



Available online at
www.heca-analitika.com/malacca_pharmaceutics

Malacca Pharmaceuticals

Vol. 1, No. 1, 2023



Antibacterial Activity of *n*-Hexane Dragon's Blood Resin Extract (*Daemonorops draco* wild Blume) from Bener Meriah, Aceh Province, Indonesia

Khairan Khairan^{1,2,3,4,*}, Musfira Arini¹, Rinaldi Idroes^{1,2,4}, Khalijah Awang⁵ and Claus Jacob⁶

¹ Department of Pharmacy, Faculty of Mathematics and Natural Sciences, Universitas Syiah Kuala, Banda Aceh 23111, Indonesia; khairankhairan@usk.ac.id (K.K.); musfiraarini@yahoo.com (M.A.); rinaldi.idroes@usk.ac.id (R.I.)

² Herbal Medicinal Research Centre, Universitas Syiah Kuala, Banda Aceh 23111, Indonesia;

³ Atsiri Research Centre, PUI-PT-Nilam, Universitas Syiah Kuala, Banda Aceh 23111, Indonesia;

⁴ Department of Chemistry, Faculty of Mathematics and Natural Sciences, Universitas Syiah Kuala, Banda Aceh 23111, Indonesia;

⁵ Department of Chemistry, Faculty of Science, University of Malaya, Malaysia; khalijah@um.edu.my (K.A.)

⁶ School of Pharmacy, Universitaet des Saarlandes, Saarbruecken, Germany; c.jacob@mx.uni-saarland.de (C.J.)

* Correspondence: khairankhairan@usk.ac.id

Article History

Received 4 May 2023

Revised 27 May 2023

Accepted 11 June 2023

Available Online 17 June 2023

Keywords:

Dragon's blood resin

Bener Meriah

Staphylococcus aureus ATCC 25923

Escherichia coli ATCC 25922

Candida albicans 10231

Abstract

The dragon's blood resin (*Daemonorops draco* wild Blume) has been used in folk medicine for pharmacological activities such as antimicrobial, antiviral, anti-inflammation, gastrointestinal disorders, blood circulation dysfunctions, antitumor, and cancer. This study was designated to evaluate the antibacterial activity of *n*-Hexane dragon's blood resin extract against *Staphylococcus aureus* ATCC 25923, *Escherichia coli* ATCC 25922, and *Candida albicans* 10231. The other purpose of this study was to determine the secondary metabolites compound of *n*-Hexane dragon's blood resin extract. The antimicrobial activities of the *n*-Hexane dragon's blood resin extract was determined using well diffusion method and the results showed that the extract at concentration of 15% exhibited antimicrobial activities against *Staphylococcus aureus* ATCC 25923, *Escherichia coli* ATCC 25922, and *Candida albicans* 10231 with the diameter inhibition of 13.20 mm; 21.3 mm; and 13.0 mm respectively. The phytochemicals screening showed that the extract contains secondary metabolites in the form of flavonoids. The GC-MS analysis showed that *n*-Hexane dragon's blood resin extract contains 48 chemicals compounds, and the compound at RT 26 was indicated a Drachorhodin compound (C₁₇H₁₈O₃) with the mass ration of m/z was 270 g/mol. Overall, the *n*-Hexane dragon's blood resin extract be a good choice for antimicrobial agent against bacteria and fungi.



Copyright: © 2023 by the authors. This is an open-access article distributed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License. (<https://creativecommons.org/licenses/by-nc/4.0/>)

1. Introduction

Dragon's blood resin (*Daemonorops draco* wild Blume), a deep red resin, is well-known used as traditional medicine obtained from four different species: *Croton* spp., *Dracaena* spp., *Daemonorops* spp., and *Pterocarpus* spp. *Daemonorops draco* produces red resin as the form

of rattan fruit secretion, and this resin is also called as "dragon blood" [1].

Daemonorops draco empirically be used to cure broken bones, rheumatics, blood circulation dysfunction, and cancer. The previous study mentioned that this resin can be potentially used as a wound healing [2]. A recent study reveals that the phenolic compound in dragon blood

resin can potentially act as protective agent in liver, brain, kidney failure, spleen, cerebrum diseases, antioxidant agent and anti-biofilm agent [3–5]. In Indonesia, this resin traditionally used for treatment of diarrhea, digestive problems, and wound healing. Besides that, this resin industrially used as natural dye for furniture, craft, tiles, and even used in composition for painting in automotive aeronautical industry [6]. Purwanti mentioned that the Ethyl acetate and Methanolic extracts of dragon's blood resin inhibited the growth of *Staphylococcus aureus* bacteria [4]. Mohammed states that dragon's blood resin with various solvent extracts such as *n*-Hexane, Ethyl acetate, Methanol, Acetone and Ethanol have antimicrobial activities against *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Escherichia coli*, and *Candida albicans* [7]. The study conducted by Pasaribu revealed that the extracts of *n*-Hexane, Ethyl acetate, and Methanol of dragon's blood resin have antibacterial and antifungal activities against *Staphylococcus aureus*, *Bacillus subtilis*, *Candida albicans*, and *Aspergillus flavus* [8].

The previous research reported that dragon's blood resin contains various compounds such as Drakoresene, Drakoalban, Benzoyacetic acid, Dracordin, Dracorhodin, Nordracordin and Nordracorubuin [6]. Dragon's blood resin also reported contains few secondary metabolites such as Flavonoid, Terpenoid, and Tannin [9]. Dragon's blood resin is a bright red resin due to presence of flavylum chromophores also called Dracorhodin, which has ethnomedicinal properties because it contains phenolic compounds [3]. Toriq also reported that Dracorhodin is a major compound contain in dragon's blood resin. Dracorhodin is a flavonoid, group of anthocyanin compound. This compound is known main key pigment that produced the color of dragon's blood resin (*Daemonorops draco* wild Blume) [6].

In this study, we designated to evaluate the antimicrobial activities of *n*-Hexane dragon's blood resin extract (*Daemonorops draco* wild Blume) against *Staphylococcus aureus* ATCC 25923 (*S. aureus*), *Escherichia coli* ATCC 25922 (*E. coli*), and *Candida albicans* 10231 (*C. albicans*). In this study, we also determined the chemicals compositions of the *n*-Hexane dragon's blood resin extract by using *Gas Chromatography Mass Spectrometry* (GC-MS).

2. Materials and Methods

2.1. Materials

This study used dragon blood's rattan fruits from Bener Meriah Regency, Aceh Province, Indonesia. Other materials used include *n*-Hexane, Sodium chloride (NaCl) 0.9%, Hydrochloric acid, H₂SO₄, Mayer, Bouchardat, and Dragendrof reagent solutions. The positive control such as Amoxicillin, Gentamicin, and Nystatin were provided

by the Department of Pharmacy, Universitas Syiah Kuala, Banda Aceh, Indonesia. Nutrient Agar (NA), Mueller Hinton Agar (MHA), and Sabouraud Dextrose Agar (SDA) media were purchased from Sigma Aldrich, Singapore.

2.2. Determination of plant

The sample fruits of the plant were botanically identified at the Indonesian Institute of Sciences (LIPI), Bogor, Indonesia. The purpose of plant determination is to find out the correct identity of the plant used.

2.3. Preparation of dragon's blood resin

Daemonorops draco wild Blume fruits were cleaned of the dirty part by washing them thoroughly with running water. The fruits were then weighed, then left to dry for 7 days at a temperature of 25 ± 5 °C, to avoid the compounds from suffering. Then the dry weight was weighed, and powdered using a blender to obtain a dragon's blood resin, the resin then stored in a plastic container in a place protected from sunlight before used.

2.4. Characterization of the resin

2.4.1. Microscopic examination

Microscopic examination of the resin was performed by sprinkling the resin on an object glass, then dripped with chloralhydrate solution and subsequently covered with a cover glass. The microscopic characterization of the resin were observed 40x1100 magnifications under a microscope (Carl Zeiss).

2.4.2. The physicochemical characterization of the resin

The physicochemical characterization of the resin was performed based on the procedure that developed by WHO. The physicochemical characterization of the resin include total of water, ash content, water and ethanol soluble of resin [10, 11].

2.5. Preparation of dragon's blood resin extract

Dragon's blood resin extract was performed by soaking 10g of the resin with 750 ml *n*-Hexane solvent in maceration container which was then stored in a room temperature for 5 days while keeping shaking it for couple times. After 5 days, the macerate was then filtered; the residue was then remacerated by using 250 ml *n*-Hexane solvent for the next 2 days. The macerates were then combined and concentrated by using a rotary evaporator to obtain a crude *n*-Hexane dragon's blood resin extract.

2.5.1. The physicochemical characterization of the extract

The physicochemical characterization of the extract was conducted based on the procedure that developed by

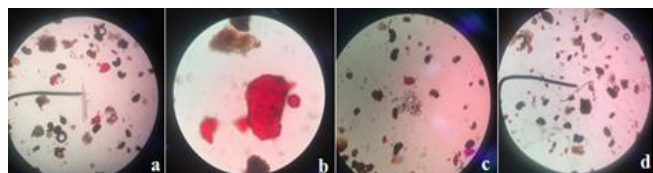


Figure 1. The microscopic characterization of resin from *Daemonorops draco* wild Blume. The resin contains (a) trichomes; (b) resins; (c) essential oil; and (d) hair cover.

Table 1. The physicochemical characterization of dragon's blood resin and *n*-Hexane dragon's blood resin extract (*Daemonorops draco* wild Blume).

Parameters	Characterization of the resin and the extract of resin	
	Resin ^a	Resin Extract ^b
Water content (%)	8.4±0.3	9.2±6.2
Ash content (%)	8.1±5.6	13.1±6.9
Water soluble content (%)	5.6±4.0	3.3±1.4
Ethanol soluble content (%)	14.0±1.0	85.8±3.8

^adragon's blood resin (*Daemonorops draco* wild Blume); ^b*n*-Hexane dragon's blood resin extract (*Daemonorops draco* wild Blume)

WHO. The physicochemical characterization of the extract include total of water, ash content, water and ethanol soluble extract [10, 11].

2.6. Phytochemical screening of the extract

The phytochemical screening of the extract was performed based on standard method. The phytochemicals screening of *n*-Hexane dragon's blood resin extract in this study included alkaloids, flavonoids, saponins, tannins, and steroid [12]. The alkaloids were tested via Mayer test (formed a white or yellow precipitate), Bouchardat's test (formed a brown-colored precipitate), and Dragendorff's test (created an orange-red precipitate). The flavonoids were tested (formed a yellow color) when added NaOH solution turned colorless in the presence of dilute HCl. The saponins test (observe the formation of foam). The tannins' presence were turned into black or blue-green precipitate when 5% of ferric chloride (FeCl₃) were added. The Salkowski and Liebermann-Burchard tests (forming a reddish-brown and red-brown coloration) were applied to detect the presence of steroids and terpenoids.

2.7. Antibacterial assay

The antibacterial activity was determined by well diffusion method. The inoculating of *Escherichia coli* and *Staphylococcus aureus* were grown into Mueller Hinton Agar (MHA) plates media through *swab* technique by using sterile cotton bud. As much as 12 µL of each sample (*n*-Hexane dragon's resin extract at various concentrations of 5%; 10%; and 15%), a positive control (Amoxicillin for *Staphylococcus aureus* or Gentamicyn for *Escherichia coli*) and a negative control (solvent) were then

placed on the well in the petri dish. The diameter of the inhibition formed after incubating the media at 37°C for 24 h was then measured. The clear zone formed on the media was measured to determine antibacterial activity of the sample [13].

2.8. Antifungal Assay

The antifungal activity was determined by Kirby-Bauer well diffusion method. The inoculating of *Candida albicans* were grown into Sabouraud dextrose agar (SDA) plates media through *swab* technique by using sterile cotton bud. As much as 12 µL of each sample (*n*-Hexane dragon's resin extract at various concentrations of 5%; 10%; and 15%), a positive control (Nystatin) and a negative control (solvent) were then placed on the well in the petri dish. The diameter of the inhibition formed after incubating the media at 37 °C for 24 h was then measured. The clear zone formed on the media was measured to determine antibacterial activity of the sample [13].

2.9. FT-IR spectroscopy analysis

The *n*-Hexane dragon's blood resin extract was performed using FT-IR spectroscopy (Cary 630 FTIR spectrometer, Agilent Technologies, 5301 Stevens Creek Blvd, Santa Clara, CA, USA) with a wavelength of 4000-650 cm⁻¹ [14].

2.10. GC-MS Spectroscopy Analysis

The *n*-Hexane dragon blood resin extract was performed on gas chromatography-mass spectrometry (GCMS-QP2010S, Shimadzu, Tokyo, Japan). Twenty microliters of sample extract was diluted to 1 mL with Hexane (≥99%, Sigma-Aldrich, Germany). The GC-MS was equipped with a RTX-5MS column (ID 30 m x 0.25 mm, film thickness 0.25 µm) and operated under the following conditions: Helium (He) was used as carrier gas (99.99%, AGA Lithuania) at a flow rate of 28 mL/min. The column temperature was maintained at 70°C for 5 min after injection and then programmed at 5°C/min to 300 °C, at which the column was maintained for 29 minutes. The split ratio was 1:10. The mass detector electron ionization was EI 70 eV. Identification of volatile compounds was carried out using mass spectra library search (NIST 14) and compared with the mass spectral data from literature [6].

3. Results and Discussions

3.1. Plant determination

The plant determination results showed that the fruits sample were used in this study was from *Daemonorops draco* wild Blue (*D. draco* w. B), family from *Arecaceae*.

Table 2. The phytochemical screening of *n*-Hexane resin dragon's blood extract (*Daemonorops draco* wild Blume) from Bener Meriah, Aceh, Indonesia.

Secondary Metabolite	Reagents	Results
Alkaloids	Mayer reagent	-(ve)
	Bouchardat reagent	-(ve)
	Dragendrof reagent	+(ve)
Flavonoids	Mg	+(ve)
Saponins	Aquadest + HCl 2N	-(ve)
Tannins	FeCl ₃	-(ve)
Steroids	Libermann-Bouchardat	-(ve)

+(ve): positive; -(ve): negative

Table 3. The diameter inhibition of *n*-hexane resin dragon's blood extract (*Daemonorops draco* wild Blume) against bacterial and fungi.

Sample	Diameter of inhibition zone (mm)
Positive control ^a	31.0±0.3
Positive control ^b	21.0±0.4
Positive control ^c	15.0±0.6
Negative control ^d	0±0
Concentration of extract	<i>Escherichia coli</i> ATCC 25922
5 %	16.0±0.3
10 %	17.5±0.3
15 %	21.3±0.1
Concentration of extract	<i>Staphylococcus aureus</i> ATCC 25923
5 %	9.0±0.4
10 %	11.0±0.1
15 %	13.2±0.1
Concentration of extract	<i>Candida albicans</i> ATCC 10231
5 %	8.6±0.3
10 %	8.1±0.2
15 %	13.0±0.3

Note: ^{a,b}positive control for *Escherichia coli* and *Staphylococcus aureus* were Gentamisin and Amoxicillin respectively; ^cPositive control for *Candida albicans* was Nystatin; ^dnegative control was *n*-Hexane

3.2. Characterization of the resin

3.2.1. Microscopic examination

In this study, the microscopic examination of the resin was also determined. The microscopic characterization of the resin is presented in Figure 1. The fragments were performed by using microscopes with 40x1100 magnifications. The results showed that the resin contain trichrome (a), resin (b), essential oil (c), and hair cover (d).

3.2.2. The physicochemical characterization of the resin

The physicochemical characterization of the resin includes total water and ash content, water soluble and ethanol soluble of the resin were performed to ensure the diversity of resin quality to fulfil the requirement of resin standard. The physicochemical characterization of dragon's blood resin can be seen on Table 1. Table 1 showed that the resin containing total water, ash, water soluble, and ethanol soluble extract of 8.4%; 8.1%; 5.6%; and 14.0% respectively.

The result showed that the water content of the resin was complied with the standard requirements, which did not exceed 10%. The result also showed that ash total content of the resin was low, this indicates the resin was used in this study was have a good quality. The Table 1 showed that dragon's blood resin was more soluble in ethanol, this indicates that the resin contained a semi-polar to a non-polar compounds.

3.3. *n*-Hexane Dragon's Blood Resin Extract

3.3.1. The physicochemical characterization of the resin

In this study, the physicochemical characterization of the *n*-Hexane dragon's blood resin extract were also determined. The physicochemical characterization includes total water and ash content, water-soluble and ethanol-soluble extract. The aim of this physicochemical characterization were to ensure the quality of the extract. The physicochemical characterizations of the *n*-Hexane dragon's blood resin extract is presented in the Table 1. Table 1 showed that the *n*-Hexane dragon's blood resin extract containing total water, ash, water soluble, and ethanol soluble extract of 9.2%; 13.1%; 3.3%; and 85.8% respectively. The results showed that the water content of the resin extract was satisfied with the required standard i.e., below 10%. The purpose of determining the water content is to ensure the quality of the extract. The extracts with low water content can prevent the growth of microorganisms that cause spoilage of the extract. The result also revealed that the ash total of the extract was still satisfied with the required standard. Similarly with the resin, *n*-Hexane dragon's blood resin extract also showed was more soluble in ethanol, this indicates that the extract contained a semi-polar to a non-polar compounds.

3.4. The phytochemical screening of *n*-Hexane dragon's blood resin extract

The phytochemical screening of *n*-Hexane dragon's blood resin extract (*Daemonorops draco* wild Blume) are presented in Table 2.

In this study, the phytochemical screening of the *n*-Hexane resin dragon's blood extract including Alkaloids, Flavonoids, Tannins, Steroids, Terpenoids and Saponins. Table 1 showed that *n*-Hexane dragon's blood resin extract (*Daemonorops draco* wild Blume) from Bener Meriah Regency, Aceh Province contains secondary metabolites in the form of flavonoids. Meanwhile, Pasaribu et al., mentioned that Ethyl acetate and Methanolic dragon's blood resin extract from Jambi, Indonesia contains Flavonoid and Terpenoid [8, 10]. However, Minami et al mentioned that Ethanolic extract of dragon's blood resin (*Daemonorops didymophylla*) contains secondary metabolites of flavonoids, alkaloids

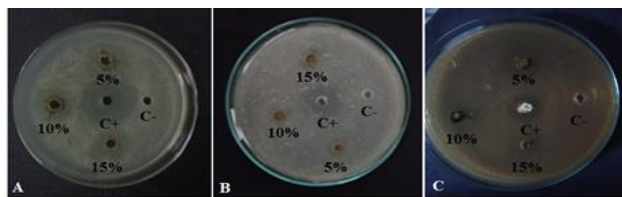


Figure 2. The activity of *n*-Hexane dragon's blood resin extract (*Daemonorops draco* wild Blume) against microorganism A. *Escherichia coli*; B. *Staphylococcus aureus*; dan C. *Candida albicans*.

and triterpenoids. Minami et al., also showed that the secondary metabolites found in *Daemonorops didymophylla* have similarities with the Ethyl acetate, *n*-Hexane, and Methanolic extracts of *Daemonorops longipes*, *Daemonorops draco* and *Daemonorops melanochets* [15].

3.5. Antimicrobial activities

The antimicrobial activities of *n*-Hexane resin dragon's blood extract (*Daemonorops draco* wild Blume) were performed against *Staphylococcus aureus* ATCC 25923, *Escherichia coli* ATCC 25922, and *Candida albicans* ATCC 10231. In this assay, Gentamicin and Amoxicillin were used as positive control for the antibacterial assay. Meanwhile, Nystatin was used as a positive control for antifungal assay. The antimicrobial activities (antibacterial and antifungal) of *n*-Hexane resin dragon's blood extract at concentration of 5%; 10%; and 15% are shown in Table 3.

The results showed that *n*-Hexane dragon's blood resin extract at higher concentration of 15% performed the higher activity against *Escherichia coli* and *Staphylococcus aureus* with the diameter of inhibition zone of 21.3 mm and 13.2 mm respectively. The same occurrence also shown that *n*-Hexane dragon's blood resin extract at concentration of 15% performed the higher activity against *Candida albicans* with the diameter of inhibition zone formed of 15.6 mm. This result was in line with the previous study reported by Pasaribu and Totok that states that *n*-Hexane dragon's blood resin extract has antimicrobial properties with high sensitivity [8]. Pelczar and Chan mentioned that the higher the concentration of the extract, produced the bigger the activity performed in the inhibition zone [16].

According to Toriq and Gupta, Dracorhodin and Darcorubin are the compounds that contained in the dragon's blood resin. These compounds were play an important role in antimicrobial activity of the dragon's blood resin [6, 17]. Shi also mentioned that Dracorhodin is the primary pigment compound of dragon's blood resin which pharmacologically and biologically has the potential to be antimicroba, antiviral, antitumor, and cytotoxic activity [18]. The inhibition zone of *n*-Hexane

dragon's blood resin extract (*Daemonorops draco* wild Blume) performed against *Staphylococcus aureus*, *Escherichia coli*, and *Candida albicans* is shown in Figure 2.

3.6. FT-IR analysis

FT-IR analysis was performed by using Agilent Technologies Cary model 630 with absorption at the wave number 4000-650 cm^{-1} . Spectrum pattern of FT-IR of *n*-Hexane dragon's blood resin extract can be seen on the Figure 3.

The result shows that absorption spectrum of FT-IR of *n*-Hexane dragon's blood resin extract was at wave number 3361.02 cm^{-1} ; 2921.08 cm^{-1} ; 2855.84 cm^{-1} ; 1605.01 cm^{-1} ; 1450.29 cm^{-1} ; 1263.38 cm^{-1} ; and 1088.85 cm^{-1} . Absorption at wave number 3361.02 cm^{-1} is the kind of absorption found in Hydroxyl ($-\text{OH}$) group. Spectra at the wave number of 2921.08 cm^{-1} and 2855.84 cm^{-1} are absorption of $-\text{C}-\text{H}$ stretching and the Carboxylate group ($-\text{CO}_2\text{H}$) be expected obtained from fatty acid found in the extract. The spectrum at wave number of 1605.01 cm^{-1} is absorption of $\text{C}=\text{C}$ that be expected from aromatic compound. The spectrum at wave number 1263.38 cm^{-1} is unique absorption might be obtained from $-\text{C}-\text{O}-\text{C}-$ originated from ether compound, where this absorption is normally absorbed at the range of wave number 1230-1270 cm^{-1} [19]. Meanwhile, the absorption at wave number of 1088.65 cm^{-1} is considered obtained from $-\text{C}-\text{O}$ group originated from Alcohol and Ether.

3.7. GC-MS analysis

The GC spectrum of *n*-Hexane dragon's blood resin extract (*D. draco* wild Blume) is presented in Figure 4. The results showed that *n*-Hexane dragon's blood resin extract originated from Bener Meriah generated 48 compounds. The results also showed that the extract contains eight mayor compounds at peak number of 4; 6; 8; 10; 14; 15; 26; and 28 with the percentage area of these compounds ranging between 13 and 18% (Table 4).

The eight mayor compounds were detected in *n*-Hexane dragon's blood resin extract are 1-Hexadesene, Hexadecanoic acid, 9,12Hexadecadienoic acidcyclododecyne;1-tetracosanol, 2H-1-Benzopyran-7-ol, 3,4-Dihydro-5-Methoxy-6 methyl -2-Phynyl and 1,2-Benzenedicaboxylic acid. The compound of 2H-1-Benzopyran-7-ol, 3,4-Dihydro-5-Methoxy-6 methyl -2-Phynyl (also known as Dracorhodin) that detected in the *n*-Hexane dragon's blood resin extract. Dracorhodin is a characteristic and identifier compound from dragon's blood resin. The results of the GC-MS analysis showed that 2H-1-Benzopyran-7-ol, 3,4-Dihydro-5-Methoxy-6 methyl -2-Phynyl ($\text{C}_{17}\text{H}_{18}\text{O}_3$) compound was detected at the 26th peak with a retention time (RT) and m/z values of

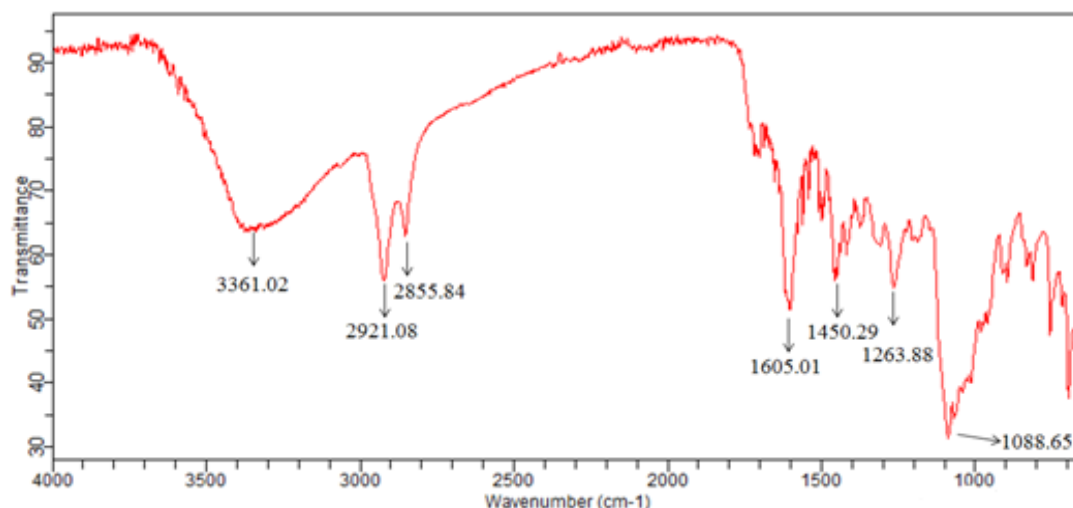


Figure 3. FT-IR analysis of *n*-Hexane dragon's blood resin extract (*Daemonorops draco* wild Blume).

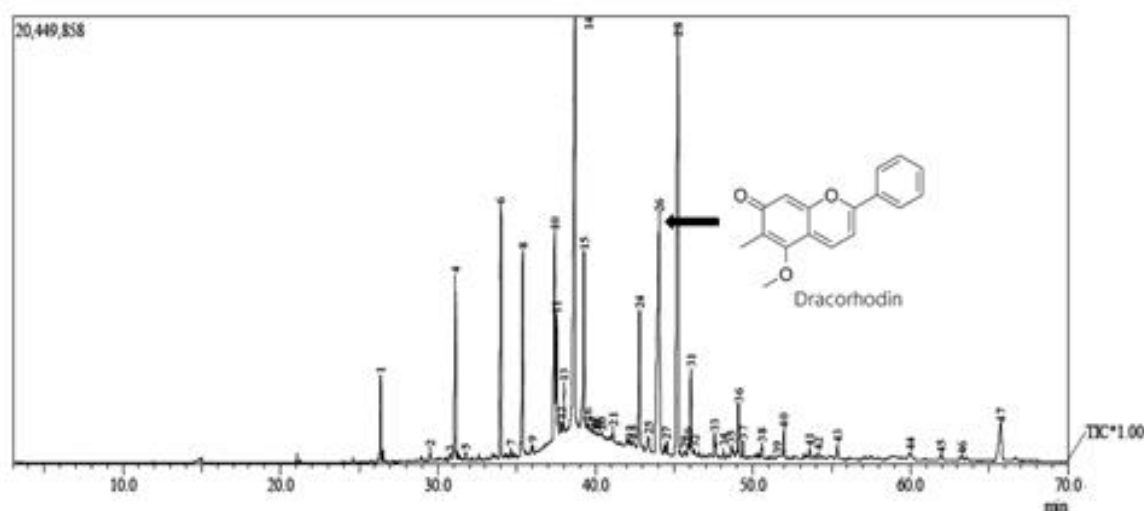


Figure 4. The GC spectrum of *n*-hexane dragon's blood resin extract (*Daemonorops draco* wild Blume) from Bener Meriah, Aceh Province, Indonesia.

Table 4. Eight mayor compounds contain in *n*-Hexane dragon's blood resin extract (*D. draco* wild Blume) by GC-MS analysis

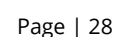
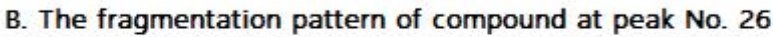
Peak No	RT	Name of Compound	Area (%)	Similarity (%)	m/z
4	31	1-Hexadesena	4.1	97	224
6	34	Hexadecanoic acid	5.7	96	270
8	35	1-Pentadecena	5.0	95	210
10	37	9,12- Hexadecanoic acid	5.8	95	266
14	38	Cyclododecyne	18.2	90	164
15	39	1-tetracosanol	6.2	95	354
26	44	2H-1-benzopyran-7-ol, 3, 4-dihydro-5-methoxy-6-methyl-2-phenyl	13.2	78	270
28	45	1, 2-Benzenedicarboxylic acid	13.9	94	390

44.103 and 270 g/mol respectively. The mass spectrum and the fragmentation pattern of the 2H-1-Benzopyran-7-ol, 3,4-Dihydro-5-Methoxy-6 methyl -2-Phnyl ($C_{17}H_{18}O_3$) can be seen in Figure 5.

Some researchers reported that compound of 2H-1-Benzopyran-7-ol, 3,4-Dihydro-5-Methoxy-6 methyl -2-

Phnyl (also known as Dracorhodin) is an important role as identifier in dragon's blood resin [1, 20, 21]. In the previous study, it was also reported that Dracorhodin and its derivatives had been used as coloring pigments for artistry stuff since 15th century [22]. According to Melo, Dracorhodin is an Antosianin derivative which is the natural color of dragon blood [23].

Peak 26



Acknowledgments: The authors express their gratitude to their individual institutions and universities.

Conflicts of Interest: All the authors declare that there are no conflicts of interest.

References

- Gupta, D., Bleakley, B., Gupta, R. K. (2008). Dragon's blood: Botany, chemistry and therapeutic uses, *Journal of Ethnopharmacology*, Vol. 115, No. 3, 361–380. doi:10.1016/j.jep.2007.10.018
- Namjoyan, F., Kiashi, F., Moosavi, Z. B., Saffari, F., Makhmalzadeh, B. S. (2016). Efficacy of Dragon's blood cream on wound healing: A randomized, double-blind, placebo-controlled clinical trial, *Journal of Traditional and Complementary Medicine*, Vol. 6, No. 1, 37–40. doi:10.1016/j.jtcme.2014.11.029
- Mahmood, S., Fatima, T., Zulfaqar, H., Saher, R., Rafiq, M., Rehman, A., Dai, R., Ashfaq, M., Hasan, M. (2017). Meta-analysis of dragon's blood resin extract as radio-protective agent, *Journal of Coastal Life Medicine*, 409–416. doi:10.12980/jclm.5.2017J7-75
- Purwanti, S. (2017). Aktivitas Antioksidan, Antibakteri, dan Antibiofilm Resin Jernang (*Daemonorops draco*), Bogor Agricultural University (IPB)
- Nisah, K., Fahrina, A., Rizki, D. R., Puspita, K. (2023). Optimization of Starch— κ -Carrageenan Hybrid Film as Drug Delivery System using Response Surface Method, *Heca Journal of Applied Sciences*, Vol. 1, No. 1, 19–23. doi:https://doi.org/10.60084/hjas.v1i1.10
- Toriq, U. (2013). Senyawa kimia penciri jernang untuk pembaruan parameter standar nasional Indonesia
- Eissa Mohammed, Y. H. (2016). In-vitro Anti-Cancer Activity of Extracts *Dracaena Cinnabari* Balf. F Resin from Socotra Island in Yemen Republic, *Biochemistry & Analytical Biochemistry*, Vol. 5, No. 3. doi:10.4172/2161-1009.1000296
- Kartono Waluyo, T., Pasaribu, G. (2015). Aktivitas Antijamur, Antibakteri dan Penyembuhan Luka Ekstrak Resin Jernang, *Jurnal Penelitian Hasil Hutan*, Vol. 33, No. 4, 377–385. doi:10.20886/jphh.2015.33.4.377-385
- K Waluyo, T., Pasaribu, G. (2013). Aktifitas Antioksidan dan Antikoagulasi Resin Jernang, *Jurnal Penelitian Hasil Hutan*, Vol. 31, No. 4, 306–315. doi:10.20886/jphh.2013.31.4.306-315
- Departemen Kesehatan RI. (2000). *Farmakope Indonesia Edisi IV*, Depkes RI, Jakarta
- Organization, W. H. (2003). *Manual for the laboratory identification and antimicrobial susceptibility testing of bacterial pathogens of public health importance in the developing world: Haemophilus influenzae, Neisseria meningitidis, Streptococcus pneumoniae, Neisseria gonorrhoea*, SWorld Health Organization
- Harborne, J. B. (1987). *Phytochemical Method: A Guide To Modern Techniquws of Plant Analysis*, Oleh Kosasih Padmawinata Dan Iwang Sudiro, ITB, Bandung
- Khairan, K., Hasan, M., Idroes, R., Diah, M. (2023). Fabrication and Evaluation of Polyvinyl Alcohol/Corn Starch/Patchouli Oil Hydrogel Films Loaded with Silver Nanoparticles Biosynthesized in *Pogostemon cablin* Benth Leaves' Extract, *Molecules*, Vol. 28, No. 5, 2020. doi:10.3390/molecules28052020
- Ismalita, Khairan, K., Rahmi, Muhammad, S., Indra, I. (2022). Green synthesis of sulfur nanoparticles using *Allium sativum*: Its effects on the growth of *Pogostemon cablin* Benth. and the chemical characterization of the patchouli oil after being harvested, *Nanotechnology for Environmental Engineering*, Vol. 7, No. 2, 359–375. doi:10.1007/s41204-022-00217-5
- Minarni, Muhaimin, Demando, G. (2020). Antibacterial Activity of Ethanol Extract of Dragon's Blood (*Daemonorops didymophylla*) Against *Salmonella typhi* and *Streptococcus* mutants, *Jurnal Akta Kimia Indonesia*, Vol. 13, No. 2. doi:http://dx.doi.org/10.20956/ica.v13i2.10506
- Pelczar, M. J., Chan, E. C. S. (1988). *Dasar-dasar mikrobiologi jilid 2*, Penerbit UI, Jakarta
- Gupta, D., Gupta, R. K. (2011). Bioprotective properties of Dragon's blood resin: In vitro evaluation of antioxidant activity and antimicrobial activity, *BMC Complementary and Alternative Medicine*, Vol. 11, No. 1, 13. doi:10.1186/1472-6882-11-13
- Shi, J., Hu, R., Lu, Y., Sun, C., Wu, T. (2009). Single-step purification of dracorhodin from dragon's blood resin of *Daemonorops draco* using high-speed counter-current chromatography combined with pH modulation, *Journal of Separation Science*, Vol. 32, Nos. 23–24, 4040–4047. doi:10.1002/jssc.200900392
- Silverstein, R. M., Webster, F. X., Kiemle, D. J. (2005). *Spectrometric Identification of Organic Compounds 7th Editio*, John Wiley & Son Inc, New York
- Brockmann, H. (1943). Constitution of dracorhodin, a new pigment from" dragon's blood", *Berl Dtsch Chem Ges*, Vol. 76, 751–763
- Xia, M., Wang, D., Wang, M., Tashiro, S., Onodera, S., Minami, M., Ikejima, T. (2004). Dracorhodin Perchlorate Induces Apoptosis via Activation of Caspases and Generation of Reactive Oxygen Species, *Journal of Pharmacological Sciences*, Vol. 95, No. 2, 273–283. doi:10.1254/jphs.FPJ03102X
- Baumer, U., Dietemann, P. (2010). Identification and differentiation of dragon's blood in works of art using gas chromatography/mass spectrometry, *Analytical and Bioanalytical Chemistry*, Vol. 397, 1363–1376
- Melo, M. J., Sousa, M., Parola, A. J., de Melo, J. S. S., Catarino, F., Marçalo, J., Pina, F. (2007). Identification of 7, 4'-Dihydroxy-5-methoxyflavylium in "Dragon's Blood": To Be or Not To Be an Anthocyanin, *Chemistry—A European Journal*, Vol. 13, No. 5, 1417–1422
- Edwards, H. G. M., de Oliveira, L. F. C., Prendergast, H. D. V. (2004). Raman spectroscopic analysis of dragon's blood resins—basis for distinguishing between *Dracaena* (Convallariaceae), *Daemonorops* (Palmae) and *Croton* (Euphorbiaceae), *The Analyst*, Vol. 129, No. 2, 134–138. doi:10.1039/B311072A