Journal of Chemical Health Risks

www.jchr.org

JCHR (2024) 14(1), 378-387 | ISSN:2251-6727

Detected Molecules and Antimalarial Activity of Bajakah (Spatholobus Littoralis Hask) Extract Combined with Bio Coil Plus in Plasmodium Falciparum Strain 3d7

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(Received: 27 October 2023 Revised: 22 November Accepted: 26 December)

KEYWORDS
Bajakah Kolaka, Antimalarial, Bio Coil Plus, Antiplasmodium

Abstract

The impact of COVID-19 in 2022 adds to the challenges for the worldwide malaria response. In 2020 WHO found that a 25% disruption in access to effective antimalarial treatment in sub-Saharan Africa could lead to 46,000 additional deaths. This study aims to find new molecules or herbs as antimalarial drugs that are more effective in overcoming the world's problems regarding the attack of malaria. In this study, 14 molecular compounds were detected in the bark and wood of the Bajakah root (Spatholobus Littoralis Hask) in Kolaka, Southeast Sulawesi, which have the potential as antimalarial drugs. This is supported by the results of the antiplasmodial activity test on the bark and wood of Spatholobus Littoralis Hask combined with Virgin Coconut Oil (VCO) in the form of a liquid herbal/herbal formulation of Bio Coil Plus which has a fairly high antimalarial activity. Further studies will be focused on isolating, purifying, and elucidating the molecular structure of the active antiplasmodial compound from the Spatholobus Littoralis Hask subfraction.

INTRODUCTION

In 2020, COVID-19 emerged as an added–and formidable–challenge to malaria responses worldwide. In line with WHO guidance, many countries have adapted the way they deliver nets, diagnostics, and medicines to ensure the safety of frontline health workers and communities (WHO, 2022)[1]. However, according to new WHO projections, even moderate disruptions in access to effective treatment could lead to a considerable loss of life. The report finds, for example, that a 25% disruption in access to effective antimalarial treatment in sub-Saharan Africa could lead to 46000 additional deaths (WHO, 2022)[1]. The P. falciparum, P. vivax, P. ovale, P. malariae, and P. knowlesi are the five Plasmodium species that cause malaria disease in humans. P. falciparum is the deadliest strain that causes malaria and this form of parasite predominates in Africa[2].

Many previous researchers have conducted efforts to find new antimalarial drugs, including molecular design of aurone derivatives as antimalarial agents[3], antiplasmodial activity tests of natural compounds alstonine and himbeline[4], 17 types of antimalarial herbs, namely T. diversifolia, M. charantia, C. rotundus, S. lingustrina, A. paniculata Nees, C. longifolia, T. crispa (L) Miers, P. betle L., P. scutellarioides L., A. scholaris (L.) R.Br, C. papaya L., A. spinosus L., A. champeden, C. siamea Lamk., A. indica, H. annuus L., and B. balsamifera[5], synthesis and antimalarial activity of (S)-methyl-(7-chloroquinolin-4-ylthio)-acetamidoalquilate derivatives[6], synthesis and antimalarial activity of some triphenyltin (IV) aminobenzoate compounds against Plasmodium falciparum[7], an assay of antimalarial activity of phenolic compounds from Macaranga beccariana Merr leave[8], the antimalarial activity of plant metabolites[2], antimalarial and antileishmanial agents from pyrazole derived moiety[9], n-hexane fraction of methanol extract and steroid compounds from the stem of Fibraurea tinctoria could inhibit the growth of Plasmodium falciparum[10].

Journal of Chemical Health Risks

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JCHR (2024) 14(1), 378-387 | ISSN:2251-6727

Several previous studies on the bark and wood of the plow root include methanol extracts of the bark and root of the plow, which contain secondary metabolites of alkaloids, flavonoids, triterpenes, and phenolics and are highly toxic to larvae of A. salina shrimp with LC_{50} values of 1.76 respectively and 2.66 ppm[11], the results of phytochemical screening showed that the reaction results of several test reagents for the ethanol extract of bajakah stem contained groups of alkaloids, phenol hydroquinone/ tannins, and flavonoids. However, the saponin and steroid compounds were not found in the extract of the bajakah stem from Bangka Belitung, so the bajakah stem (Spatholobus littoralis Hassk) has potential as a breast anticancer and antioxidant[12], ethanol extract of the bajakah wood (Spatholobus Littoralis Hassk) has effectiveness as an anti-inflammatory[13], red bajakah root powder and white bajakah root plant both on the bark and stems contain secondary metabolites, namely phenolics, tannins, flavonoids, and based on the content of secondary metabolites and antioxidant activity in root crops. Bajakah wood (Spatholobus littoralis Hassk) has anticancer activity and is weak against breast cancer and uterine cervical cancer, categories against liver cancer and lung cancer, while it is not toxic to normal cells[14], results of phytochemical test analysis of ethanol extract Poikilospermum suaveolens (Blume) Merr leaves contain alkaloids, saponins, tannins, and terpenoids, while the results of phytochemical test analysis of the n-hexane extract of Poikilospermum suaveolens (Blume) Merr leaves contain tannins, carotenoids, and steroids[15]. Computational research has also been carried out, including research on potential active compounds of Spatholobus littoralis Hassk with in silico analysis, namely gentisic acid, 3,4,7-trihydroxyflavone, 6-methoxyeriodictyol, butin, plathymenin, dihydrokaempferol, liquiritigenin, calycosin, dihydroquercetin, eriodictyol, formononetin, neoisoliquiritigenin, daidzein, and saponins. Components analysis of root wood of Spatholobus littoralis Hassk compounds as an antioxidant, anti-inflammatory, immunosuppressor, and antipruritic is predicted to have the computational ability in the activity tested, but in laboratory tests, it has not been proven or has little potential. The highest potential bioactivity of Spatholobus littoralis Hassk is an antioxidant in which the active compound that plays the most role is dihydrokaempfero[16].

Based on the phenomenon of previous research, most organic compounds and natural active ingredients as anticancers are also active as antimalarials which can be proven by several previous studies including artesunate compounds, the three artemisinin artesunate, dihydroartemisinin (artenimol, DHA), and artemisone (BAY 44-9585), another semi-synthetic artemisinin derivative compounds[17], artemisinin[18], halogenated-arylvinyl-1,2,4-trioxanes, isolated compounds from Salvia radula[19], and indole sulfonamide derivatives[20].

Based on the functional groups possessed by the chemical molecules of the bark and root of bajakah above, it can be presumed that the root of bajakah is thought to have antimalarial activity and needs to be empirically proven in the laboratory. Another reason is that in general an anticancer compound also has antimalarial activity. Previous research related to the root of bajakah wood empirically has anticancer activity[11],[21], anti-inflammatory activity[13], antioxidant activity[12], and others.

1. MATERIAL AND METHODS

2.1 Making of VCO as a Solvent

Grated coconut meat weighed as much as 5000 grams and added enough water. The mixture was stirred for 10 minutes or until the fresh coconut milk was formed. The mixture was filtered using a sterile white cloth and the waste was processed into animal feed. The mixture of fresh coconut milk and water is left for 1.5 hours or until 2 layers are formed. The water layer below was separated through a white transparent hose. Next, the fresh coconut milk was fermented in a transparent bucket container for 16 hours in a row. The fermentation process was carried out in a closed until 2 layers were formed. The VCO layer above was separated through a transparent hose and then filtered using white cotton wrapped in filter paper. The pure oil obtained is clear white and weighed so that the yield can be calculated. Identification of VCO components and chemical structure using FT-IR spectro-photometer and GC-MS.

2.2 Isolation of Active Compounds from Bajakah Root with VCO Solvent

A total of 45 grams of piracy powder samples were put into a set of maceration tools, then 100 mL of VCO solvent was added. The flask containing the VCO solvent was assembled and then stirred using a shaker for 72 hours or until the active substance of the bajakah

Journal of Chemical Health Risks

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JCHR (2024) 14(1), 378-387 | ISSN:2251-6727

medicinal plant changed color. The results of the maceration of the bajakah roots in the form of the filtrate were filtered using Whatman paper. Furthermore, the isolates of the root mixture were dried with Na_2SO_4 powder and then filtered using Whatman paper. The solubility test of the filtrate (Bio Coil Plus bajakah) was carried out with the following solvents: water, acetone, acetonitrile, dichloromethane, and n-hexane. The structure of the chemical components of the bajakah Bio Coil Plus was identified by FT-IR and GC-MS spectrophotometers.

2.3 Isolation of Active Compounds from Bajakah of Kolaka with Organic Solvents

The root of the Spatholobus littoralis Hassk was extracted using the soxhletation method, where as much as 40 grams of the powder sample of the bajakah root was wrapped in filter paper and then put into the soxhletation column. Next, the powder was added with 275 mL of n-hexane or ethyl acetate solvent into a round bottom flask. The flask containing the solvent was assembled with a soxhlet extraction apparatus and extracted continuously for 20 hours. The result of soxhlet extraction in the form of a brown solid was carried out by solubility test and TLC test. Furthermore, the chemical components of the bark and wood extracts of bajakah were identified using FT-IR and LC-MS/MS spectrophotometers.

2.4 Antimalarial Activity Test on Bajakah Root Extract

In vitro, an antiplasmodial activity test was carried out on Plasmodium falciparum strain 3D7 by calculating the value of parasitemia using Giemsa staining. A total of 100 mcl of RPMI medium containing schizont with parasitemia 0.5-1% was put into 96 well-plates. Furthermore, as much as 100 MCL of medium containing the extract with 10 graded concentrations was added to the culture so that the final concentration of the compound was 500 mg/mL; 250 mg/mL; 125 mg/mL; 62.5 mg/mL, 31.25 mg/mL; 15.625 mg/mL; 7.813 mg/mL; 3.906 mg/mL; 1.953 mg/mL and 0.977 mg/mL. Each concentration was replicated 3 times (triple). Plasmodium falciparum strain 3D7 which had been given the extract was incubated for 72 hours. The parasitemia value was calculated by making a thin smear stained with Giemsa 5%. The value of parasitemia is calculated based on the following formula:

$$\text{Parasitemia value} = \frac{\sum \text{plasmodium cells}}{\sum \text{cells red blood}} \text{x} 100\%$$

Negative control values used Plasmodium falciparum strain 3D7 without extract. The antiplasmodial activity was expressed in IC_{50} value, which is the concentration required for an extract to inhibit the growth of Plasmodium falciparum as much as 50% obtained through probit analysis.

2. RESULT AND DISCUSSION

The bajakah root plant (Spatholobus sp.) is one of the plants used empirically by the people of Kalimantan as a medicine, the boiled water is believed to have been used for generations as a medicine for stomachaches and diarrhea[22], while the people of Mekongga Kolaka, Southeast Sulawesi are consumed as drinking water when needed on trips in the forest.

3.1 Chemical Compounds of Extract Bajakah Root

The active compound of the bajakah root was extracted using n-hexane or ethyl acetate with the soxhletation method. The component and chemical structure of the bajakah extract were analyzed using FT-IR and LC-MS/MS spectrophotometers. The compounds detected in the bark and wood of bajakah roots included: (1) apocynoside I, (2) quercetin, (3) hexosylphingosine, (4) 3-hydroxy-7-methoxybaicalein, (5) momorcerebroside I, (6) ambronal, (7) stigmastan-3,6-dione, (8) trilaurin, (9) trichosanic acid, (10) linolein, (11) uncarinic B acid, (12) 1-palmitoyl-2-arachidonoyl-sn-glycerol, (13) 4-[2-O-11-Z-octadecenoyl-beta-glucopyranosyl]-4,4'-diapoly-copene-4,4'-dioic acid, and (14) 6-[9,10,11-trihexoxy-2,12-bis-(5-oxohexoxy)-triphenylen-2-yl]-oxyhexan-2-one completely can be seen in Tables 1, 2, and 3, and the structures of these compounds were shown in Figure 1.

The 14 components of chemical compounds contained in the bark and root wood of bajakah Kolaka which are completely isolated can be seen in Tables 1, 2, and 3. Based on the polarity and functional groups of these 14 compounds, they are distributed according to the polarity and functional groups of the ethyl acetate solvent (polar) and n-hexane (non-polar). The soluble compounds in the ethylacetate solvent are compounds 1-8 which have polar functional groups, namely the hydroxyl functional group (-OH) found in compounds 1-6; the ketone functional group (=C=O) is found in compounds 1, 2, 4, 6, and 7, the ester functional group (RCOOR) is found in

Journal of Chemical Health Risks

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JCHR (2024) 14(1), 378-387 | ISSN:2251-6727

compound 8, the ether functional group (R-O-R) was found in compounds 1-5, the amine functional group found in compound 3, the amide functional group was found in compound 5, the phenol functional group (PhOH) was found in compounds 2 and 4, the phenoxy functional group was found in compound 4, and the aldehyde functional group (RCOH) was found in compound 6. which isolated through n-hexane solvent is a component of compound 9-14 which has a non-polar alkyl chain functional group found in compounds 9, 10, 12, 13, and 14, but also has a carboxylic functional group (-COOH) found in compound 9, 11, and compound 13, the ester functional group (RCOOR) was found in compounds 10-13, the ketone functional group is 14, the phenol functional group (PhOH) was found in compound 11, the aldehyde functional group was found in compound 14, and the ether functional group was found in the compound 13, the phenoxy functional group is present in 11 and 14 compounds. Although compounds 9-14 contain polar functional groups, non-polar properties remain dominant due to the presence of non-polar alkyl chain functional groups so that they can be isolated in n-hexane solvents.

3.2 Chemical Compounds of VCO as Solvents for Making Bio Coil Plus

Chemical components of VCO were identified using GC-MS, and there were absorption peaks of 122 components. Among the 122 components, there are 10 highest peaks with similarity index above 80%, namely component 30 (rt=14.046 minutes) as much as 1.94%, component 31 (rt=14.067 minutes) as much as 1.86%, component 43 (rt=16.405 minutes) as much as 5.03%, component 44 (rt=16.469 minutes) as much as 1.71%, component 57 (rt=18.552 minutes) as much as 2.84%, component 58 (rt=18.595 minutes) 1.80%, component 71 (rt=20.518 minutes) is 2.06%, component 72 (rt=20.548 minutes) is 1.73%, component 82 (rt=22.120 minutes) is 1.61%, and component 98 (rt=26.247 minutes) as much as 2.37%. There are 5 highest peaks with similarity index below 80%, namely component 17 (rt=10.162 minutes) as much as 2.17%, component 20 (rt=11.433 minutes) as much as 1.95%, component 21 (rt=11.456 minutes) as much as 1.54%, component 81 (rt=22.089 minutes) as much as 2.08%, and component 83 (rt=22.324 minutes) as much as 3.24%. Among the 122 peaks, there were 14 peaks of compounds that were identified, namely decanoic acid compounds (component 30; rt=14.046 minutes as much as 1.94% with a similarity index of 89.00% and component 31 (rt=14.345 minutes) as much as 1.86%. with a similarity index of 93.12%), dodecanoic acid (component 43, rt=16.405 minutes) as much as 5.03% with a similarity index of 98.88% and component 44 (rt=16.469 minutes) as much as 1.71% with a similarity index of 91.43%), myristic acid (4 components are the same, namely component 57 (rt=18.552 minutes) as much as 2.84% with a similarity index of 88.12%, component 58 (rt=18.595 minutes) as much as 1.80% with a similarity index of 97.97%, component 56 (rt=18.452 minutes) as much as 0.18% with a similarity index of 89.87%, and component 59 (rt=18.854 minutes) as much as 0.08% with a similarity index of 59.65%), palmitic acid (component 71, rt=20.518 minutes as much as 2.06% with a similarity index of 83.15% and component 72, rt=20.548 minutes as much as 1.73% with a similarity index of 90.17%), stearic acid (component 83, rt=22.324 minutes) as much as 3.24% with a similarity index of 75.52%, tridecanoic acid (component 50, rt=17.0514 minutes) as much as 0.10% with a similarity index of 98.02%), pentadecanoic acid (component 63, rt=19.563 minutes) as much as 0.13% with a similarity index of 93.08%), and palmitalaidic acid (component 69, rt=20.284 minutes) as much as 0.13% with a similarity index of 92.94% and component 70, rt=20.329 minutes as much as 0.11% with a similarity index of 90.02%).

According to Novilla et al.[23] the main component of VCO has many benefits including anti-inflammatory, analgesic, antipyretic, and antifungal, while according to Sulastri et al.[24] and Maromon et al.[25] it has benefits as antiviral, antibacterial, and antiprotozoal. Based on the chemical components found in the bark and wood of the bajakah root, it can be assumed that these components are active as antiplasmodial, this is to the chemical components of natural ingredients isolated from Nigerian flora[26].

3.3 Antimalarial Activity Test

Based on the literature search there are many antimalarial molecules on the market including quinine, chloroquine, amodiaquine, pyrimethamine, proguanil, sulfonamides, mefloquine, atovaquone, primaquine, artemisinin and derivatives, halofantrine, doxycycline, and clindamycin[27]. Generally, antimalarial compounds have an N atom with heterocyclic functional groups including quinine and quinidine compounds[28], chloroquine[29],

Journal of Chemical Health Risks

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JCHR (2024) 14(1), 378-387 | ISSN:2251-6727

amodiaquine[30], pyrimethamine and sulfadoxine[31], mefloquine[32], primaquine[33], and clindamycin[34]. Other functional groups such as aliphatic amine groups and cyclic amines are owned by the antimalarial molecules quinine and quinidine[28], chloroquine[29], amodiaquine[30], pyrimethamine and sulfadoxine[31], primaquine[33], proguanil[35], clindamycin[34], doxycycline[36], and halofantrine[37]. The hydroxyl functional group (-OH) is also commonly owned by antimalarial molecules that have been circulating in the market including quinine and quinidine[28], amodiaquine[30], mefloquine[32], clindamycin[34], halofantrine[37], doxycycline[36], and atovaquone[38]. In addition to the functional groups mentioned above, the ketone functional group (C=O) is also owned by antimalarial molecules including clindamycin[34], artemisinin, and derivatives[39], doxycycline[36], and atovaquone[38]. Other functional groups such as the methoxy functional group (-OCH_3) are owned by the antimalarial molecules quinine and quinidine[28], sulfadoxine[31], and primaquine[33]. While the chlorine functional group (-Cl) is owned by the antimalarial molecule including chloroquine[29], amodiaquine[30], clindamycin[34], halofantrine[37], and atovaquone[38]. The functional group that is thought to have an important role as an antimalarial drug is the -CF_3 functional group which is owned by the antimalarial molecules including mefloquine[32] and halofantrine[37]. The aliphatic alkene functional group belongs to the antimalarial molecules quinine and quinidine[28], the -SO_2 functional group belongs to the sulfadoxine antimalarial molecule[31], and the aromatic functional group is owned by almost all antimalarial molecules including quinine and quinidine[28], chloroquine[29], amodiaquine[30], sulfadoxine[31], mefloquine[32], primaquine[33], halofantrine[37], doxycycline[36], and atovaquone[38]. Based on the literature, the functional groups possessed by antimalarial molecules are N atoms which contain heterocyclic functional groups, aliphatic amine groups, cyclic amines, hydroxyl functions (-OH), ketone functional groups (C=O), methoxy functional groups (-OCH_3), chlorine functional groups (-Cl), -CF_3 functional group, aliphatic alkene functional group, -SO_2 functional group, and aromatic functional group.

Based on the functional groups possessed by antimalarial molecules, in general, they are also owned by the components of chemical compounds found in the bark and wood of the bajakah Kolaka, so this is a strong reason to test antiplasmodial activity on bark extracts and wood extracts from the bajakah Kolaka. The results of the antimalarial activity against Plasmodium falciparum strain 3D7 are presented in Table 4.

The antimalarial activity test of bajakah root was carried out at levels of 40.9g/mL, 51.2g/mL, 64g/mL, 80g/mL, 100g/mL, and 125g/mL, the IC_{50} value was 107.92g/mL. Based on these data, the determination of the dose is very important as shown in Table 3 has a high antimalarial activity caused by a change in dose. The antimalarial activity test of the root bark was carried out at concentration levels of 20.64g/mL, 25.6g/mL, 32g/mL, 40g/mL, 50g/mL, and 62.5g/mL, the IC_{50} value was 33.55g/mL. The same thing with the root bark fraction, the activity of the root bark also increased if the dose was changed as shown in Table 5, where previously the IC_{50} value of 33.55g/mL increased its activity to 30.01g/mL.

3. CONCLUSION

A total of 14 chemical molecular components were detected in the bark and wood of the roots of the bajakah (Spatholobus Littoralis Hask) Kolaka, Southeast Sulawesi which was extracted using n-hexane and ethyl acetate solvents were suspected to be antimalarial active compounds based on the type of functional group of the chemical composition of the Spatholobus Littoralis Hask fraction. The bark and wood extract of Spatholobus Littoralis Hask macerated with VCO in the form of Bio Coil Plus formulation has high in vitro antiplasmodial activity. Further studies will focus on isolating and identifying antimalarial compounds from Spatholobus Littoralis Hask subfractions.

4. ACKNOWLEDGEMENT

We would like to thank the Directorate of Research and Community Service of the Ministry of Research and Technology/National Research and Innovation Agency for funding this study in 2020, and we would like to thank the Ministry of Education, Culture, Research, and Technology for the cost of this research in 2022-2023.

6. REFERENCES

1. WHO. World Malaria Report 2022. https://www.who.int/teams/global-malaria-programme/reports/world-malaria-report-2022.
2. Pan WH, Xu XY, Shi N, Tsang SW, and Zhang HJ. Antimalarial Activity of Plant Metabolites. Int. J. Mol. Sci. 2018; 19(1382):1-140. doi:10.3390/ijms19051382.

3. Hadanu R. A QSAR Modeling on Aurone Derivatives as Antimalarial Agents. Asian J. Chem. 2020; 32(11):2839-2845. https://doi.org/10.14233/ajchem. 2020.22846.
4. Arnold MSJ, Macdonald JR, Quinn RJ, Skinner-Adams TS, Andrews KT, and Fisher GM. Antiplasmodial activity of the natural product compounds alstonine and himbeline. International Journal for Parasitology: Drugs and Drug Resistance. 2021; 16:17–22. https://doi.org/ 10.1016/j.ijpddr.2021.04.003.
5. Ihwan and Koda SHA. Antimalarial Herbal Plants in Kupang, Indonesia. Biosaintifika: Journal of Biology & Biology Education. 2017; 9(1): 95-104. https://doi.org/ 10.15294/ biosaintifika.v9i1.5811.
6. Colmenarez C, Acosta M, Rodríguez M, and Charris J. Synthesis and antimalarial activity of (S)-methyl-(7-chloroquinolin-4-ylthio)-acetamido-alquilate derivatives. Journal of Chemical Research. 2019; 0(0):1-6. DOI: 10.1177/ 1747519819890559.
7. Hadi S, Fenska MD, Noviany N, Satria H, Simanjuntak W, and Naseer MM. Synthesis and antimalarial activity of some triphenyltin (IV) aminobenzoate compounds against Plasmodium falciparum. Main Group Met. Chem. 2021; 44:256–260.
8. Marliana E, Saleh C, and Hendra M. Antioxidant And Antimalarial Activities of Phenolic Compounds From Leaves of Macaranga beccariana Merr. Jurnal Kimia Mulawarman. 2018; 15(2):106-110.
9. Bekhit AA, Nasralla SN, Bekhit SA, and Bekhit AEA. Novel Dual Acting Antimalarial Antileishmanial Agents Derived from Pyrazole Moiety. Biointerface Research in Applied Chemistry. 2022; 12(5):6225-6233. https://doi.org/10.33263/BRIAC125.62256233.
10. Sulistiarini R, Soemardji AA, Elfahmi, Iwo MI, Puspitasari DJ, Prabandari EE, and Waluyo D. Antiplasmodial Activity And Malate Quinone Oxidoreductase Inhibitor Of Steroid Isolated from Fibraurea tinctoria. Rasayan J. Chem. 2022; 15(1):377-386. http://dx.doi.org/10.31788/ RJC.2022.1516096.
11. Maulina S, Pratiwi DR, Erwin. Phytochemical Screening And Bioactivity of Root Extract of Uncaria Nervosa Elmer (Bajakah). Jurnal Atomik. 2019; 04(2):100-102.
12. Abdulrahman, Utami SR, Widia, dan Roanisca O. Secondary Metabolites Study of Bajakah Stems (Spatholobus Littoralis Hassk.) in Development as Anticancer and Antioxidant Herbal Medicines. Proceding SNPPM. 2021:46-49.
13. Nastati K. and Nugraha DF. Anti-inflammatory Activity of Bajakah Wood Extract (Spatholobus Littoralis Hask). Jurnal Surya Medika. 2022; 7(2):45-50.
14. Yuniarti L., Kharisma Y., Respati T., and Tejasari M. Halal Critical Point Analysis of Bajakah Wood (Spatholobus littoralis Hassk.) Nano Particle as Anticancer Agent. Global Medical and Health Communication. 2021; 9(22):81-87.
15. Bandy NA, Erniwati, Muthmainnah, Ariyanti, Hapid A, Asniati, and Rimba JW. Phytochemical Analysis of Bajakah Leaf Extract (Poikilospermum Suaveolens (Blume) Merr) from Kapiroe Village. Jurnal Warta Rimba. 2021; 9(1):31-41.
16. Prasetyorini BE, Kusumawardani A, Fitriani F, Oktriana P, Amelinda N, and Ramadhani AN. In Silico Analysis of Active Compounds of Bajakah Wood Stems (Spatholobus Littoralis Hassk) as Psoriasis Therapy. Herb-Medicine Journal. 2022; 5(1):26-35.
17. Huijsduijnen RHV, Guy RK, Chibale K, Haynes RK, Peitz I, Kelter G, Phillips MA, Vennerstrom JL, Yuthavong Y, Wells TNC. Anticancer Properties of Distinct Antimalarial Drug Classes, PLOS ONE. 2013; 8(12):1-11. https://doi.org/10.1371/journal.pone. 0082962.
18. Ortiz MPC. and Wei MQ. Antitumor Activity of Artemisinin and Its Derivatives: From a Well-Known Antimalarial Agent to a Potential Anticancer Drug. Journal of Biomedicine and Biotechnology. 2012; 247597:1-18. https:// doi.org/10.1155/2012/247597.
19. Kamatou GPP, Zyl RLV, Davids H, Heerden FRV, Lourens ACU, and Viljoen AM. Antimalarial and anticancer activities of selected South African Salvia species and isolated compounds from S. radula. South African Journal of Botany. 2008; 74:238-243. https://doi.org/ 10.1016/j.sajb.2007.08.001.
20. Pingaew R, Mandi P, Prachayasittikul V, Thongnum A, Prachayasittikul S, Ruchirawat S, and Prachayasittikul V. Investigations on

Anticancer and Antimalarial Activities of Indole-sulfonamide Derivatives and In Silico Studies. ACS Omega. 2021; 6:31854-31868 https://doi.org/10.1021/acsomega.1c04552.

21. Aliviyanti RUY, Sudibyo RS, and Murwanti R. Cytotoxic Effect of Kalimantan Bajakah Roots on T47D Breast Cancer Cells. Jurnal Penelitian Saintek. 2021; 26(2):131-140.
22. Saputera MMA. and Noverda Ayuchecaria N. Effectiveness Test of Bajakah Tampala Stem Ethanolic Extract (Spatholobus littoralis Hassk.) on Wound Healing Time. Jurnal Ilmiah Ibnu Sina, 2018; 3(2):318-327.
23. Novilla A, Nursidika P, and Mahargyani W. Composition of Pure Coconut Oil Fatty Acids (Virgin Coconut Oil) Potential as Anti-Candidiasis, EduChemia. 2017; 2(2):161-173.
24. Sulastri E, Mappiratu, and Sari AK. Antibacterial Activity Test of Lauric Acid Cream Against Staphylococcus aureus ATCC 25923 and Pseudomonas aeruginosa ATCC 27853. GALENIKA Journal of Pharmacy. 2016; 2(2): 59-67.
25. Maromon Y, Pakan PD, and Agnes EDM. Test of Anti Bacterial Activity of Pure Coconut Oil (Virgin Coconut Oil) on the Growth of Staphylococcus Aureus Bacteria in In Vitro. Cendana Medical Journal. 2020; 20(2):250-255.
26. Ungogo MA, Ebiloma GU, Ichoron N, Igoli JO, de Koning HP, and Balogun EO. A Review of the Antimalarial, Antitrypanosomal, and Antileishmanial Activities of Natural Compounds Isolated From Nigerian Flora. Frontiers in Chemistry. 2020; 8:1-28 https://doi.org/10.3389/fchem. 2020.617448.
27. Sharma GK., Yogi A., Gaur K., and Dashora A. A Review on Anti Malarial Drug. International Journal of Basic Clinical Pharmacy and Research. 2016: 1-15.
28. Eyal S. The Fever Tree: from Malaria to Neurological Diseases. Toxins. 2015; 10(491):1-12. https://doi.org/10.3390/toxins 10120491.
29. Fraczkiewicz R., Zhuang D., Zhang J., Miller D., Woltosz WS., and Bolger MB. Busting the Black Box Myth: Designing Out Unwanted ADMET Properties Machine Learning Approaches. CICSJ Bulletin. 2009; 27(4):96-102.
30. Deshpande S, Goodarzi M, Katti SB, and Prabhakar YS. Topological Features in Profiling the Antimalarial Activity Landscape of Anilinoquinolines: A Multipronged QSAR Study. Journal of Chemistry. 2013; (154629):1-14. http://dx.doi.org/10.1155/2013/154629.
31. Mohamed HMA, Imran M, Ali MH, Abdelwahab MF, and Alhaj **AA.** A UV-Vis Spectrophotometric Chemometric Method for the Simultaneous Determination of Sulfadoxine and Pyrimethamine in Tablets, Asian Journal of Pharmaceutical Research and Health Care**,** 2016; 8(3):76-83. https://doi.org/10.18311/ ajprhc/2016/3965.
32. Iglesias R, Spray DC, and Scemes E. Mefloquine blockade of Pannexin1 currents: Resolution of a conflict. Cell Commun Adhes. 2010; 16(5-6):131–137. https://doi.org/ 10.3109/ 15419061003642618.
33. Marcsisin SR, Reichard G, and Pybus BS. Primaquine Pharmacology in the Context of CYP 2D6 Pharmacogenomics: Current state of the art. Pharmacology & Therapeutics. 2016; xxx–xxx. https://doi.org/10.1016/j.pharmthera.2016.03.011.
34. Raju ChBVN, Panda G, Rao GN, and Rockey J. HPLC-UV Assay Method for Clindamycin Palmitate Hydrochloride as Drug Substance and Oral Solution. Analytical Letters. 2008; 41:2033-2043. https:// doi.org/10.1080/00032710802209334.
35. Paci A, Caire-Maurisier AM, Rieutord A, Brion F, and Clair P. Dual-mode gradient HPLC procedure for the simultaneous determination of chloroquine and proguanil. Journal of Pharmaceutical and Biomedical Analysis. 2002; 27:1-7. https://doi.org/ 10.1016/S0731-7085(01)00555-6.
36. Holmes NE. and Charles PGP. Safety and Efficacy Review of Doxycycline. Clinical Medicine: Therapeutics. 2009; 1:471-482.
37. Ugochukwu CNC, Ebong PE, and Eyong EU. Biochemical Implication of Long Term Administration of Halofantrine Hydrochloride (Halfan) on Estradiol Levels of Female Wistar Rats. Pakistan Journal of Nutrition. 2008; 7(2):227-230.
38. Karaman R., Fattash B, and Karaman D. Design, Synthesis and In-Vitro Kinetic Study of Atovaquone Prodrug For The Treatment of Malaria. World Journal of Pharmaceutical Research. 2015; 4(9):361-390. https://doi.org/10.20959/wjpr20159-4479.

Journal of Chemical Health Risks

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JCHR (2024) 14(1), 378-387 | ISSN:2251-6727

39. Jahan M, Leon F, Fronczek FR, Elokely KM, Rimoldi J, Khan SI, and Avery MA. Structure-Activity Relationships of the Antimalarial Agent Artemisinin 10. Synthesis and Antimalarial Activity of Enantiomers of rac-5-hydroxy-D-Secoartemisinin and Analogs: Implications Regarding the Mechanism of Action. Molecules. 2021; 26(4163):1-24. https:// doi.org/10.3390/molecules26144163.

Table 1. LC-MS/MS analysis of ethylacetate fraction of root wood bajakah husk

Comp.	RT	Compound name	Mol. Formula	Mol. Mass
1.	04.31	Apocynoside I	$C_{19}H_{30}O_8$	409.1826
2.	06.01	Quercetin	$C_{15}H_{10}O_7$	303.0500
3.	08.14	Hexosylphingosine	$C_{24}H_{47}NO_8$	478.3378
4.	08.37	3-Hydroxy-7-methoxybaicalein	$C_{16}H_{12}O_6$	301.0713
5.	09.25	Momor-cerebroside I	$C_{48}H_{93}NO_{10}$	844.6878
6.	09.52	Ambronal	$C_{30}H_{46}O_2$	439.3571
7.	10.28	Stigmastan-3,6-dione	$C_{29}H_{48}O_2$	429.3726
8.	11.45	Trilaurin	$C_{39}H_{74}O_6$	661.5360

Table 2. LC-MS/MS analysis of n-hexane fraction of root wood bajakah husk

Comp.	RT	Compound name	Molecule formula	Molecule mass
9.	09.33	Trichosanic acid	$C_{18}H_{30}O_2$	279.2318
7.	10.08	Stigmastan-3,6-dione	$C_{29}H_{48}O_2$	429.3731
10.	14.07	Linolein	$C_{57}H_{98}O_6$	901.7253

Table 3. LC-MS/MS analysis of n-hexana fraction of root bark bajakah husk

Comp.	RT	Compound name	Molecule formula	Molecule mass
11.	09.44	Uncarinic B acid	$C_{40}H_{56}O_7$	649.4108
2.	09.54	Ambronal	$C_{30}H_{46}O_2$	439.3571
12.	10.38	1-Palmitoyl-2-arachidonoyl-sn-gliserol	$C_{39}H_{68}O_5$	639.4962
13.	10.75	4-[2-O-11Z-octadecenoyl-beta-glucopyranosyl]-4,4'-diapolycopene-4,4'-dioat acid	$C_{54}H_{78}O_{10}$	887.5675
14.	10.87	6-[9,10,11-Trihexoxy-2,12-bis-(5-oxohexoxy)-triphenylen-2-yl]-oxyhexan-2-one	$C_{54}H_{78}O_9$	871.5731

Table 4. In vitro antiplasmodial activities of crude extract of root wood bajakah husk combine with Bio Coil Plus

Dose (µg/mL)	Parasitemia ± SD	Persentase Penghambatan (%)	IC_{50} (µg/mL)
Kontrol	6.82±0.79		
0.98	7.59±0.93	-11.27	
1.95	6.23±0.14	8.59	
3.91	6.72±0.95	1.39	
7.81	6.16±0.23	9.69	
15.63	7.63±0.27	-11.86	48.54
31.25	6.13±0.13	10.18	
62.5	5.01±1.42	26.48	
125	0	100	
250	0	100	
500	0	100	

Journal of Chemical Health Risks

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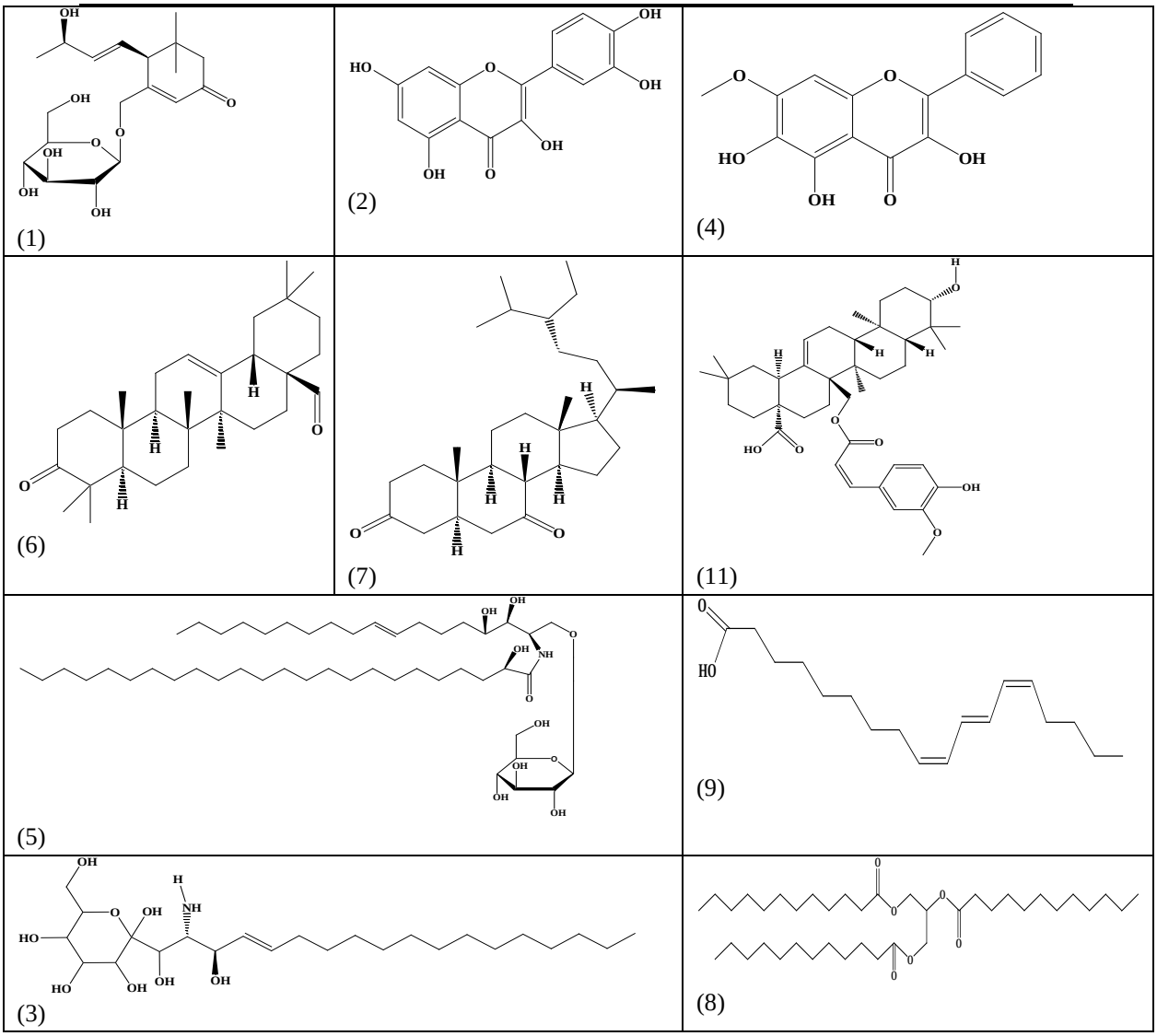
JCHR (2024) 14(1), 378-387 | ISSN:2251-6727

Table 5. In vitro antiplasmodial activities of crude extract of root bark bajakah husk combine with Bio Coil Plus

Dose (µg/mL)	Parasitemia ±SD	Persentase Penghambatan (%)	IC_{50} (µg/mL)
Kontrol	0.79		
0.98	1.74±4.06	4.06	
1.95	0.57±11.05	11.05	
3.91	0.80±3.46	3.46	
7.81	1.88±5.86	5.86	
15.63	2.05±16.56	16.56	30.01
31.25	0.04±83.52	83.52	
62.5	0	100	
125	0	100	
250	0	100	
500	0	100	



Journal of Chemical Health Risks

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JCHR (2024) 14(1), 378-387 | ISSN:2251-6727

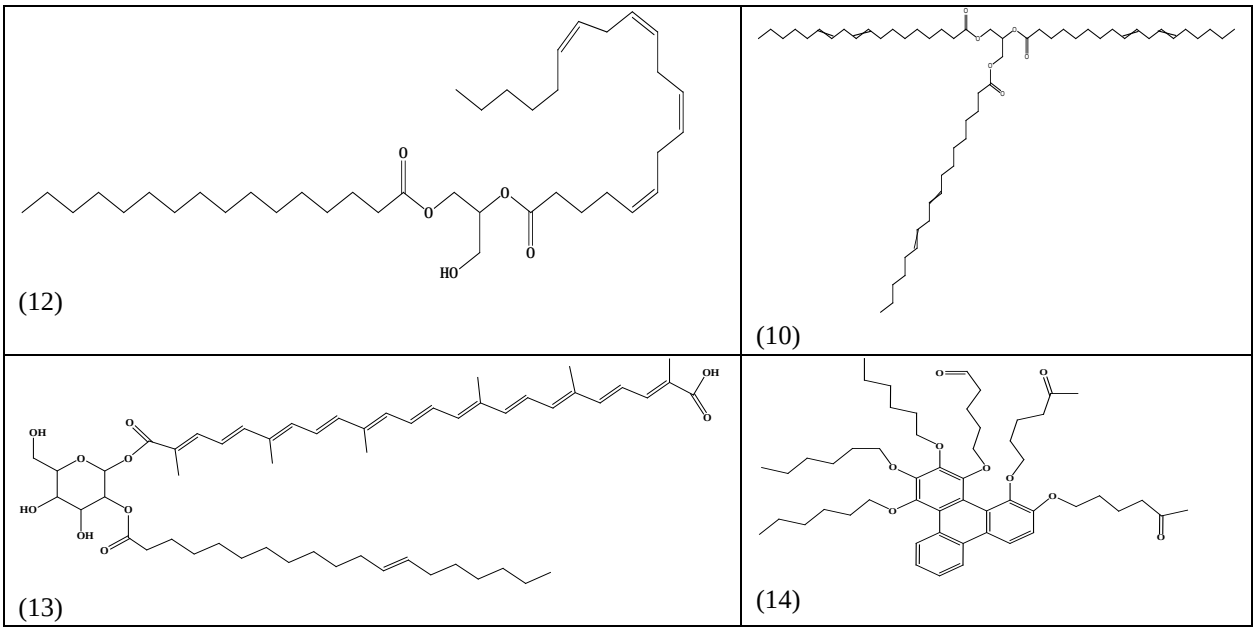

Figure 1. The structures of these bajakah root plant compounds