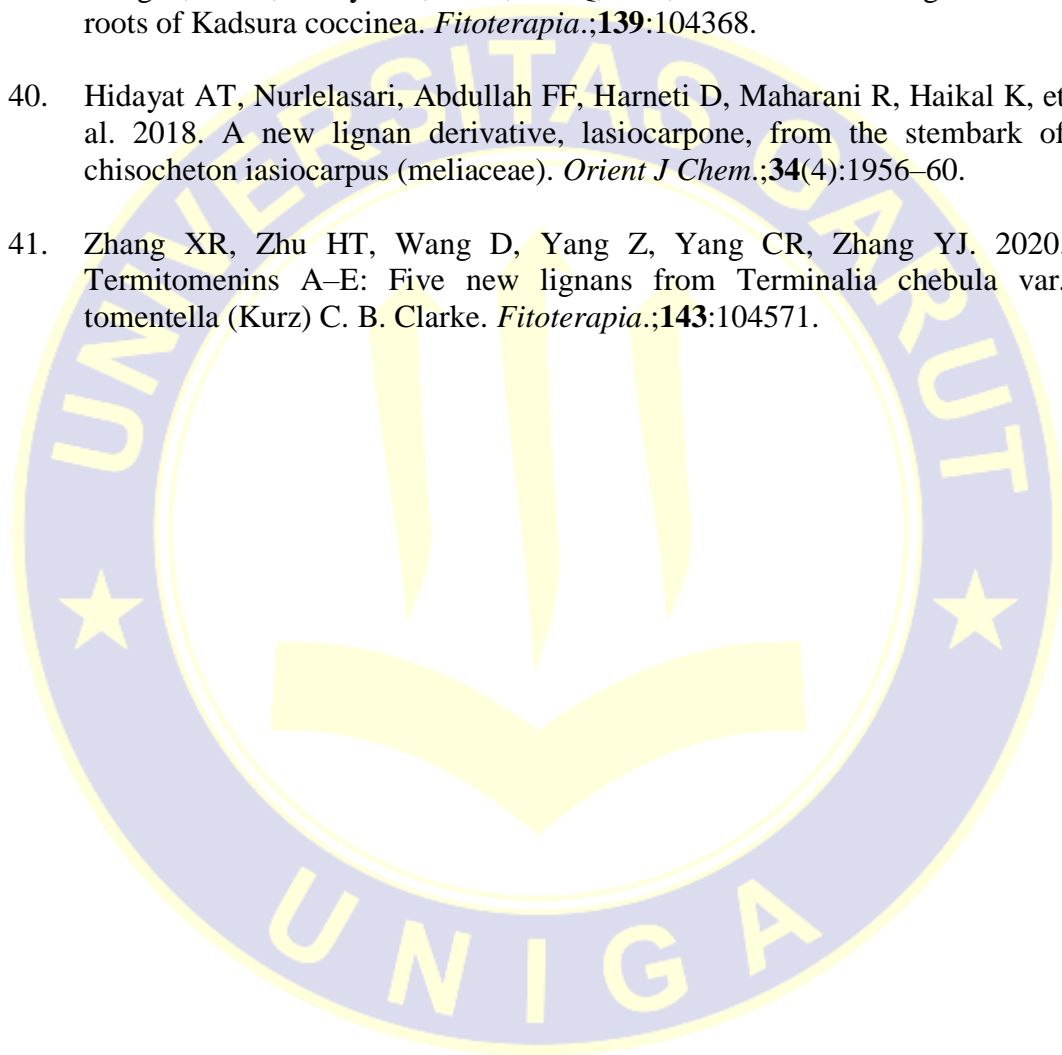
## DAFTAR PUSTAKA

1. Saragih, D. E. & Arsita, E. V. 2019, The phytochemical content of *Zanthoxylum acanthopodium* and its potential as a medicinal plant in the regions of Toba Samosir and North Tapanuli, North Sumatra. *Pros. Semin. Nas. Masy. Biodiversitas Indones.* **5**, 71–76.
2. Miftakhurohmah dan Suhirman, S. 2009, Potensi Andaliman Sebagai Sumber Antioksidan Dan Antimikroba Alami. *Warta Penelitian Dan Pengembangan Industri.* **15**(2): **9**.
3. Moektiwardoyo, M., Muchtaridi, M. & Halimah, E. 2014, Chemical composition and locomotor activity of Andaliman fruits (*Zanthoxylum acanthopodium* DC.) essential oil on mice. *Int. J. Pharm. Pharm. Sci.* **6**, 547–550.
4. Bhatt, V., Kumar, N., Sharma, U. & Singh, B. 2018, Comprehensive metabolic profiling of *Zanthoxylum armatum* and *Zanthoxylum acanthopodium* leaves, bark, flowers and fruits using ultra high performance liquid chromatography . *Sep. Sci. Plus* **1**, 311–324.
5. Sati Rakesh., Badoni, Prabhakar., Singh, Harpreet., M. D. . R. 2011, Anti-Inflammatory and Antioxidant Activities of *Zanthoxylum Armatum* Stem Bark. *Glob. J. Res. Eng. J Gen. Eng.* **5**, 19–21.
6. Negi, J. S., Bisht, V. K., Bhandari, A. K., Singh, P. & Sundriyal, R. C. 2011, Chemical constituents and biological activities of the genus *Zanthoxylum*: A review. *African J. Pure Appl. Chem.* **5**, 412–416.
7. Su, G. Y., Wang, K. W., Wang, X. Y. & Wu, B. 2015, Bioactive lignans from *Zanthoxylum planispinum* with cytotoxic potential. *Phytochem. Lett.* **11**, 120–126.
8. Indahningrum, R. putri. 2020, Potensi Ekstrak Tumbuhan Andaliman (*Zanthoxylum acanthopodium* DC.) Sebagai Atibakteri *Staphylococcus aureus*. *Alotrop* **2507**, 1–9.
9. Agroekoteknologi, J., Usu, F. P. & No, E. 2018, Identifikasi Karakter Morfologis Andaliman (*Zanthoxylum Acanthopodium* Dc.) Di Beberapa Kabupaten Di Sumatera Utara. *J. Agroekoteknologi* **6**, 745–756.
10. Li, L. *et al.* 2020, Chemical constituents from the leaves of *Zanthoxylum nitidum* (Roxb.) DC. *Biochem. Syst. Ecol.* **91**, 104080.

11. Tangjitjaroenkun, J., Chantarasriwong, O. & Chavasiri, W. 2012, Chemical constituents of the stems of *Zanthoxylum limonella* Alston. *Phytochem. Lett.* **5**, 443–445.
12. Hu, J. *et al.* 2010, Alkaloids from *Zanthoxylum nitidum* (Roxb.) DC. *Biochem. Syst. Ecol.* **35**, 114–117.
13. Zhang, Y., Wang, D., Yang, L., Zhou, D. & Zhang, J. 2014, Purification and characterization of flavonoids from the leaves of *Zanthoxylum bungeanum* and correlation between their structure and antioxidant activity. *PLoS One* **9**.
14. Li, W. *et al.* 2013, Coumarins and lignans from *Zanthoxylum schinifolium* and their anticancer activities. *J. Agric. Food Chem.* **61**, 10730–10740.
15. Cao, X. L. *et al.* 2013, Isolation of anti-tumor compounds from the stem bark of *Zanthoxylum ailanthoides* Sieb. & Zucc. by silica gel column and counter-current chromatography. *J. Chromatogr. B Anal. Technol. Biomed. Life Sci.* **929**, 6–10.
16. Kirschenbaum, L. J. & Ruekberg, B. A 2013, Correlation of the Solubility of Water in Hydrocarbons as a Function of Temperature Based on the Corresponding Vapor Pressure of Pure Water. *CSJ-101 I Chem. Sci. J.* **2013**, 101.
17. Drying, S. & Method, E. 2020, *Review : Solubility Enhancement by Advance Techniques - Lyophilization , Spray Drying and Rotary.* vol. 9.
18. Forestryana, D. & Arnida. 2020, Skrining Fitokimia dan Analisis Kromatografi Lapis Tipis Ekstrak Etanol Daun Jeruju ( *hydrolea spinosa* l.). *J. Ilm. Farm. Bahari* 113–124.
19. Kartasapoetra, G. 1994. *Teknologi Penyuluhan Pertanian.* Bina Aksara. Jakarta.
20. Sirait, M. 2016, *Penuntun Fitokimia Dalam Farmasi.* Institut Teknologi Bandung Bandung.
21. Harborne, J. B. 1996, *Metode Fitokimia Penentuan cara modern menganalisis tumbuhan.* Terjemahan Padmawinata, K., dan Soediro, I., Ed. 2 Penerbit ITB, Bandung.
22. Mutiasari., Irma, R.. 2012, Uji Aktivitas Antioksidan Ekstrak Jamur dengan Metode DPPH dan Identifikasi Golongan Senyawa Kimia dari Fraksi Teraktif, Fakultas Matematika dan Ilmu Pengetahuan Alam, Depok.

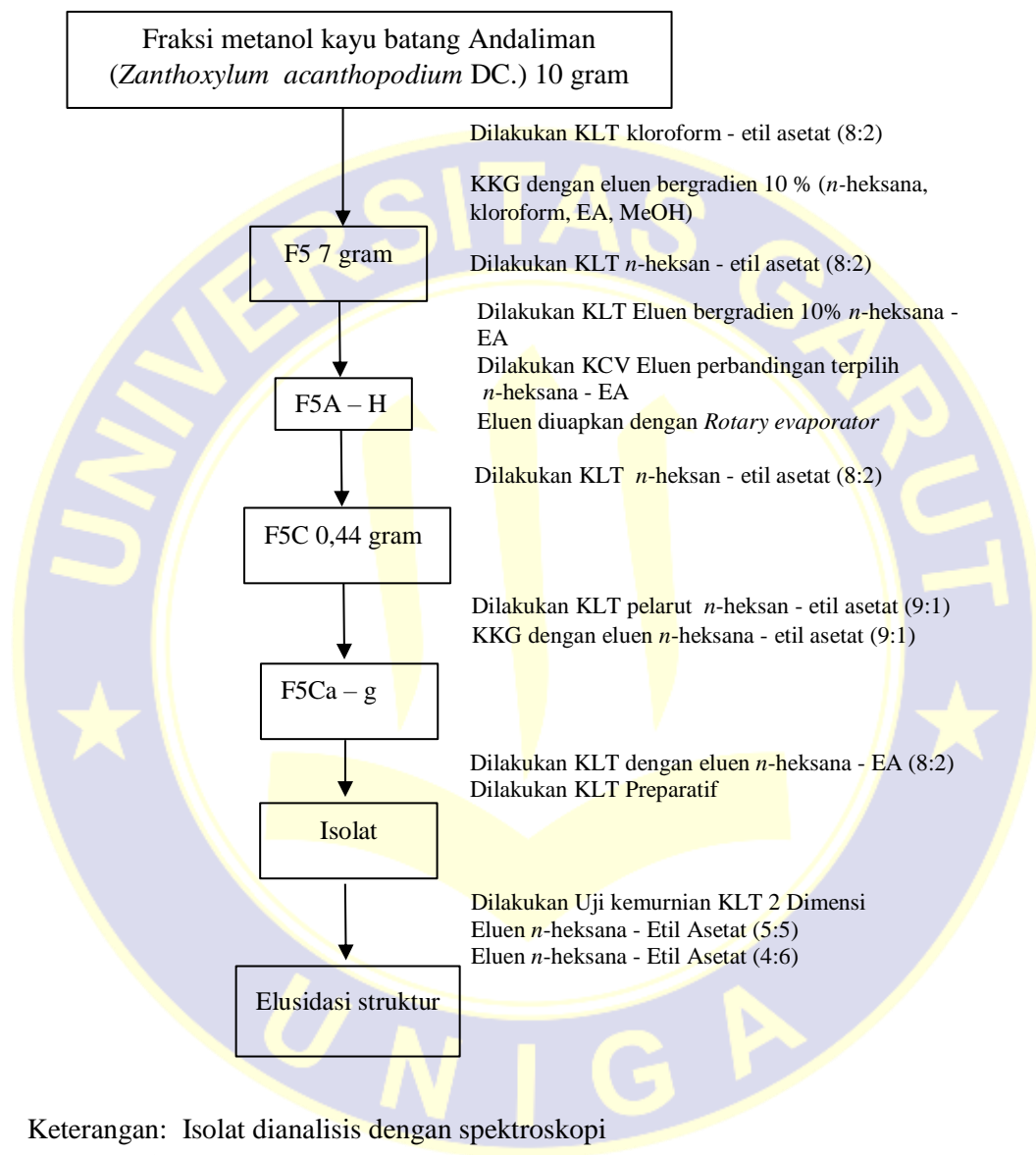
23. Wilson R. Cunha, Márcio Luis Andrade e Silva, Rodrigo Cassio Sola Veneziani, Sérgio Ricardo Ambrósio and Jairo Kenupp Bastos. 2012, Lignans: *Chemical and Biological Properties*, Phytochemicals - A Global Perspective of Their Role in Nutrition and Health.
24. Departemen Kesehatan RI., 2000, *Parameter Standar Umum Ekstrak Tumbuhan Obat*. Direktorat Jendral Pengawasan Obat dan Makanan: Jakarta.
25. Agoes. G. 2007, *Teknologi Bahan Alam*, ITB Press Bandung.
26. Maurya A, et al. 2018, Vacuum Liquid Chromatography: Simple, Efficient and Versatile Separation Technique for Natural Products. *Organic and Medical Chemistry*. 7 (2) 555710. Ministry of AYUSH, Govt. of India.
27. Gritter, R.J., Bobbit, J.M., Schwarting, A.E. 1991, *Pengantar Kromatografi*, Terjemahan Padmawinata, K., Edisi Kedua, Penerbit ITB, Bandung.
28. Hostettmann, K., Hostettmann, M., dan Marston, A. 1995, *Cara Kromatografi Preparatif*. Terjemahan Padmawinata, K., Penerbit ITB, Bandung.
29. Julianto, Tatang Shabur. 2019, *Fitokimia Tinjauan Metabolit Sekunder dan Skrining Fitokimia*. Yogyakarta: Universitas Islam Indonesia. Hal 32-33.
30. Syah, Y. M. 2016, *Dasar-Dasar Penentuan Struktur Molekul Berdasarkan Data Spektrum  $^1\text{H}$  dan  $^{13}\text{C}$  NMR*. Bandung: ITB
31. Dachriyanus. 2004, *Analisis Struktur Senyawa Organik Secara Spektroskopi*. Edisi 1. Padang: Andalas University Press.
32. Silverstein, B. dan Morcill. 1986, *Penyelidikan Spektrometri Senyawa Organik*. Alih bahasa Drs. A. J. Hartomo, dan Anny Victor Purba. Erlangga. Jakarta.
33. Maulana, M. 2018, Profil kromatografi lapis tipis (KLT) ekstrak daun bidara arab (*Ziziphus spina cristi, L.*) berdasarkan variasi pelarut. [Skripsi]. Malang.: Fakultas Sains dan Teknologi, Universitas Islam Negeri Maulana Malik Ibrahim.
34. Hardjono, S. 1985, *Dasar-Dasar Spektroskopi*. Yogyakarta : Penerbit Liberti.
35. Khopkar, S.M. 2008, *Konsep Dasar Kimia Analitik*. Jakarta: UI Press.
36. Gandjar, I. G. dan Rohman, A., 2007, *Kimia Farmasi Analisis*, Pustaka Pelajar, Yogyakarta.

37. Park S, Kim JH, Kim SH, Shin D. 2020, Transition Metal-Mediated Annulation Approaches for Synthesis of Arylnaphthalene Lignan Lactones. *Front Chem.* ;**8**(August):1–15.
38. Cha JM, Lee TH, Subedi L, Ha YJ, Kim HR, Kim SY, et al. 2021. Isolation and structural characterization of four diastereomeric lignan glycosides from *Abies holophylla* and their neuroprotective activity. *Tetrahedron.*;**77**:131735.
39. Yang Y, Liu Y, Daniyal M, Yu H, Xie Q, Li B, et al. 2019. New Lignans from roots of *Kadsura coccinea*. *Fitoterapia.*;**139**:104368.
40. Hidayat AT, Nurlelasari, Abdullah FF, Harneti D, Maharani R, Haikal K, et al. 2018. A new lignan derivative, lasiocarpone, from the stem bark of *chisocheton lasiocarpus* (meliaceae). *Orient J Chem.*;**34**(4):1956–60.
41. Zhang XR, Zhu HT, Wang D, Yang Z, Yang CR, Zhang YJ. 2020. Termitomenins A–E: Five new lignans from *Terminalia chebula* var. *tomentella* (Kurz) C. B. Clarke. *Fitoterapia.*;**143**:104571.



## LAMPIRAN 1

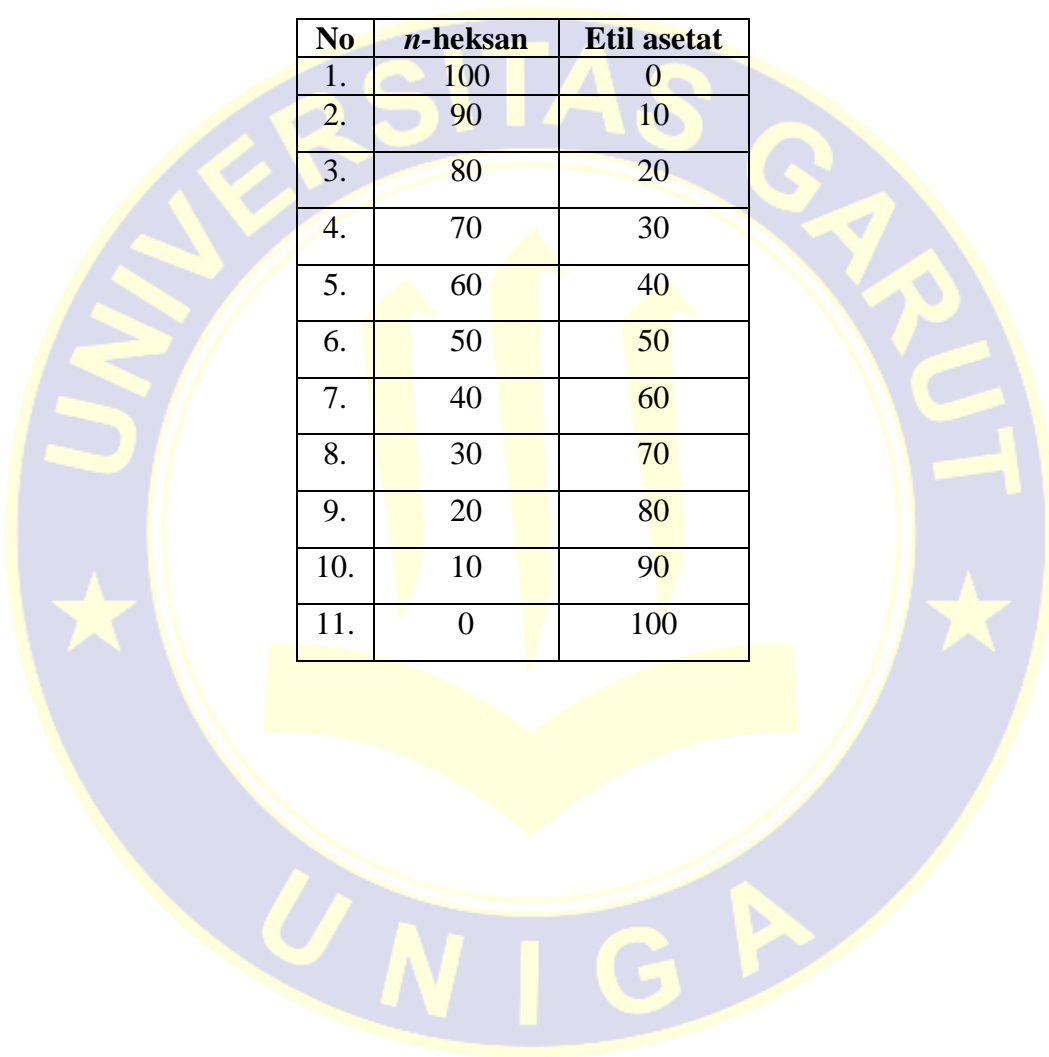
### ALUR PENELITIAN



**Gambar V.1** Alur penelitian

**LAMPIRAN 2****TABEL PELARUT GRADIEN****Tabel V.1**

Pelarut gradien 10% KLT (Kromatografi Lapis Tipis)



<b>No</b>	<b><i>n</i>-heksan</b>	<b>Etil asetat</b>
1.	100	0
2.	90	10
3.	80	20
4.	70	30
5.	60	40
6.	50	50
7.	40	60
8.	30	70
9.	20	80
10.	10	90
11.	0	100

**LAMPIRAN 2  
(LANJUTAN)**

**TABEL PELARUT GRADIEN**

**Tabel V.2**

Pelarut gradien KCV (Kromatografi Cair Vakum)

No	PELARUT			
	<i>n</i> -Heksana	Etilasetat	Metanol	Pengulangan
1.	90	10	-	3x
2.	80	20	-	2x
3.	70	30	-	2x
4.	60	40	-	5x
5.	-	100	-	3x
6.	-	-	100	2x

**LAMPIRAN 2  
(LANJUTAN)**

**TABEL PELARUT GRADIEN**

**Tabel V.3**

Pelarut gradien KKG (Kromatografi Kolom Gravitasi)

No	<i>n</i> -heksan	Kloroform	Etil asetat	Metanol
1.	4	6	-	-
2.	3	7	-	-
3.	2	8	-	-
4.	1	9	-	-
5.	0	10	0	-
6.	-	9	1	-
7.	-	8	2	-
8.	-	7	3	-
9.	-	6	4	-
10.	-	5	5	-
11.	-	4	6	-
12.	-	3	7	-
13.	-	2	8	-
14.	-	1	9	-
15.	-	0	10	-
16.	-	-	9	1
17.	-	-	8	2
18.	-	-	7	3
19.	-	-	-	10
20.	-	-	-	10

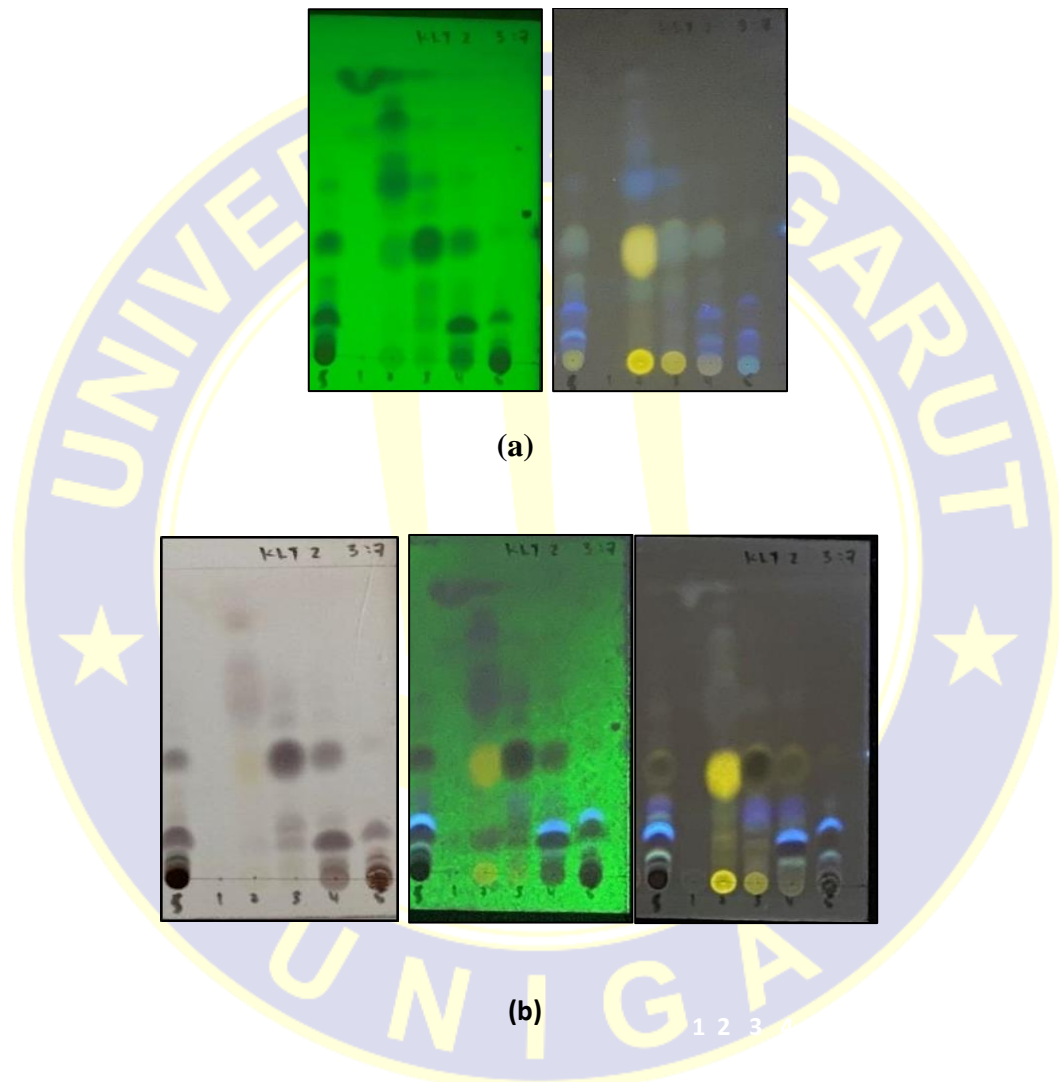
**LAMPIRAN 3**  
**DOKUMENTASI**



**Gambar V.2** Fraksi Polar kayu batang Andaliman (*Zanthoxylum acanthopodium* DC.)

### LAMPIRAN 3 (LANJUTAN)

### DOKUMENTASI



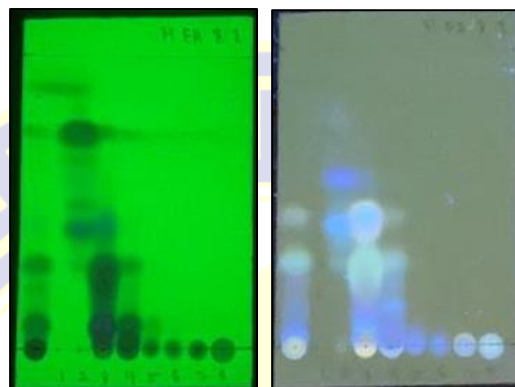
**Gambar V.3** Hasil KLT Analitik gabungan KCV F1-5

Keterangan:

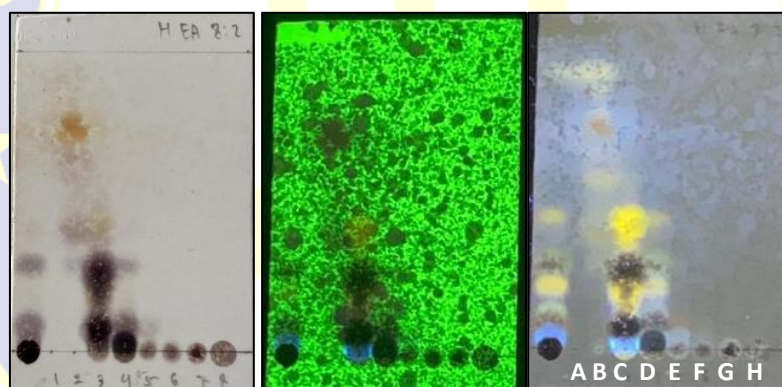
- (a) = Pengembang *n*-heksana : kloroform (3:7) di bawah sinar UV 254 dan 366 nm
- (b) = Hasil setelah di semprot penampak bercak  $\text{H}_2\text{SO}_4$  di bawah sinar UV 254 dan 366 nm

### LAMPIRAN 3 (LANJUTAN)

### DOKUMENTASI



(a)



(b)

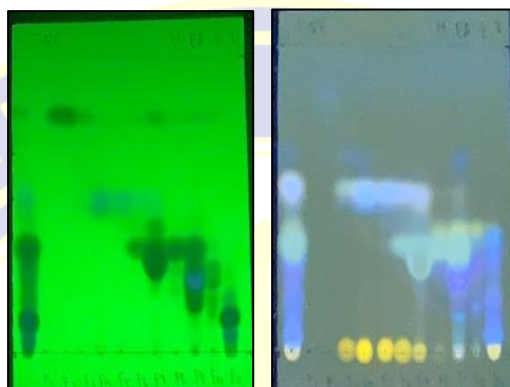
**Gambar V.4** Hasil KLT Analitik hasil KKG F5A-H

Keterangan:

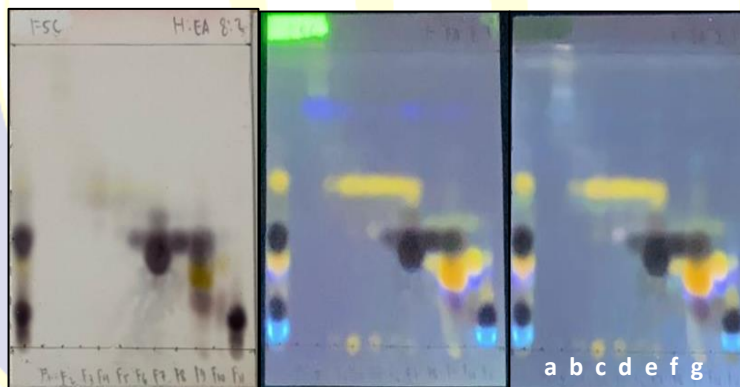
- (a) = Pengembang *n*-heksana : etil asetat (8:2) di bawah sinar UV 254 dan 366 nm
- (b) = Hasil setelah di semprot penampak bercak H<sub>2</sub>SO<sub>4</sub> di bawah sinar UV 254 dan 366 nm

### LAMPIRAN 3 (LANJUTAN)

### DOKUMENTASI



(a)



(b)

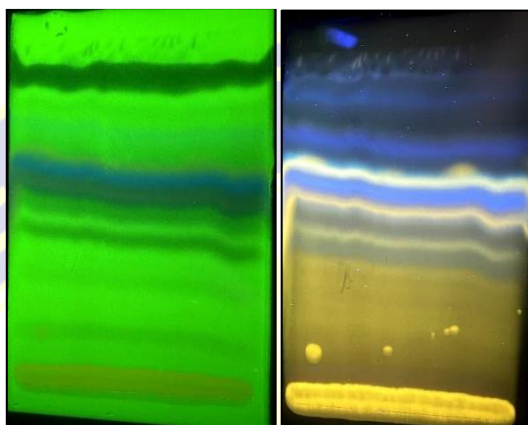
**Gambar V.5** Hasil KLT Analitik dari KKG F5Ca - g

Keterangan:

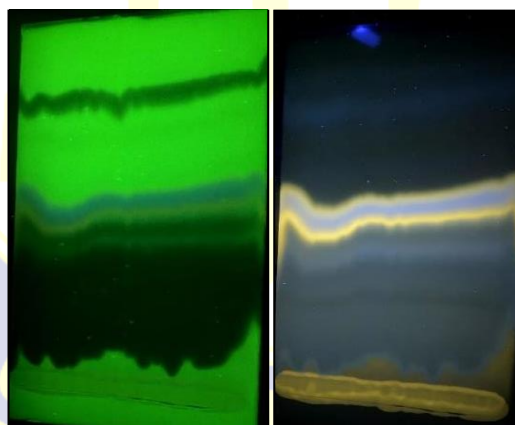
- (a) = Pengembang *n*-heksana : etil asetat (8:2) di bawah sinar UV 254 dan 366 nm
- (b) = Hasil setelah di semprot penampak bercak  $\text{H}_2\text{SO}_4$  di bawah sinar UV 254 dan 366 nm

**LAMPIRAN 3  
(LANJUTAN)**

**DOKUMENTASI**



(a)



(b)

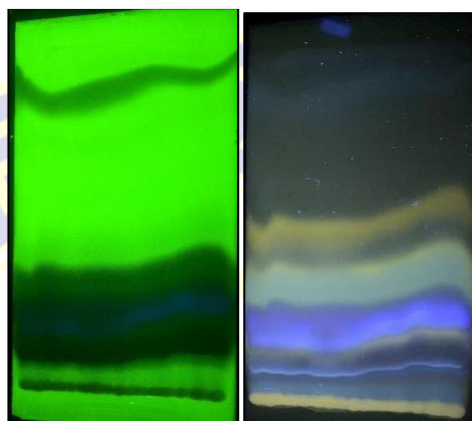
**Gambar V.6** Hasil analisis KLTP (a) F5Cc dan (b) F5Cd

Keterangan:

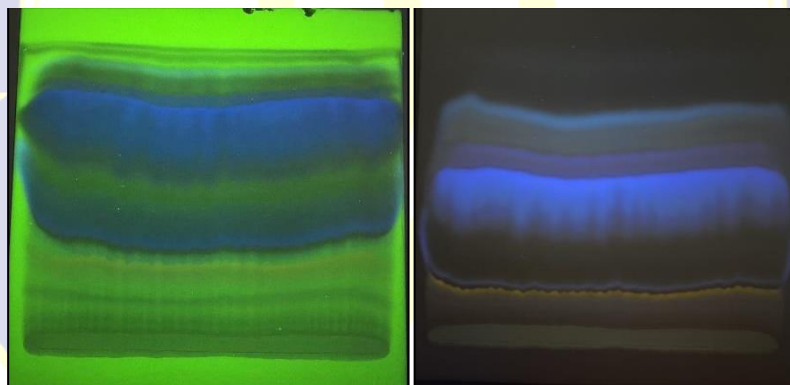
- (a) = F5Cc pengembang *n*-heksana : etil asetat (8:2) di bawah sinar UV 254 dan 366 nm
- (b) = F5Cd pengembang *n*-heksana : etil asetat (8:2) di bawah sinar UV 254 dan 366 nm

### LAMPIRAN 3 (LANJUTAN)

### DOKUMENTASI



(a)



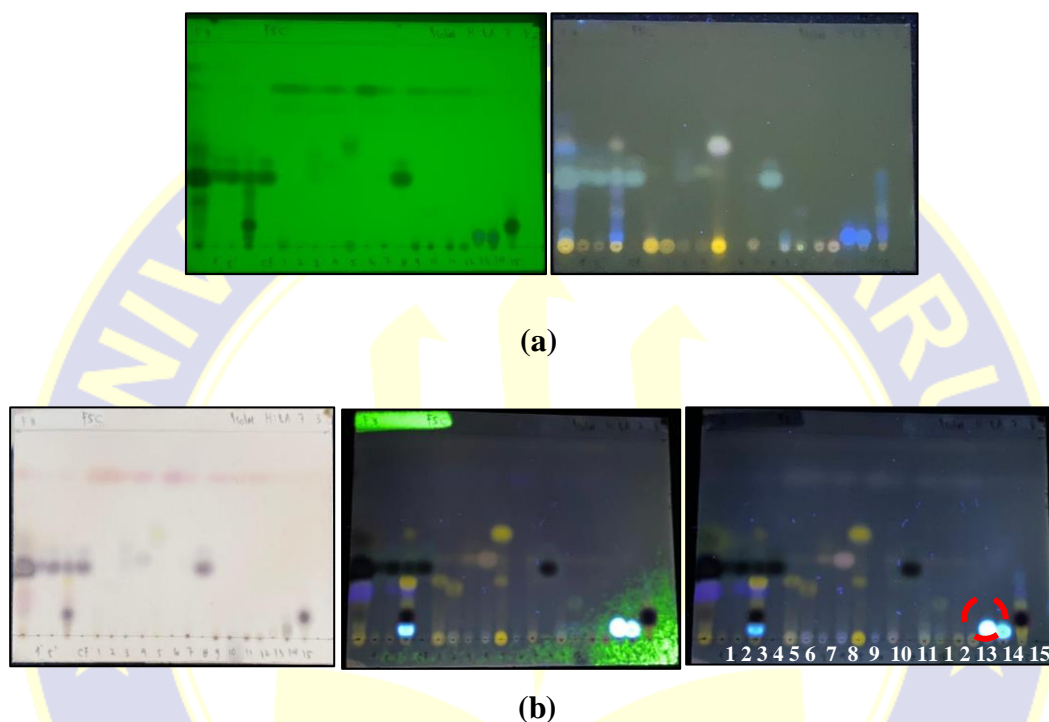
(b)

**Gambar V.7** Hasil analisis KLTP (a) F5Cf dan (b) F5Cg

Keterangan:

- (a) = F5Cf pengembang *n*-heksana : etil asetat (8:2) di bawah sinar UV 254 dan 366 nm
- (b) = F5Cg pengembang *n*-heksana : etil asetat (6:4) di bawah sinar UV 254 dan 366 nm

**LAMPIRAN 3  
(LANJUTAN)  
DOKUMENTASI**



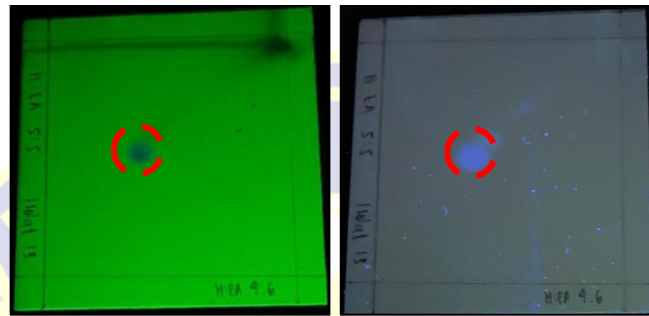
**Gambar V.8** Hasil KLT Analitik 15 isolat dari KLTP (Kromatografi Lapis Tipis Preparatif)

Keterangan:

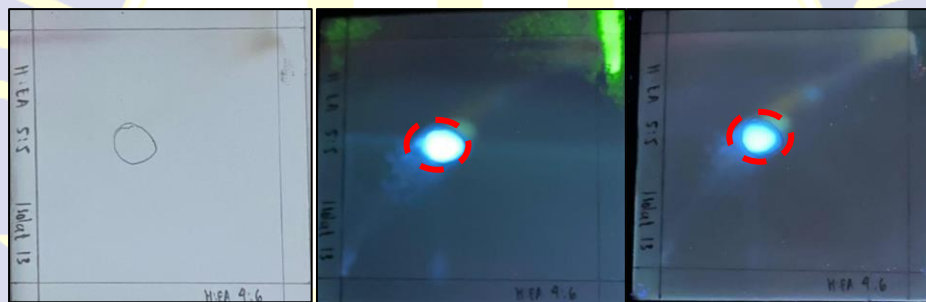
- (a) = Pengembang *n*-heksana : etil asetat (7:3) di bawah sinar UV 254 dan 366 nm
- (b) = Hasil setelah di semprot penampak bercak H<sub>2</sub>SO<sub>4</sub> di bawah sinar UV 254 dan 366 nm

### LAMPIRAN 3 (LANJUTAN)

#### DOKUMENTASI



(a)



(b)

**Gambar V.9** Hasil KLT 2 Dimensi Isolat 13 dari F5Cg

Keterangan:

- (a) = Isolat 13 pengembang *n*-heksana : etil asetat (5:5)  $R_f = 0,38$  dan *n*-heksana : etil asetat (4:6)  $R_f = 0,6$  di bawah sinar UV 254 dan 366 nm
- (b) = Hasil setelah di semprot penampak bercak  $H_2SO_4$  di bawah sinar UV 254 dan 366 nm

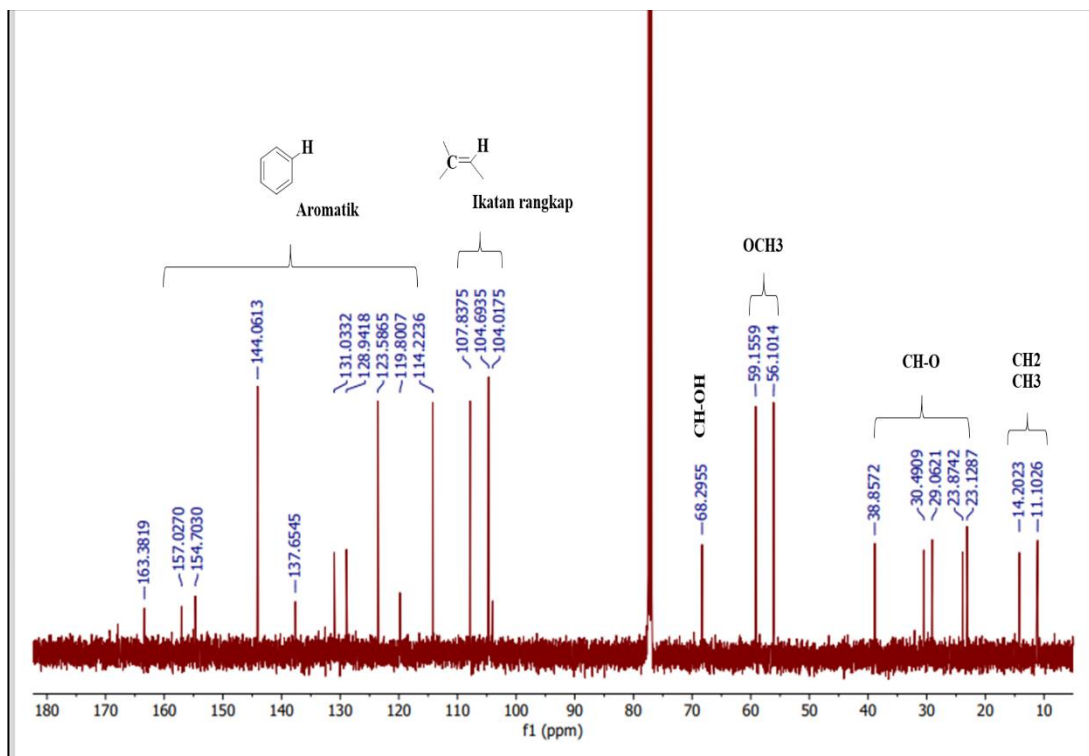
**LAMPIRAN 3  
(LANJUTAN)**

**DOKUMENTASI**



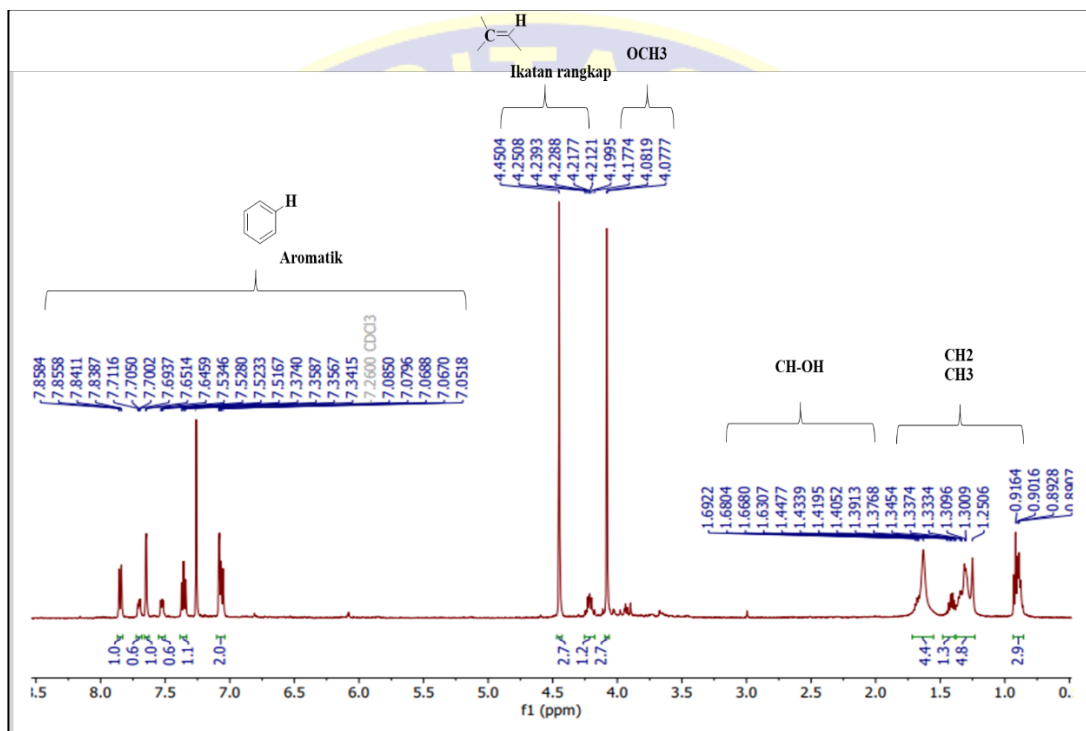
**Gambar V.10 Hasil Isolat 13 F5Cg**

## LAMPIRAN 4

ANALISIS SPEKTROSKOPI NMR (*Nuclear Magnetik Resonansi*)Gambar V.11 Hasil  $^{13}\text{C}$ -NMR (*Nuclear Magnetik Resonansi*)

## LAMPIRAN 4 (LANJUTAN)

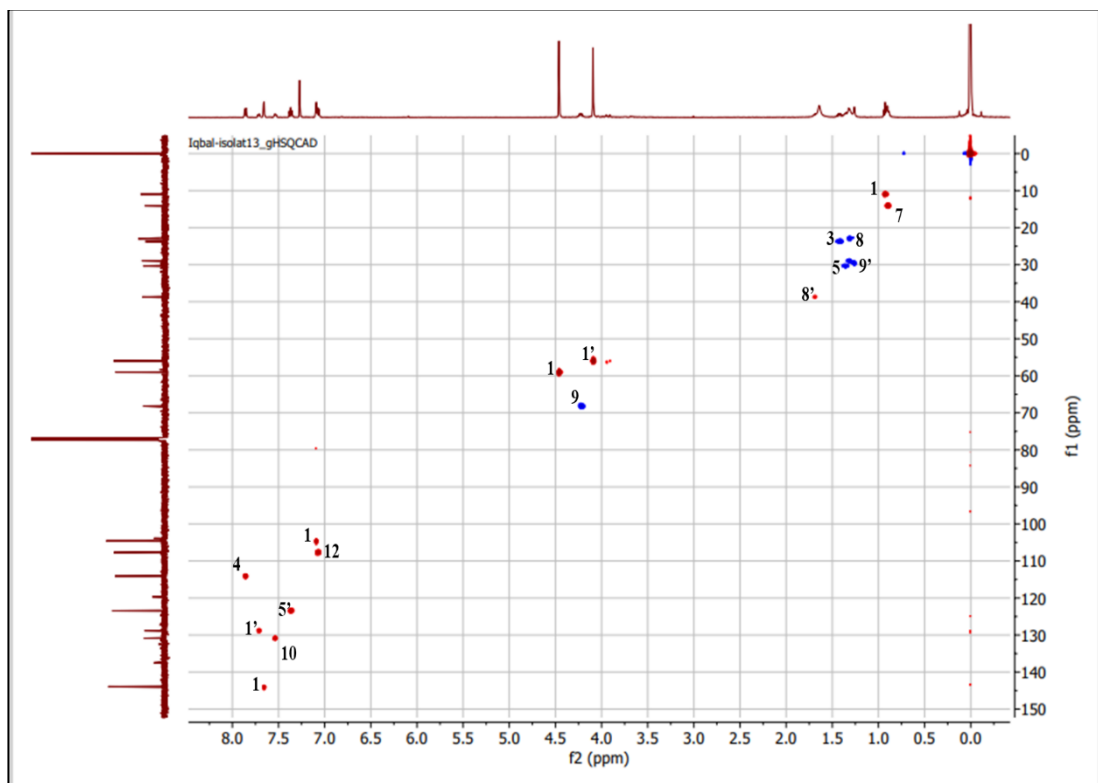
### ANALISIS SPEKTROSKOPI NMR (*Nuclear Magnetik Resonansi*)



Gambar V.12 Hasil  $^1\text{H-NMR}$  (*Nuclear Magnetik Resonansi*)

## LAMPIRAN 4 (LANJUTAN)

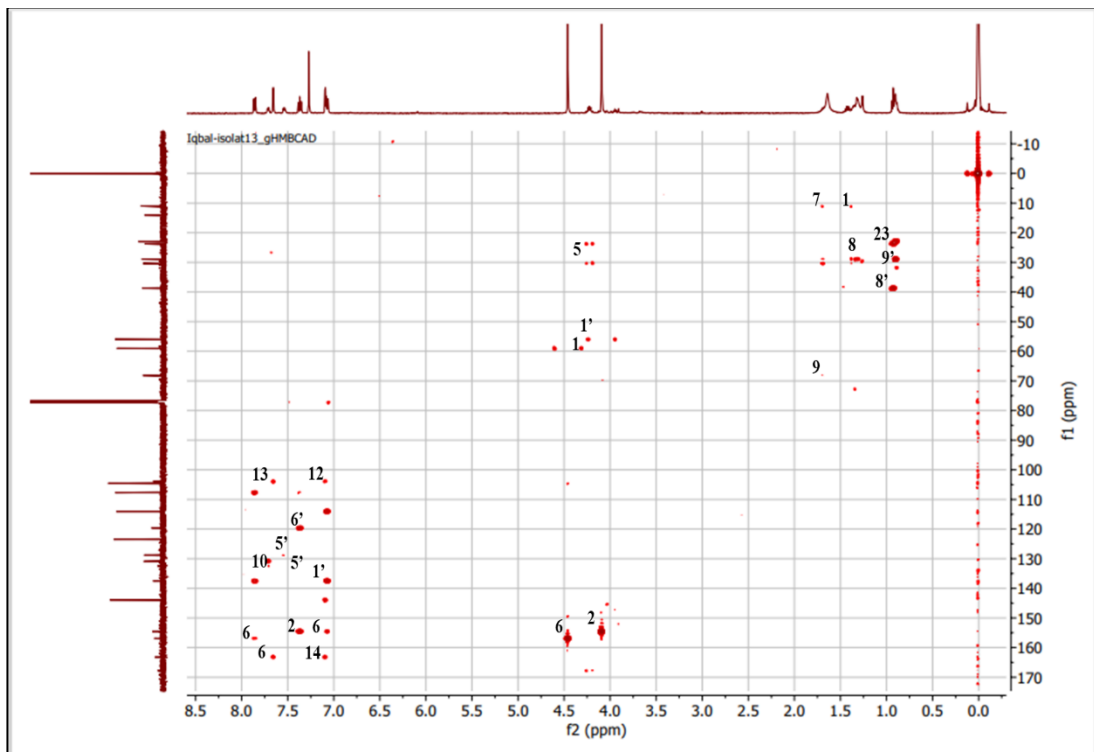
### ANALISIS SPEKTROSKOPI NMR (*Nuclear Magnetik Resonansi*)



Gambar V.13 Hasil spektroskopi NMR HSQC (*Heteronuclear Single Quantum Coherence*)

## LAMPIRAN 4 (LANJUTAN)

### ANALISIS SPEKTROSKOPI NMR (*Nuclear Magnetik Resonansi*)



**Gambar V.14** Hasil spektroskopi NMR HMBC (*Heteronuclear Multiple Bond Connectivity*)

**LAMPIRAN 4  
(LANJUTAN)**

**ANALISIS SPEKTROSKOPI NMR (*Nuclear Magnetik Resonansi*)**

**Tabel V.4**

Hasil analisis Spektroskopi NMR (*Nuclear Magnetik Resonansi*)

NO <sup>13</sup> C-NMR $\delta$ (ppm)	<sup>13</sup> C-NMR $\delta$ (ppm)	HSQC ( <sup>1</sup> H-NMR $\delta$ (ppm))	HMBC
1	11,1	0,91 (m)	3;4;5;7;
1	144,0	7,64 (d)	11;12;
1	104,0	7,07 (m)	11;12;
1	59,1	4,45 (s)	22;
2	154,7	-	-
3	23,1	1,30 (t)	-
4	114,2	7,84 $J= 1,3\text{Hz}$ 7,85 $J=1,2\text{Hz}$ (dd)	13;
5	29,0	1,25 (s)	5;6;
6	157,0	-	-
7	14,2	0,90 (s)	-
8	23,8	1,41 $J= 7,15\text{Hz}$ 1,44 $J=6,9\text{Hz}$ (dd)	-
9	68,2	4,21 (s)	8;4;6;22
10	131,0	7,52 $J=3,3\text{Hz}$ 7,53 $J=3,3\text{Hz}$ (dd)	-
1'	56,1	4,08 (d)	21;
1'	137,6	-	-
5'	128,9	7,70 $J=3,3\text{Hz}$ 7,71 $J=3,25\text{Hz}$ (dd)	12;

**LAMPIRAN 4  
(LANJUTAN)**

**ANALISIS SPEKTROSKOPI NMR (*Nuclear Magnetik Resonansi*)**

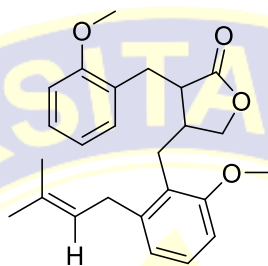
**Tabel V.4**

Hasil analisis Spektroskopi NMR (*Nuclear Magnetik Resonansi*)

NO <sup>13</sup> C-NMR δ (ppm)	<sup>13</sup> C-NMR δ (ppm)	HSQC ( <sup>1</sup> H-NMR δ (ppm))	HMBC
6'	119,8	-	-
8'	38,8	1,66 (t)	-
9'	30,4	1,39 (d)	5;1;
11	123,5	7,35 <i>J</i> =7,6Hz 7,37 <i>J</i> = 7,65Hz (dd)	21;22;
12	104,6	-	-
13	107,8	7,07 (s)	-
14	163,3	-	-
6'	119,8	-	-

**LAMPIRAN 4  
(LANJUTAN)**

**ANALISIS SPEKTROSKOPI NMR (*Nuclear Magnetik  
Resonansi*)**



**1'-2 Dimetoksi 6-prenil dibutirolakton**

**Gambar V.15** Hasil elusidasi struktur senyawa 13 F5Cg