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Model distribution of poisonous plants as conservation biopesticides sources in Batang Gadis National Park, Mandailing Natal, North Sumatera

Y Afifuddin*, P Patana, J Rangkuti, P Pulungan, and S Lubis

Department of Forestry, Faculty of Forestry, Universitas Sumatera Utara, Medan, Indonesia

Email: yunus.afifuddin@usu.ac.id or afifzn@yahoo.com

Abstract. Poisonous plant species diversity in Indonesia have not been explored as a potential source of biopesticides. Batang Gadis National Park (BGNP) as one of the biodiversity of poisonous plants need to be explored. The study aimed was the identification of poisonous plants, analysis of diversity, Shannon index-Wiener modeling on various heights and locations poisonous plants, and phytochemical analysis to determine the content of alkaloids, terpenes, flavonoids, saponins and tannins. The identification results obtained 14 species of poisonous plants with 10-12 species in different levels (understory, seedlings, saplings, poles, and trees). Analysis vegetation results obtained were Ayu Ara, Ayu Otang, Dongdong, and Supi which dominates all levels of plants. Modelling is obtained Model Vapor Pressure for lower plants, Sinusoidal Model fit for seedlings, saplings and poles, as well as to the Hoerl Model for Tree. The content dominant on poisonous plants in BGNP predominantly of terpene content except for Tabar-Tabar (*Costus speciosus* Sm.) which containing flavonoids and tannins. Potential of poisonous plants as biopesticides were species of Dong-dong (*Laportea stumulus* Gaud), Lange (*Homalomena propinqua* Ridl), Modang / Modang Londir (*Persea rimosa*), and Sitarak (*Macaranga gigantea*). While the species with the highest sources were Latong (*Litsea lefeana*) and Dong-dong (*Laportea stumulus* Gaud).

1. Introduction

The diversity of poisonous species as a source of drugs and toxins are very large, which most of the potential of the species was not identified. One of the potentials that hasn't been explored is the source of toxins for the manufacture of natural pesticides (biopesticides). In 2012, the trading of pesticides ranged from 5.3 to 5.6 trillion rupiah, where in the future will be increased [1]. Based on the type and proportion, differentiated as insecticides (41%), herbicides (37%), fungicide (21%), and others (2%). Market share of pesticide in 2015 amounted to 100.736 tons with a growth rate of 2.69% so that the projected in 2016 is amounted to 103.446 tons/year [1]. The amount of this pesticide market share making opportunities of biopesticides are also increasingly challenging. Related to this, the exploration of poisonous plant needs to be done in a variety of forest areas. Sumatran tropical forest resources into one area of study that needs to be a focus of research. The resources of Sumatran tropical forest became one of the study areas which needs to be the focus of research. One of the areas that hasn't been studied is the Batang Gadis National Park (BGNP) in Mandailing Natal, North Sumatra.



The purpose of the research in BGNP are 1) Identification of poisonous plants, 2) Analysis of species diversity of poisonous plants, 3) Modelling Diversity Index (H-index) at various altitudes and locations poisonous plants, 4) Analysis secondary metabolites of poisonous plant and potential development as a source of biopesticides.

2. Material and methods

The research location is in Batang Gadis National Park (BGNP), Mandailing Natal, North Sumatra in July to December 2016. Identification through two methods, namely the survey of local knowledge through local resource persons and using a determination key of the introduction of poisonous plant species and literature study of Sumatra useful plants.

Vegetation analysis as follows: (1) Do group, (2) determine the location of the path will be surveyed (sample units) on a map. Path created with the direction perpendicular to the contour (cut the contour). (3) Identify the types of flora; (4) Measure the diameter (dbh) and height (total height and bole height) for poles and trees, and the type and number of seedlings and saplings. In these surveys, using the criteria of growth as follows: Seedling (A) is a tree saplings begin to sprout up as high as < 1.5 meters, Sapling (B) is a tall tree saplings which have height as > 1.5 cm and a diameter of < 7 cm, Poles (C) is a young trees with a diameter ranging > 7 cm until diameter < 20 cm, and the tree (D) is the mature trees with diameter > 20 cm. The analysis used Importance Value Index (IVI) and Shannon Wiener Index. The results of data processing further is analyzed descriptively. Value of density, relative density, frequency, relative frequency, dominance, relative dominance and Shannon Wiener Index.

This model by finding the relationship between the altitude of the location to Shannon-Wiener index (H-index) every level of the plant is: (H- Index) plants = f (height), which, H-index = dependent variable, and F (height) = independent variable. The formation of this equation curve using Curve Expert Ver.1.3 software with ranking system based on the smallest value of the Standard Error (SE), the largest value of Coefficient of Determination (R²) and the largest value of Correlation Coefficient (r).

Phytochemical screening of poisonous plant with test the contains of alkaloids, terpenes, flavonoids, saponins, and tannins. Phytochemical testing procedure conducted [2], are as follows:

2.1. Test for Alkaloids

Simplicia powder/crude drug was weighed approximately 0.5 g then added 1 mL of 2 N hydrochloric acid and 9 ml of distilled water, heated over a water bath for 2 minutes. Cooled and filtered. The filtrate was used for the experiment as follows: (a) 3 drops filtrate plus 2 drops of reagent solution of Meyer, will form precipitates a white or yellow colored clumping; (b) 3 drops filtrate plus 2 drops of reagent solution of Bouchardat, will form precipitates a brown to black; (c) 3 drops filtrate plus 2 drops of reagent solution of Dragendorff, will form precipitates a red or orange. Alkaloid positive if precipitates or turbidity at least two of the three trials [3].

2.2. Test for Terpenes

About 1 g of powder botanicals was macerated with 10 ml of n-hexane for 2 hours, filtered, the filtrate evaporated in vaporizer cup, and the remainder was added 10 drops of acetic acid anhydride and 1 drop of concentrated sulfuric acid (Liebermann - Burchard reagent). When formed red or purple color then changes into blue green indicate the presence of terpenes [4].

2.3. Test for Flavonoids

About 0.5 g of crude drug powder was added 20 ml of hot water, boil for 10 minutes and filtered hot, into 5 ml of the filtrate was added 0.1 g of magnesium powder and 1 ml of concentrated hydrochloric acid and 2 ml of amyl alcohol, shaken and left apart. Flavonoids positive case of red, yellow, orange on layers amyl alcohol [3].

2.4. Test for Saponins

About 0.5 g of crude drug powder, was added to the test tube, add 10 ml of hot water, cooled and then shaken for 10 seconds. If the foam is formed as high as 1 to 10 cm which stable no less than 10 minutes and does not disappear with the addition of 2 N hydrochloric acid when there is saponin [3].

2.5. Test for Tannins

About 0.5 g of the sample that has been refined (botanicals) filtered / macerated with 10 ml of distilled water for 15 minutes. Then filtered, filtrate diluted with distilled water until almost colorless. Taken 2 ml filtrate, add 2 drops of solution of FeCl₃ 10%. Note the color occurs, blue or green color indicates the presence of tannins. The blue color shows the presence of three hydroxyl groups on the aromatic core of tannins. The green color indicates there are 2 pieces of hydroxyl groups on the anti aromatic tannins [4].

3. Result and discussion

3.1. Composition, Structure and Distribution of Vegetation of BGNP

The vegetation of BGNP, Mandailing Natal on Sopotinjak Village, Hutabaringin and Sibanggor Julu found 158 species of tree, 113 poles, 95 saplings, 87 seedlings, and 98 undergrowth plant. While poisonous plants BGNP are 10 species of trees, 12 kinds of poles, 11 species of saplings, 10 types of seedlings, and 11 species of undergrowth plants.

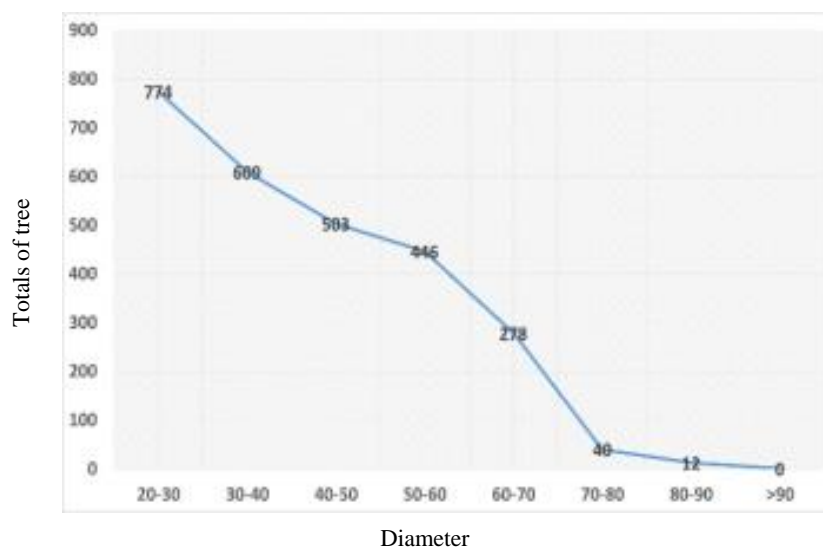


Figure 1. Distribution Pattern of Tree Diameter BGNP

The results of the study (Figure 1) showed that the distribution of trees in locations BGNP already resembles the letter "J" upside down, although not as ideal as virgin forest / primary without interruption. This indicates that the population of large-diameter trees are relatively decreased dramatically with small-diameter trees that generally causes the number of trees decreases dramatically with the growth of diameter classes.

That condition is a normal thing for the existence of a natural forest, because usually the composition of small-diameter trees more numerous than large-diameter trees. It is possible the level of competition among individual plants to meet their needs in the form of light, soil water, oxygen, nutrients, and carbon dioxide.

3.2. Structure of Vegetation

Table 1. Vegetation Stratum in BGNP

Class of Total Height (m)	Stratum	Amount
>30	A	1137
20-30	B	810
4-20	C	3081
Shrubs and Bushes	D	4940
Under stories	E	2023

Based on the class stratification of the forest canopy [5], it appears that the tree of primary forest in Sopotinjak, Hutabaringin and Sibanggor Julu has complete canopy statum, ranging from starum A (a height of 30 m or more) until starum D (height 1-4 m). Stratum E (height 0-1 m) filled by seedlings and shrubs.

The existence of the canopy layer is very important in supporting the diversity of wildlife, and reducing the kinetic energy of rainwater, which in turn can reduce the risk of erosion. The erosion control function is getting stronger with the high-density stratum class C and D as well as the presence of shrubs and litter on the forest floor, which is based on field observations, litter thickness of more than 30 cm. While in secondary forest canopy is dominated stratum C, D, and E, which are often any the clearing of land for planting rubber trees and coffee.

3.3. Description of Poisonous Plants in BGNP



Figure 2. Dong-dong (*Laportea stumulus* Gaud)



Figure 3. Langge (*Homalonema propinqua* Ridl).



Figure 4. Latong (*Litsea leefeana*)



Figure 5. Modang / Modang Londir (*Persea rimosa*)



Figure 6. Ruam (*Flacourtia rukam* Zoll. & Mortizi)



Figure 7. Rube (*Ficus lowii* King.)



Figure 8. Sibagori (*Sida rhombifolia*)



Figure 9. Sitarak (*Macaranga gigantea*)



Figure 10. Tabar-tabar (*Costus speciosus* Sm.)



Figure 11. Tampar badak (*Pogonanthera pulverulenta* Blume)

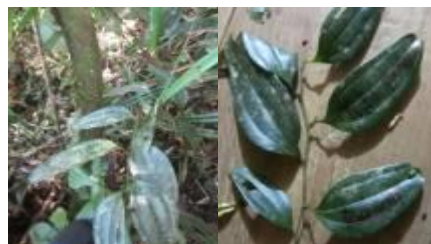


Figure 12. Tuba Pangkal (*Cinnamomun* sp.)

3.3.1. Dong-dong (*Laportea stumulus* Gaud). Dong-dong is a tree. Dong-dong love moist and shaded areas, often found at the edges of the path. This plant can be seen in Figure 2. The content of the chemical is from the class of Flavonoids, Terpenes, Alkaloids and Saponins. The leaves contain toxic (when exposed human skin can make itching). The top and the edge of the leaf covered with fine hairs which only visible when viewed from very close range. When these hairs touched the part of our skin which delicate and sensitive can cause itching, burning and stinging hot enough.

3.3.2. Langge (*Homalonema propinqua* Ridl). Based on observations in the field, which is a kind of taro plants yarns. This plant can grow in moist state and can grow in a protected state or shaded. The characteristics of this plant is the leaves are green, heart-shaped leaves. *Homalonema propinqua* is an herbaceous plant, perennial crops, can grow in wetlands or damp, sometimes are epiphytes or climbing. The content of the chemical is from the class of Flavonoids, Terpenes, Alkaloids and Saponins. Characteristic of this plant can be seen in Figure 3.

3.3.3. Latong (*Litsea leefeana*). Latong is species of tree. Description of these plants as found in the study site is the location where the growth of sunlight. This plant life on littered dry land. The characteristics of the leaves of this plant are reddish brown bone. Characteristics of plants can be seen in Figure 4. Chemical constituents contained in this plant are terpenes, alkaloids and saponins. Latong also have the sap in the stem and petiole, when in contact with skin will itch.

3.3.4. Modang/Modang Londir (*Persea rimosa*). Modang (*Persea rimosa*) is a tree with a height up to 40 meters with the color of the wood is dark yellow to reddish. The stem is finely textured and slightly shiny. The bark has a thickness of 1-1.5 cm. Modang has a leaves with rounded oval-shaped, the upper and lower leaf surface is smooth and shiny. The leaves have a mucus that can be used as a pesticide (repels insects). Characteristic of this plant can be seen in Figure 5.

3.3.5. Ruam (*Flacourtia rukam* Zoll. & Mortizi). Ruam is a tree. Ruam or Rukem is the name of a fruit-producing trees are said to be native from Indonesia. The fruit is commonly eaten in the location of the research community, Ruam did not bear fruit throughout the year, but there are seasons. Ruam which in Latin is called *Flacourtia rukam* are scarce in Indonesia. Characteristic of this plant can be seen in Figure 6. The content of the chemical is from the class of Flavonoids, Terpenes, and Saponins. the outskirts of the leaves is coarsely toothed. Upper leaf surface color is shiny dark green. When young the leaves of this tree in brownish red.

3.3.6. Rube (*Ficus lowii* King.). Rube is a tree. In general, the types known as ara, ara tree or ara wood (Mink. *kayu aro*; Sd. *ki ara*; English: *fig trees* or *figs*). Characteristic of this plant can be seen in Figure 7. Chemical constituents contained in this plant is a class of Flavonoids, Terpenes, Alkaloids and Saponins. The leaves is conical elongated and leave a mark which similar to rings. Flowers are not found when identified. Seeds are not found at the time identified.

3.3.7. Sibagori (*Sida rhombifolia*). Sibagori grown in areas containing litter and moist. Sibagori rod is reddish, and there are mucus when the skin peeled, usually grows in the shade and grow in groups. The flowers color is yellow, shaped like a duck's beak, the fruit was not found when identified and this type of plant root is root fibers. Characteristics of plants can be seen in Figure 8.

3.3.8. Sitarak (*Macaranga gigantea*). Sitarak is a tree, the rods are round, smooth and gray dirty. Chemical content of flavonoids and alkaloids in the leaves. A place to grow normally in the open or disturbed areas but is most common in secondary forest and shrubs vegetation. Sitarak on BGNP can be seen in Figure 9.

3.3.9. Tabar-tabar (*Costus speciosus* Sm.). This plant is an undergrowth plant. The local name of this plant at the study site in BGNP is Tabar- tabar. The rods color is brownish yellow, amounting to an adult's finger and contains a lot of water and easily broken, and has a segment on the stem. Characteristic of this plant can be seen in Figure 10. Chemical constituents contained in this plant is a class of Terpenes and Alkaloids.

3.3.10. Tampar badak (*Pogonanthra pulverulenta* Blume). This plant grows in dry areas and rocks. This plant contains flavonoid compounds in the leaves and flowers as well as the class of compounds saponin in the leaves [6]. Characteristics of plants can be seen in Figure 11.

3.3.11. Tuba Pangkal (*Cinnamomun sp.*). Based on field observations of this plant is a undergrowth plant. This plant is found in shady locations slightly exposed to sunlight and moisture. Characteristics of this plant has a rough surface and color of the leaves are dark green. Characteristic of this plant can be seen in Figure 12.

3.4. Analysis of Vegetation

The Results of Importance Value Index (IVI) of poisonous plants shows that Ayu Otang (67.66), Supi (56.24), Suat arangan (29.50), Latong (20.54), dominate at the class of undergrowth plant. While at the seedling stage, the largest is Modang (139.51), and Supi (126.50). At the class of Sapling, the largest is Dongdong (94.82), Latong (35.22), and Ruam (15.66).

While at the class of pole, thr largest is Dongdong (47.50), Ayu Ara (41.54), Monton (36.75), and Modang Tano (31.91). While the rate of trees is dominated by Ayu Ara (85.88), Ayu Otang (67.38), Dongdong (52.79), and Modang Tano (23.11). From the results of this IVI, at the class of tree is describe about diversity of species dominance, so that if the intervention, which needs to be done is the process of enrichment of species on vacant lands in the area around the forest.

The composition of poisonous plants that were found as many as 310 individuals of undergrowth plants and the most type which commonly found is Ayu Otang and Supi as many as 113 and 69 individuals were found in a field that is growing spread. The fewest types which found are Tabar-tabar, Ambolung, Langge (*Homalonema propinqua* Ridl) a number of 2-7 individuals. This is because the growing requirements differed among plant species. Barbour, et al [6] states that the value could range from 0-7 H' only. The criteria include the relatively low 0-2, 2-3 classified as moderate and more than 3 is high.

According [1] that the air temperature conditions can affect to the life of flora and fauna, as various species have temperature requirements of an ideal or optimum living environment as well as the tolerance levels are different from each other. In terms of attendance at a plant community can be said that the higher a place the less plants grow. Temperature and light intensity will be smaller with higher place to grow.

3.5. Modelling Results

Selection of the best model associated with the value of the ranking, the higher the ranking can be seen that the smallest of the value of the standard deviation (*Standard Error*) with the coefficient of

determination (R^2) is getting close to one. Each level of the model produces a value that is unique and different, but there is the tendency that the curve created is an ascending form, then at a certain position will start to move down.

Table 2. Selection Process Model Equations Matching at All Rates of Vegetation

Rate	Model Name	Equations	Coefficient Data
Undergrowth Plant	Vapor Pressure	$y = \exp(a + b/x + \ln(x))$	a = 1.85205147770E+001
			b = -2.84614070711E+003
			c = -2.12522184717E+000
			a = 2.80446484206E+000
Seedling	Sinusoidal Fit:	$y = a + b * \cos(cx + d)$	b = 1.98060172772E-001
			c = 6.70192242694E-002
			d = 1.26623885688E+000
			a = 3.13364037897E+000
Sapling	Sinusoidal Fit:	$y = a + b * \cos(cx + d)$	b = 3.57995164819E-001
			c = 1.21744405286E-002
			d = -8.52757685538E+000
			a = 3.83565403212E+000
Poles	Sinusoidal Fit:	$y = a + b * \cos(cx + d)$	b = 2.09038748159E-001
			c = 3.68380250158E-002
			d = -6.03684251606E+000
			a = 2.21734272577E-005
Trees	Hoerl Model:	$y = a * (b^x) * (x^c)$	b = 9.98687977488E-001
			c = 1.92992694404E+000

Description: **E+002=10²

This value is highly influenced by the location of the altitude's vegetation surveys where the higher the oxygen, the pressure reduced of 1 bar and the temperature will be cool. That equations can describe forest conditions at various altitudes. Observations by other factors such as changes in temperature, changes in forest cover and soil type has not been carried out at the research stage.

Modelling of poisonous plants with a variety of habitat types fact obtained a value close to the model in the field is the value of altitude location and the value of the H-index (*Shannon Wiener*). The model is obtained *Vapor Pressure Model* for undergrowth plants, *Sinusoidal Fit Model* for seedlings, saplings and poles. And *Hoerl Model* for trees.

3.6. Analysis of Secondary Metabolites

The content of secondary metabolites tested in plants as indicators of the presence of toxins in the plants body there are four groups which commonly tested are compounds alkaloids, terpenes, flavonoid / tannins and saponins.

From the phytochemical test results obtained that a poisonous plant in BGNP neighborhood Sopotinjak region, Sibanggor Julu, and Hutabaringin Julu contains alkaloids, terpenes and saponins.

Each plant contains phytochemical compounds, but not all plants contain alkaloids. Positive test of alkaloids (contains alkaloids) is characterized by a white precipitate [1]. For testing of alkaloids is using a reagent Bouchardat, Meyer and Dragendorff. The color change indicated by the Bouchardat reagent solution is brown while for Meyer reagent solution, the color changes to a yellowish white and the reagent Dragendorff indicated by an orange-colored sediment.

The content of the largest and dominant are terpenes except on Tabar-tabar (*Costus speciosus* Sm.) include the class of flavonoid and tannin and Aldulpak containing alkaloids. All plants contain toxic phenolics, terpenes, alkaloid, except Tuba Pangkal containing only terpenes. Dongdong contains all compounds incomplete.

Results of laboratory studies show that the greatest potential possessed Langge, Modang Londir and Sitarak. While Latong and Dongdong also potentially as a biopesticide given the potential in nature is still a lot and worth developing for the future.

Results of testing of alkaloid performed that Latong is a plant that has potential as a poisonous plant because it gives effect to humans or animals. The role of alkaloids compounds that can give effect to the organism makes Latong as a poisonous plant that contains the alkaloids compounds and can be used as materials for biopesticides [1]. Crop or plants derived from nature and potential as botanical pesticides generally have the characteristic bitter flavor (contains alkaloids and terpenes), smelling foul and taste slightly spicy. Testing Dong-dong also shows the content of secondary metabolites complex enough in order to get the candidate biopesticides given species is also very numerous and abundant in the area BGNP. With potential resources is expected in the future of their studies related to the contents of secondary metabolites in more detail in order to get the right application on the use of plantation agriculture.

Table 3. Result Phytochemical Identified of Poisonous Plants at BGNP

Local Name	Fenolik	Terpen/Steroid	Alkaloid				Saponin	Flavonoid	Tanin
	FeCl ₃	CeSO ₄	Bouchardart	Meyer	Dragendorf	Wagner	Aquades	Etilasetat	NaOH
Andulpak	-	-	++	-	-	-	-	-	-
Dong-dong	++++	+++	-	++	-	++	+++	++++	++
Langge	++++	+++	-	-	++	-	+	-	-
Latong	-	++++	-	-	++	-	-	-	-
Modang	++	+++	-	-	-	-	-	-	++++
Modang Londir	++	+++	-	-	++	-	-	-	-
Sitarak	+	+	+	+	+	-	+	++	-
Tabar-tabar	-	-	-	-	-	-	-	+++	++
Tuba Pangkal	-	+++	-	-	-	-	-	-	-

description

Bouchardart : KI + Aquades + Iodium

Meyer : HgCl₂ + Aquades + KI

Dragendorf : BiNO₃ + HNO₃ + KI + Aquades

-

+

++

+++

++++

: Not reaction

: Little reaction

: Middle reaction

: Higher reaction

: Highest reaction

4. Conclusions

1. The identification of poisonous plants found 14 species of poisonous plants, with 10-12 species at every rate undergrowth plant, seedlings, saplings, poles, and trees. The composition and vegetation stratum in primary forest is approaching to ideal forest picture slightly encroached upon by humans.
2. Analysis of poisonous plant species diversity of species is dominated obtained Ayu ara, Ayu otang, and Dongdong almost in all levels of undergrowth plants, seedlings, saplings, poles, and trees.
3. Modelling of poisonous plants with a variety of habitat types fact obtained a value close to the model in the field is the value of location altitude and the value of the H-index (Shannon Wiener). The model is obtained Vapor Pressure Model for undergrowth plants, Sinusoidal Fit Model for seedlings, saplings and poles. And Hoerl Model for trees.
4. The potential development of poisonous plants is in a kind of Langge, Modang Londir and Sitarak as a source of natural pesticides. However with the highest abundance is Latong and Dong-dong.

Based on these research results, further exploration is needed at different altitudes of less than 1000 masl to obtain a better model. While the type that found based on the analysis of secondary metabolites necessary for the application of research, farming, and city pest control which environmentally friendly.

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