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Comparison of the Flavonoid Contents of Bajakah Plants from Tropical Forest in Kalimantan, Indonesia

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Abstract: Kalimantan tropical forests have very high biodiversity wealth and are natural resources that need to be conserved and researched for human use. One type that is still a mystery for its benefits to humans is the type of liana, a type of climbing plant. These types have been used in local wisdom, namely one of the Bajakah types of plants as an anti-cancer. This research was conducted in two provinces in Kalimantan, Indonesia, namely Central Kalimantan in the tropical peat-swamp forest and South Kalimantan in the KHDTK ULM, a highland tropical forest. The content of flavonoids as antioxidants that act as anti-cancer for humans will be compared from each plant. The method used is a quantitative method, according to Robinson, 1995. The research goals are to find the Bajakah plant species with the highest flavonoid content and plant parts with the highest flavonoid content. The results showed that there were four species of Bajakah plants which local wisdom used by the community, namely yellow Bajakah (*Jasminum elongatum* (PJ Bergius) Wild.) and Balaran (*Merremia peltata* (L.) Merr) in highland tropical forests in South Kalimantan and yellow Bajakah (*Fibraurea tinctoria* Laur.) and red Bajakah (*Uncaria acida* (Hunter) Roxb) in the tropical peat-swamp forest in Central Kalimantan. The scientific novelty of research found that the content of each species and each part of the plant (stems, twigs, and leaves) contained flavonoids. In contrast, the highest content of flavonoids was found in red Bajakah leaves (*Uncaria acida* (Hunter) Roxb) from a topical peat-swamp forest in Central Kalimantan of 140.17 mg/ml, the highest of flavonoids in the stem is the species of yellow Bajakah (*Jasminum elongatum* (PJ Bergius) Wild.) from upland tropical forests in South Kalimantan at 83.00 mg/ml.

Keywords: Bajakah, flavonoids, stems, twigs, leaves.

印度尼西亞加里曼丹熱帶森林巴哈卡植物類黃酮含量比較

摘要：加里曼丹熱帶森林擁有非常豐富的生物多樣性，是需要保護和研究供人類使用的自然資源。一種對人類的好處仍然是個謎的類型是藤本植物，它是一種攀緣植物。在當地智慧中，這些類型已被使用，即作為抗癌植物的巴賈卡類型之一。這項研究是在印度尼西亞加里曼丹的兩個省進行的,即熱帶泥炭沼澤森林中的中加里曼丹和位於高地熱帶森林KHDTK超低功耗中的南加里曼丹。將從每種植物中比較的是作為抗氧化劑的黃酮類化合物的含量，這些抗氧化劑對人類起到抗癌作用。使用的方法是根據羅賓遜,1995的定量方法。研究目標是找到類黃酮含量最高的巴賈卡植物物種和類黃酮含量最高的植物部位。結果表明，在南加里曼丹的高原熱帶森林中，有四種當地智慧被社區使用的巴賈卡植物，即黃巴賈卡（茉莉花(PJ貝吉烏斯)荒野）和巴拉蘭（馬齒莧(升.)拿）。和黃色巴賈卡(纖維脲劳尔.)和紅色巴賈卡(酸鉤藤(獵人)羅克斯)在加里曼丹中部的熱帶泥炭沼澤森林中。研究的科學新穎性發現，植物的每個物種和每個部分（莖、枝和葉）的含量都含有黃酮類化合物，而黃酮類化合物含量最高的是從外用的紅巴哈卡葉（酸鉤藤(獵人)羅克斯）中發現的。中加里曼丹的泥炭沼澤森林為140.17毫克/毫升，莖中最高的黃酮類物質是來自南加里曼丹高地熱帶森林的黃色巴贾卡(茉莉花(PJ貝吉烏斯) 荒野)，為 83.00 毫克/毫升。

关键词：巴賈卡、黃酮類化合物、莖、小枝、葉。

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1. Introduction

Tropical rain forests in Kalimantan have a very high natural wealth of biodiversity. The diversity of plants is one of the natural resources that need to be preserved, given their role and benefits for life. Liana or climbing plants are one of the types of plants characteristic of tropical rainforests. Their existence adds to the diversity of plant species in tropical rainforest ecosystems [2]. These lianas are easily recognized because of their climbing and twisting growth on other plants [5]. The lack of knowledge owned by the community causes a group of lianas to be unknown and not used by the community, so that they are known only as wild plants, even though lianas have high ecological and economic values well as high aesthetic values [11].

One type of plant that is classified as a liana is a Bajakah. The name of this Bajakah plant is increasingly recognized by the public as an anti-cancer and is increasingly being sought [25,26]. Because of the popularity of this Bajakah stem, several e-commerce sites have been found that sell this Bajakah. The price offered is also getting higher, starting from tens of thousands of rupiah to hundreds of thousands per stick, and sometimes it is packaged in small pieces [26].

In line with the popularity of this Bajakah plant, which is known to be effective in treating cancer, there is overexploitation of this Bajakah, so conservation efforts are needed for this plant. This research was conducted to identify further the various species of Bajakah and the properties of each species, especially the flavonoid content of each species, both those that grow in wetlands, in this case, peat swamps and also those that live in mountainous areas.

Flavonoids in plants play a role in providing color, taste to seeds, flowers, and fruit, and aroma [8] and protecting plants from environmental influences [27] as an antimicrobial and protection from exposure to UV rays. In the health sector, flavonoids act as anti-bacterial, anti-oxidant, anti-inflammatory, and anti-diabetic [10,28] and strong anticancer activities [29,30,31,32]. Flavonoids are one of the most common secondary metabolite compounds found in plant tissues [12]. Flavonoids are included in the phenolic compound group with a chemical structure of C6-C3-C6 [14, 6, 7, 10, 32]. Flavonoids act as antioxidants by donating their hydrogen atoms or through their ability to chelate metals in the form of glycosides (containing glucose side chains) or in the free form called aglycones [3]. One of the important secondary metabolites in plants is flavonoids which are a derivative of 2-phenyl-benzyl-γ-pyrone.

2. Materials and Methods

2.1. Field of Research and Sample Collections

Bajakah generally lived in primary and secondary forests with a very variable microclimate, with 29-31°C, the humidity of 75-81%, and light intensity of 20%. Samples were collected from natural forests in KHDTK ULM, South Kalimantan Province, and tropical peat-swamp forest in Pulang Pisau Regency, Central Kalimantan Province, Indonesia. The Dayak ethnic community is an ethnic group that has local wisdom in utilizing medicinal plants found in a tropical peat-swamp forest in Central Kalimantan Province. The location where the plant is collected can be seen in Figure 1 below.

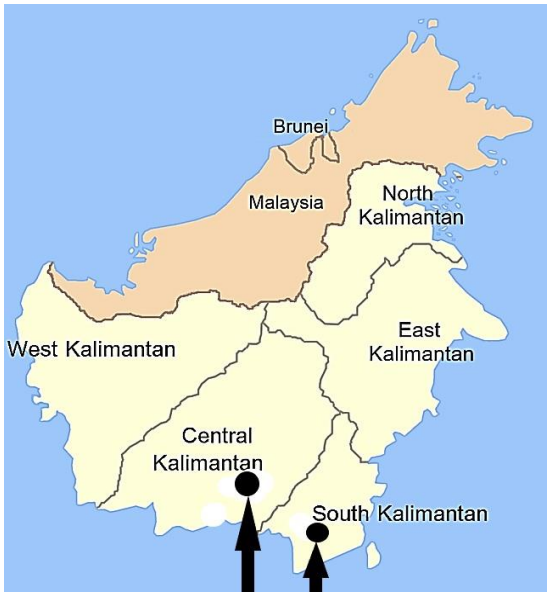

Fig. 1 Bajakah plant sampling locations

2.2. Preparation of Extracts and Flavonoid Content Analysis

Parts of an anatomical plant (rood, leaves, and flower) were used as materials. It was cleaned with water (preferably with water flow) and then dried. The dried materials were put in a plastic bag so that the sample is maintained fresh. The materials were cut to become small in size, and then it was made powder using a commercial blender [1]. For quantitative phytochemical testing is using the Gravimetry method. The working procedure for determining each parameter is as follows.

In a quantitative flavonoid test, the sample was macerated for 24 hours with 80% methanol. 80% methanol is used for maceration because 80% methanol is the best and most often used solvent for flavonoid extraction [13]. The extract was filtered, and the solvent was evaporated to dryness, so a dry solid of flavonoids was obtained. The flavonoid solids are weighed.

3. Results

In the highlands forest of KHDTK ULM, two species of Bajakah were found that could potentially be used as medicinal plants that were already used by the community, namely yellow Bajakah (*Jasminum elongatum* (P.J. Bergius) Wild.) and Balaran (*Merremia peltata* (L.) Merr). The community uses the yellow Bajakah as a cancer treatment and Balaran as cough medicine.

Two species of Bajakah in the highland area of KHDTK ULM South Kalimantan Province and two species of Pulang Pisau Regency, Central Kalimantan Province, have been identified with the following results.

Table 1 Bajakah species found in the highlands and lowlands (peat swamps)

Local name	Botanical name	Habitat
Yellow Bajakah	*Jasminum elongatum* (P.J. Bergius) Willd.	highlands in KHDTK ULM South Kalimantan
Balaran	*Merremia peltata* (L.) Merr	highlands in KHTDK ULM South Kalimantan
Yellow Bajakah	*Fibraurea tinctoria* Laur.	Peat-swamp in Pulang Pisau Regency, Central Kalimantan
Red Bajakah	*Uncaria acida (Hunter)* Roxb	Peat-swamp in Pulang Pisau Regency, Central Kalimantan

As for the tropical peat swamp forest in Pulang Pisau Regency, Central Kalimantan, two species of Bajakah were found which were used by the community as a cancer treatment, namely red Bajakah (*Uncaria acida* (Hunter) Roxb) and yellow Bajakah (*Fibraurea tinctoria* Laur.). Bajakah belongs to various species of more than one genus. Three Bajakah can be identified as Bajakah from the peat-swamp ecosystem of Central Kalimantan. Those were the genus of Uncaria and Salacia [25]. Traditional people believe that the boiled Bajakah could be cured cancer, tumors, mioms, and cysts [25, 26]. These two species are also often traded by the public in the market. In general, those sold are stems and leaves, but the community most consumed is the stem of the red Bajakah. Uncaria genus is a member of the Rubiaceae family, contains 55 species and varieties, and eight species were encountered in Borneo [20].

In Figure 2 above, it can be seen that the highest flavonoid content is in the leaves, especially the Yellow Bajakah KHDTK ULM South Kalimantan Province, red Bajakah in Pulang Pisau Regency, Central Kalimantan, and Bajakah, which are sold in the market. All species of Bajakah, the highest flavonoid compound was found in the red Bajakah leaves from Pulang Pisau Regency, Central Kalimantan Province of 140.17 mg/ml. In general, leaves contain high flavonoids. The flavanol compounds found in tea leaves are known to be potent antioxidants [15]. Consumption of seven to eight cups of green tea containing epigallocathecingallate (approximately 100 ml per cup) can increase LDL resistance to oxidation in vivo, thereby reducing the risk of cardiovascular disease [16]. The study results showed that natural flavonoid compounds such as kaempferol, morin, myricetin, and quercetin had varied protective activities against decreasing α-tocopherol in LDL. In contrast, kaempferol and morine were less effective than myricetin and quercetin. The α-tocopherol component (the general form of vitamin E) is a primary antioxidant that can protect LDL from oxidation [17].

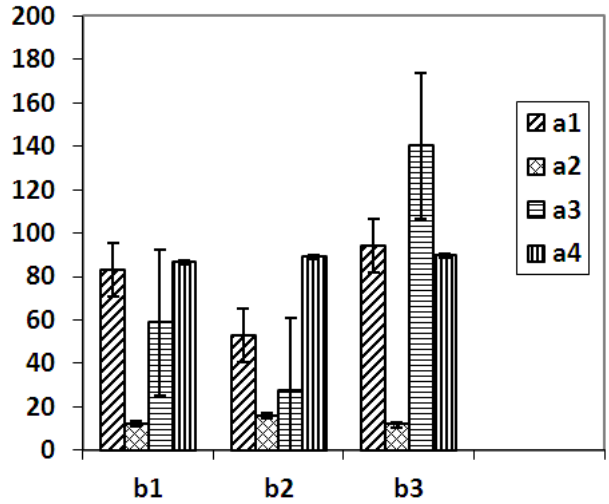

Fig. 2. Comparison of the flavonoid content (mg/ml) at each location and part of the plant
Legend: a1: yellow Bajakah in KHDTK ULM, South Kalimantan; a2: yellow Bajakah in Central Kalimantan: a3: red Bajakah in Central Kalimantan; a4: Bajakah in the market: b1: stems: b2: twigs: b3: leaves

Table 2 Analysis of variance flavonoid levels based on where it was found and parts of the plant

sd	df	ns	ms	F (count)	F(table)	
					5%	10%
Treatment	11	54308.92	4937.17	17998.81	2.22	2.80
a	3	31115.18	10371.73	37810.85	3.01	4.40
b	2	8790.20	4395.10	16022.64	3.40	5.27
ab	6	14403.54	2400.59	8751.52	2.51	3.37
Error	24	6.58	0.27			
Total	35	54315.50				

The content of flavonoids is also found in many parts of the stems commonly used by the community, especially yellow Bajakah from KHDTK ULM South Kalimantan Province and Bajakah, which are sold in the market. Flavonoids were also found in the twig, where the highest was found in Bajakah, which was sold in the market at 88.83 mg/ml. The Bajakah sold in the market are generally called Red Bajakah from

Pulang Pisau Regency, Central Kalimantan Province. It means that the red Bajakah of Central Kalimantan Province is the species that contains the highest flavonoids compared to the others. However, the Yellow Bajakah KHDTK ULM contains high flavonoids and is also used by the public as an anti-cancer.

In Table 2 below, it can be seen that based on the variant analysis test that the difference flavonoid content between each species, both in the highlands of KHDTK ULM South Kalimantan Province and in the peat swamp of Pulang Pisau Regency, Central Kalimantan Province is very significant. This condition is also the same in treating the ratio of each part of the plant (stems, twigs, and leaves), which has a very significant difference at the 5% and 10% confidence levels).

Table 3 Turkey test results of flavonoid content in each species of Bajakah

Treatment	Middle Value	Different Value										
		a3b3	a1b3	a4b3	a4b2	a4b1	a1b1	a3b1	a1b2	a3b2	a2b2	a2b1	a2b3
a3b3	140.17												
a1b3	94.25	45.92**											
a4b3	89.67	50.50**	4.58**										
a4b2	88.83	51.33**	5.42**	0.834ns									
a4b1	86.50	53.67**	7.75**	3.17**	2.33**								
a1b1	83.00	57.17**	11.25**	6.67**	5.83**	3,5**							
a3b1	58.83	81.33**	35.42**	30.83**	30.00**	27,67**	24,17**						
a1b2	52.92	87.25**	41.33**	36.75**	35.92**	33,58**	30,08**	5.92**					
a3b2	27.08	113.08**	67.17**	62.58**	61.75**	59,42**	55,92**	31.75**	25.83**				
a2b2	15.67	124.50**	78.58**	74.00**	73.17**	70,83**	67,33**	43.17**	37.25**	11.42**			
a2b1	12.25	127.92**	82.00**	77.42**	76.58**	74,25**	70,75**	46.85**	40.67**	14.83**	3.42**		
a2b3	11.83	128.33**	82.42**	77.83**	77.00**	74,67**	71,17**	47.00**	41.08**	15.25**	3.83**	0.42ns	
Tukey	5%	1.54											
	1%	1.85											

Notes: **- very significantly different; *- real quite different; ns - no significantly different

In Table 3, Turkey's different test results on the flavonoid content in each species. It was found that in the highlands of KHDTK ULM South Kalimantan Province and the lowlands of the peat swamps in Pulang Pisau Regency, Central Kalimantan Province and the flavonoid content in each part of the plant, it was found that almost all were very significantly different, only one treatment which is not entirely different, namely a4b2 and a4b3 (the species of Bajakah that is on the market between the twigs and leaves is not different), which means that the species of Bajakah that is sold on the market the content of flavonoids in the twigs and leaves tends to be the same

4. Discussion

Flavonoids are found in all species of Bajakah found in the highlands of South Kalimantan and lowlands, especially in the tropical peat-swamp forest in Central Kalimantan. Flavonoids are found in all green plants, so they can also be found in plant extracts. Flavonoids are also a class of compounds that are widely expressed in nature. Each plant generally contains one or more typical flavonoid group compounds [4, 32]. It can be said that almost all plants contain flavonoids, but the levels are different, as well as Bajakah. This research shows that red Bajakah found in a tropical peat-swamp forest in Pulang Pisau Regency has a very high flavonoid content, namely 140.17 mg/ml in leaves and yellow Bajakah found in an upland tropical forest in KHDTK ULM Kalimantan. The south also has a high flavonoid content, 94.25 mg/ml, also located in leaves.

It has been previously described that flavonoids are found in all parts of the plant. As the results of this study, flavonoids are found in stems, twigs, and leaves. Flavonoids are found in almost all parts of plants, such as leaves, roots, pollen bark, nectar, flowers, fruit, and seeds [9]. The results of this research show that the highest content in almost all species of Bajakah is in the leaves as described earlier, compared to those found in stems and twigs. In the branch, the highest flavonoid content is found in red Bajakah originating from Central Kalimantan, which has been traded in the market, namely 86.50 mg/ml and yellow Bajakah found in highland forests in South Kalimantan at 83.00 mg/ml. The lowest flavonoid content is located in the leaves and stems of yellow Bajakah found in the tropical peat-swamp forest of Central Kalimantan, respectively 11.83 mg/ml and 12.25 mg/ml.

According to [18], red Bajakah (*U. acids*) bark has the highest phenolic and flavonoid content. The red Bajakah stem bark also contains levoglucosan with a concentration of 6.9%. Levogglucosan or 1.6-anhydro-beta-d-glucopyranose is formed by pyrolysis glucans

such as cellulose and starch [19]. Simplisia of *U. acida* bark contains the highest total phenolic compounds identified as guaiacol, 2-methoxy-4-methylphenol, and eugenol [18]. Eugenol, also called clove oil, is used to treat toothache and gastrointestinal and respiratory complaints [21, 22]. Eugenol also shows antibacterial activity on the growth of some species of Gram-positive (*Bacillus cereus*; *Bacillus subtilis*; *Staphylococcus aureus*) and Gram-negative (*Escherichia coli*; *Salmonella typhi*; *Pseudomonas aeruginosa*) [23]. The anti-cancer activity mechanism of eugenol is also due to induction of apoptosis through Reactive Oxygen Species (ROS) and mitochondria-dependent mechanism and expressed a possibility to develop it as a chemotherapeutic or chemopreventive agent [24]. The FDA of the USA has declared eugenol to be safe and considered non-carcinogenic and non-mutagenic.

5. Conclusion

All species of Bajakah and all parts of the plants studied (stems, twigs, and leaves), whether those in the highlands or lowlands, especially the peat-swamp forest, contain flavonoids. However, the flavonoid content varies significantly in number, and the highest is mainly found in leaves. Especially red Bajakah (*Uncaria acida*) where is found in tropical peat-swamp forests in Central Kalimantan Province, and yellow Bajakah (*Jasminum elongatum* (PJ Bergius) Willd.) where is located in highland secondary forests in South Kalimantan Province, respectively 140.17 mg/ml and 94.25 mg/ml. The highest flavonoid content in the stem was found in the yellow Bajakah from an upland tropical forest in South Kalimantan at 83.00 mg/ml. The flavonoid content of each species from the highland secondary forest in South Kalimantan Province and lowland secondary forest, especially in peat-swamp, was a very significant difference. The flavonoid content in each part of the plant (stems, twigs, and leaves) was almost very significantly different, only one treatment which is not entirely different, namely: a4b2 and a4b3 (the species of red Bajakah is sold in the market between the twigs and leaves is not significantly different). Sometimes the source of Bajakah obtained in the market is unknown, so it is strange what kind of species and where it was received, whether from the lowlands or highlands tropical forest.

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