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by Marina Silalahi

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Diversity of medicinal plants and their uses by the Sanger tribe of Sangihe Islands, North Sulawesi, Indonesia

DINGSE PANDIANGAN^{1*}, MARINA SILALAH², FARHA DAPAS¹, FEBBY KANDOU¹

¹Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Sam Ratulangi, Bahu, Manado 95115, North Sulawesi, Indonesia. Tel./fax.: +62-431- 863786, *email dingsepan@unsrat.ac.id, dingsepan@yahoo.com

²Department of Biology Education, Faculty of Education and Teacher Training, Universitas Kristen Indonesia, Jl. Mayjen Sutoyo No. 3, Cawang, Jakarta 13510, Indonesia

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Abstract. Pandiangan D, Silalahi M, Dapas F, Kandou F. 2019. Diversity of medicinal plants and their uses by the Sanger tribe of Sangihe Islands, North Sulawesi, Indonesia. *Biodiversitas* 20: 621-631. The Sanger tribe is an indigenous tribe in Sangihe Islands, North Sulawesi, who still continue to use traditional medicinal plants. The objectives of this study were to document the diversity of medicinal plants and their general uses by the Sanger tribe in the selected villages of Sangihe Islands and to identify plants that have anti-cancer potential. The study was conducted with ethnobotanical approach using survey and interviews among 90 respondents selected from 9 study villages located in 3 sub-districts of Sangihe Islands. The study showed that 118 species of medicinal plants belonging to 47 families had been used by the Sanger tribe to treat 39 different types of diseases. Thirteen (13) species each were used for treating fever and ulcers, 12 species in the treatment of poisoning, 10 species each for cough and kidney diseases, 8 species for each of the diabetes mellitus and cancer or tumors, and 7 species each for itching, hypertension, physical injury and blood circulation disorders. For other diseases, the number of plant species used as medicines varied from 1 to 6. Leaves were the most predominantly used part for medicinal purposes as this was used in case of 73 species, followed by stems (37 species), roots (29 species), flowers (25 species), fruits (20 species) and seeds (17 species). Twenty percent (20% of the recorded medicinal plants were consumed directly and others after different methods of processing and preparation, such as boiling (51%), crushing (15%), roasting (2%), soaking (16%) and pasting (7%), and a species can be used more once. A utilization of *Dischidia nythesiana* as medicines for cancer/tumor by the Sanger tribe has not been reported before.

Keywords: *Crotalaria striata*, *Dischidia nythesiana*, *Eleutherine americana*, medicinal plant diversity, Sanger tribe

INTRODUCTION

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Indonesia is an archipelago with more than 17,000 islands, about 300 ethnic groups and 30,000 plant species (Indrawan et al. 2007). Plants are used for various purposes by the native tribes, mainly in their practice of traditional medicines. Research to discover medicinal properties of plants have been performed in various ways, such as by screening for biologically active secondary compounds, taxonomical studies and ethnomedicinal approach (Martin 1995) as well as through scrutiny of ancient manuscripts (Nawangningrum et al. 2004).

An ethnomedicinal approach is a research method with efficient use of the time and cost for discovering new chemical compounds for development of new medicines (Fabricant and Farnsworth 2001; Purwanto 2002), especially for chronic problems like cancer and tumors. Fabricant and Farnsworth (2001) stated that as many as 80% of drugs used globally have similar benefits with ethnomedicine. Some ethnomedicine drugs derived from quinine were adapted from indigenous knowledge of the Incas who have long used *Cinchona* as an anti-malarial drug (Achan et al. 2011). Moreover, legundi (*Vitex trifolia*) which is used as an expectorant is derived from the Javanese local wisdom (Wahyono 2008).

More ethnobotanical documentation studies are needed

to intensify the research on medicinal plants, which are used by the local communities, especially since there is a tendency of high rate of erosion of local knowledge (Hoang et al. 2008). Moreover, the rate of species loss is almost parallel to the rate of loss of local knowledge (Hoang et al. 2008; Kartawinata 2010). The main objective of this research was to identify the potential medicinal plants, especially for cancers, since they are still very limited.

Cancer is the leading cause of death nowadays. Medical treatment and prevention of cancer have been carried out through removal of tumors, chemotherapy or radiotherapy (Pandiangan and Kandou 2006). Compounds that play roles in commercial cancer treatment are vincristine and vinblastine, belonging to the group of alkaloids (Alexandrova et al. 2000). They can be extracted directly from plants or produced from their precursors that are extracted from plants. Efforts to identify more plants for cancer treatment are needed. Silalahi et al. (2015b) reported that *Hoya* sp. and *Dischidia* sp. are used for cancer treatment as advertised by the medicinal herb sellers of traditional markets in Kabanjahe, North Sumatra, Indonesia.

To explore new sources of information on the use of herbs as medicines, various ethnomedicinal studies have been carried out, but they have been mostly focused on Java, Bali and some areas of Sumatra, while from other islands, such studies are very limited. Sulawesi is a unique

island due to its biodiversity that is a combination of the western and eastern parts of Indonesia. This phenomenon has resulted in a variety of distinctive plants found only in Sulawesi, which is also the reason for the diversity of their utilization. Some studies have been attempted to inventory the medicinal plants of some regions of Sulawesi such as the Bolaang Mongondow district (Pangemanan and Rondonuwu 1991; Wardah and Danimiharja 1996; Windardi and Uji 1996; Widadeti and Roemantyo 1996; Simbala and Potabuga 2002; Bulut 2005). However, the Sanger tribe of Sangihe Island has not been studied yet in this regard.

The Sangihe Islands are a group of islands separated from the mainland Sulawesi, which is inhabited by the Sanger tribe. Documentation of medicinal plants have been carried out in Central Tabukan (Talengen, Gunung, and Tariang Baru Villages), South Tabukan (Pintareng Village) and Tahuna (Tahuna Village) by Pandiangan and Kandou (2006) and Mulalinda (2006). However, other islands in the area have not been studied yet. Kandou and Pandiangan (2006) found that medicinal plants rich in alkaloids, such as *Catharanthus roseus*, *Carica papaya*, *Coleus scutellarioides (mayana)*, *Coleus amboinicus (panise)*, *Codiaeum variegatum (kalubahangi)*, *Ficus emery (hope)*, *Melaleuca bracteata (balakama)*, *Peperomia pellucida (suruhan)*, *Piper betel*, *Cassitha filiformis (taliputri)*, *Morinda citrifolia (seha)* and *Persea gratissima* were found here. Therefore, this study was undertaken with the objectives of determining the diversity of medicinal plants and their use by the Sanger tribe in the Sangihe Islands in general and identifying the medicinal plants which are used in cancer treatment, in particular.

21 MATERIALS AND METHODS

Study area

The study was conducted from January to July 2017, in nine villages located in Sangihe Islands District and Sitaro (Siau Tagulandang Biaro) Islands District, North Sulawesi Province, Indonesia (Figure 1). The Sangihe Islands consist of 105 islands of which 79 islands are uninhabited and 26 islands are inhabited, while Sitaro Islands consist of 47 islands of which 37 islands are uninhabited and 10 islands are inhabited by the Sanger ethnic group. The Sangihe Islands are geographically located between 2°4'3"- 4° 44'22" N and 125°9'28"- 125°56'57" E; while Sitaro Islands are located between 2°4'13"-2°52'47" N and 125°9'28" - 125°24'25" E (BPS 2017, 2018). The villages selected for the present study were Lesa, Tapuang, and Batulewehe of East Tahuna sub-district of Sangihe Islands District; Mala, Naha, and Kalakube of North Tabukan sub-district of Sangihe Islands District; and Lumbo, Bawoleu, and Bawo of North Tagulandang sub-district of Sitaro Islands District.

Sanger tribe

Majority of people belonging to Sanger tribe are fishermen, living in the coastal areas, and farmers who live in the mountain areas. The farmers mainly cultivate coconut (*Cocos nucifera*), nutmeg (*Myristica fragrans*) and

clove (*Syzygium aromaticum*) (Figure 2).

Data collection

Data was collected through ethnobotanical approach of semi-structured, in-depth interviews and participatory observations. A group of 90 respondents, which consisted of 10 people from each of the study village, were interviewed. The respondents were religious leaders, staff of the village administrative office, respected elders of the village and traditional healers who were selected using positive snowball sampling method. Herbarium specimens of medicinal plants were collected and their local names, parts used and method of utilization was noted along with uses.

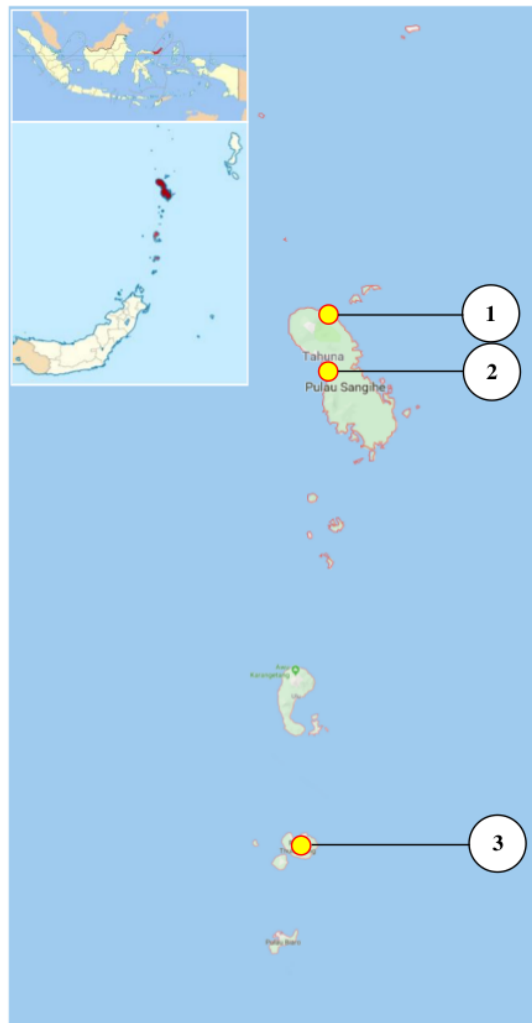


Figure 1. The research sites in the North Tabukan (1) and East Tahuna (2) sub-districts of Sangihe Islands District and North Tagulandang (3), Sitaro Islands District, North Sulawesi Province, Indonesia



Figure 2. Research sites in Lumbo Village, North Sulawesi, Indonesia showing coconut cultivation in coastal lowland area (left), and cultivation of nutmeg in mountainous area (right)

Interviews were based on modified methods of Martin (1995), Alexiades and Sheldon (1996) and Kandou and Pandiangan (2006). Medicinal plants collected from the field were identified refer to Bakhuizen v.d. Brink (1963-1968). The botanical names of the plants were then verified using the online www.theplantlist.org database version 2017.

Data analysis

The ethnomedicinal data collected in this study were analyzed qualitatively and quantitatively. The index of similarity and inequality was calculated using Jaccard Index (Ji) equation (Mueller-Dombois and Ellenberg 1974; Krebs 1978;).

Jaccard index (Ji) was calculated using the equation:

$$Ji = \frac{a}{a + b + c}$$

Where:

- a: Number of species found in villages A and B
- b: Number of species found in village A, but not found in village B
- c: Number of species found in village B, but not found in village A

RESULTS AND DISCUSSION

Medicinal plants used by the Sanger tribe

The Sanger tribe was found to be using a total of 118 species of plants as medicinal, which belongs to 46 families. Table 1 provides family-wise list of all these plants with information on their local names, scientific names, uses, and location or villages where the plants were found. The number of species of medicinal plants recorded in this study was lower than that of the Batak Simalungun tribe (Silalahi et al. 2015a) and Batak Karo tribe (Purba et al. 2016), but higher than that of the Lahat tribe (Harmida and Yuni 2010). The number of species recorded during ethnobotanical studies is strongly

influenced by the natural plant diversity of the study area as well as the number of respondents. Anwar et al. (1984) stated that Sumatra has a very high floral diversity, with about 10,000 species of plants, while the Sangihe Islands are floristically less diverse. The species diversity within the area is directly proportional to the total area of the islands (Cox and Moore 2008).

Plant family-wise analysis of medicinal plants indicated that Lamiaceae (11 species), Euphorbiaceae (9 species), Acanthaceae (7 species), Zingiberaceae (6 species), Malvaceae (5 species) and Verbenaceae (5 species) were the families with largest number of species found in the study. Lamiaceae members were the most often found plants since they do not require any special maintenance, are resistant to deficiency and excess of water, and are easily propagated through cuttings and seeds. Three species collected in the present study were identified only to the genus level. They are *tate filipina* (*Coleus* sp.2), *panesse* (*Coleus* sp.1), and *betadin* (*Sterculia* sp.). The plant called *tate filipina* (*Coleus* sp.2) has been known as a cure for cancer. The limitations in collecting the plant specimens were the major constraints for further identification of these unidentified species.

Members of Acanthaceae have been used to treat various diseases, such as increasing the number of blood cells (*Asystasia gangetica*, *Hemigraphis colorata*), fever (*Graptophilum pictum*), malarial fever (*Andrographis paniculata*), kidney disease (*Strobilanthes crispus*), and toothache (*Barleria prionitis*). Lamiaceae members are used for treating fever (*C. amboinicus*), cough (*C. scutellaroides*) and heart disease (*Pogostemon hedgei*). Moreover, there are three species of the Euphorbiaceae family that are known to treat cases of poisoning: *Jatropha curcas*, *Phyllanthus niruri* and *Euphorbia antiqorum*.

Some of the medicinal plants found useful in this study have already been reported to be medicinal by earlier studies and they mainly belong to Zingiberaceae family, such as *Curcuma longa*, *Alpinia galanga*, *Zingiber officinale* and, *Curcuma xanthorrhiza* (Silalahi et al. 2015a,b). However, medicinal uses of species, such as *Clerodendrum sahelangi*, *Leucas lavandulifolia*,

Clerodendrum calamitosum, *Talinum triangulare*, *Abelmoschus manihot*, *Eleutherine americana*, *Coleus* sp., *Pedilanthus tithymaloides*, *Dischidia nythesiana*, *Eurycles amboinensis* and *Barleria prionitis* are new since they have not been reported before.

Analysis of number of medicinal plants employed to treat various diseases showed that a maximum number of 13 species each were used to treat fever and ulcers. Other major diseases were poisoning (12 species), cough (10 species), kidney disorders (10 species), diabetes (8 species), cancer/tumors (8 species), itching (7 species), hypertension (7 species), injuries or cuts (7 species) and circulation disorders (7 species). Medicinal plants were also used to treat about 28 other diseases and the number of species used against each such disease varies from one to six (Figure 3).

The plants that were found to be used to treat fever were *Hemigraphis colorata*, *Pluchea indica*, *Euphorbia thymifolia*, *J. curcas*, *C. amboinicus*, *Oxalis corniculata*, and *Piper betel*. The utilization of *Piper betel* and *J. curcas* to treat fever has also been reported from the Batak Simalungun (Silalahi et al. 2015a), Karo (Purba et al. 2016) and Minang (Khairiah 2017) tribes. There is a belief among the villagers that certain plants are 'cold' in nature, thus they can be used to treat fever and lower the patient's body temperature.

Silalahi et al. (2015a) stated that the Simalungun ethnic group use plants that have coarse leaves to treat kidney disorders. The Sanger tribe uses *Orthosiphon spicatus* and *S. crispus* to treat kidney disorders. They are both known as diuretics and the leaf of *Orthosiphon spicatus* has also been listed as 11 retic (MoH 1977). The local people also exchange information on the medicinal uses of plants with other communities.

The local use of *Artemisia vulgaris*, *Momordica charantia*, *P. niruri*, *J. curcas* to treat cases of poisoning may be considered as relatively new reports. *P. niruri* has been known as a diuretic *J. curcas* is known to cure fever and *M. charantia* has been reported to be used in the treatment of diabetes (Wijayakusuma 1996a, 1996b, 1996c, 2000). The Sanger ethnic group has been using about 12 species to treat cases of poisoning, such as bites of snakes, insects and other animals. For medicinal purposes, the plants are consumed fresh or as a simple extract in water. Parts of the plants that are believed to be having medicinal properties are usually boiled and then consumed with 7 palm sugar.

A total of eight species of medicinal plants were used in cancer or tumor treatment. They are *D. nythesiana*, *A. vulgaris*, *Crotalaria striata*, *E. americana*, *Catharanthus roseus*, *Philippines Coleus* sp. 1., *Derris elliptica* and *Coleus* sp. 2. *Catharanthus roseus* has long been used for cancer treatment because it produces the alkaloid vincristine and vinblastine, the compounds that have been shown to inhibit the growth of cancer cells. Thus, this

plant, which originated from Madagascar, has been commercialized as a medicine for cancer. *D. nythesiana*, *A. vulgaris*, *C. striata*, and *E. americana* have also been known as cancer drugs.

As many as 79 species of the medicinal plants used by the Sanger tribe have been cultivated, while the remaining 39 species were found in the wild. The wild plants can be found 6 roadsides, in gardens growing wild and also in the forest. The medicinal plants that are often cultivated by the locals are those with additional benefits, such as spices (*C. longa*, *A. galanga*, *Z. officinale*), hedgerow (*J. curcas*, *S. crispus*), vegetables (*C. amboinicus*, *Allium cepa*), and fruit tree 23 *Carica papaya*, *Annona muricata*.

Different parts of the plants are utilized for medicinal purposes. The parts used in current study are the roots (29 species), stems (37 species), leaves (73 species), flowers (25 species), fruits (20 species) and seeds (17 species) (Fig. 4). Among all parts of a plant, medicinal property is mainly found in the leaves (36%), followed by stems (18%), roots (14%), flowers (13%), fruits (10%) and seeds (9%).

The methods of preparation of the medicinal plants were boiling in water (51%), crushing (15%), direct consumption (20%), roasting (2%), soaking (16%) and pasting (7%). Medicinal plants that are consumed directly can be done by eating plant parts or parts of the extract. One type of plant can be used in more ways, this results in a total plant of more than 100%. For example, the *Piper betle*, *C. longa* can be used directly, that is by taking fresh extracts or by stirring first. Boiling, as a method of preparation, is seen to be more hygienic and simpler for consumers. Moreover, boiling in water helps to lower the level of bitterness, and the secondary metabolites present in the plants get dissolved in water (Harbone 1987). Thus, boiling results in the extraction of the active compounds and, therefore, it increases the efficacy of the medicinal preparations.

Potential anti-cancer plants 7

The Sanger tribe uses a total of eight species of medicinal plants for the treatment of cancer, or tumor *D. nythesiana* is a new report. *D. nythesiana*, *A. vulgaris*, *C. striata*, *E. americana* and *Coleus* sp. that belong to four different families. The Sanger tribe believes that cancer or tumor is difficult to cure and they often result in death. Local people recognize cancer with symptoms of large lumps in the body, and cause interference with all parts of the body. Treatment for cancer is done by taking various *Dischidia* herbs for a long time. Alkaloid from *Catharanthus roseus*, such as vincristine and vinblastine, as well as taxol from *Taxus* sp. are commercially available cancer drugs that are extracted from plants (Munim and Hanani 2011). Tests on anti-cancer activity are mostly done *in vitro* using cell line.

Table 1. Family-wise list of medicinal plants utilized by the Sanger tribe in Sangihe Islands and Sitaro Islands districts, North Sulawesi Province, Indonesia. For each plant, local name/s, scientific name, uses, name of the village (s), where used and life form is given

Scientific name	Local name	Uses	Villages	Lifeform
Acanthaceae				
<i>Andrographis paniculata</i> (Burm.f.) Nees	Sambiloto	Malaria fever, Liver problems	TG, BE, LA, BO	Herb
<i>Asystasia gangetica</i> And.	Bungang hisa	Anemia	LO, BU	Shrub
<i>Barleria prionitis</i> L.	Kalu burung	Scabies, itching, toothache	TG, LA, NA	Shrub
<i>Graptophyllum pictum</i> L.	Limpadaleng	Ulcer	NA, LO	Shrub
<i>Hemigraphis colorata</i> L.	Marilah	Cough, bleeding, fever, anemia	TG, BE, LA, MA, LO, BU	Herb
<i>Justicia gendarussa</i> Burm. f.	Nggahusa	Gout, cholera	TG, NA, MA, LO, BU, BO	Shrub
<i>Strobilanthes crispus</i> Blume	Kaca beling	Kidney disease	TG, BE, LA, NA, LO, BO	Shrub
Alliaceae				
<i>Allium cepa</i> L.	Lansuna mahamu	Ulcer	LA, LO, BU	Herb
<i>Allium schoenoprasum</i> L.	Ganda	Hypertension, diarrhea, dysentery	TG, BE, LA, NA, KE, MA, LO, BU, BO	Herb
Amaranthaceae				
<i>Amarantus spinosus</i> L.	Bayam putih	Ulcer	NA, KE, BU	Herb
<i>Celosia argentea</i> L.	Kaliapa umboh	Anemia	TG, LA, NA	Herb
<i>Celosia cristata</i> L.	Sasihungu manu	Measles	LA, NA	Herb
Amaryllidaceae				
<i>Eurylesamboinensis</i> Loud	Walantuluhi	Ulcer	TG, BO	Herb
Annonaceae				
<i>Annona muricata</i> L.	Nangka walanda	Gout, stomach ache, heart disease, headache	LA, NA, MA, BO	Tree
Apiaceae				
<i>Centella asiatica</i> L. Urban	Dalimase	Kidney disease, Chicken fox	TG, BE, KE, MA, LO, BU, BO	Herb
<i>Foeniculum vulgare</i> Mill	Anis	Cough	BO	Herb
Apocynaceae				
<i>Alstonia scholaris</i> R. Br	Galiti	Malaria fever, headache	BO	Tree
<i>Catharanthus roseus</i> (L.) G. Don.	Gendola	Diabetes mellitus, cancer, hypertension	LA, NA, KE, MA, LO, BU, BO	Herb
<i>Plumeria acuminata</i> Ait	Kamboja	Ulcer	BE	Tree
Araceae				
<i>Homalomena occulta</i> (Lour.) Schott.	Kalintama	Stroke	BU	Herb
Arecaceae				
<i>Areca catechu</i> L.	Tilade	Diabetes mellitus, diarrhea, disentry	TG, LA, NA, KE, BU	Tree
<i>Arenga pinata</i> (Wurmb) Merr.	Pohon seho	Kidney disease	LO, BU	Tree
<i>Cocos nucifera</i> L.	Wango	Measles, influenza	NA, LO, BU, BO	Tree
Araliaceae				
<i>Nothopanax scutellarium</i> Merr	Daun mangkok	Hair loss	BE	Herb
<i>Panax ginseng</i> C.A. Mey	Ginseng	Aphrodisiac	LO	Herb
Asclepiadaceae				
<i>Dischidia nythesiana</i>	Lintakuhi	Cancer	LO, BO	Herb
Asteraceae				
<i>Artemisia vulgaris</i> L.	Daun tatutup	Heart disease, poisoning, cancer	TG, NA, KE, BO	Herb
<i>Gynura</i> sp.	Daun berkat	Diabetes mellitus	TG, BU, BO	Herb
<i>Pluchea indica</i> L.	Balontas	Fever	LO, BO	Herb
<i>Spilanthes ocyimifolia</i> Moore	Ruku sising	Diabetes mellitus, toothache	LO	Herb
Balsaminaceae				
<i>Impatiens balsamina</i> L.	Laka	Injury, disentry	TG, LA, NA, MA, BU	Herb
Bromeliaceae				
<i>Annanas comosus</i> L. (Merr.)	Nanasi	Kidney disease	KE, LO, BU	Herb
Caesalpiniaceae				
<i>Cassia allata</i> L.	Kalumparehi	Scabies, fracture	BU, BO	Herb
Caricaceae				
<i>Carica papaya</i> L.	Kapala	Hypertension, worm disease	MA, LO, BU	Herb
Commelinaceae				
<i>Rhoe discolor</i> (L. Her) Hance	Adam dan hawa	Hypertension	TG, BE, LA, LO, BU, BO	Herb
Convolvulaceae				
<i>Ipomoea pes-caprae</i> (L.) Sweet	Batata pante	Sprain	BO	Herb
Cucurbitaceae				
<i>Momordica charantia</i> L.	Papare	Poisoning, body odor	TG, NA	Herb
Crassulaceae				

<i>Kalanchoe pinnata</i> (Lamp.) Pers	Tahulending	Ulcer, fever	TG, BE, LA, LO, BO	Herb
Euphorbiaceae 11				
<i>Euphorbia antiqorum</i> L.	Kau leper	Poisoning	BE, LO, BO	Herb
<i>Euphorbia hirta</i> L.	Ruku tinta	Cataract	TG, LA, KE, LO BO	Herb
<i>Euphorbia thymifolia</i> L.	Onasi	Fever	KE, BU	Herb
<i>Euphorbia tirucalli</i> L.	Kau duhi	Fracture	TG, BU	Herb
<i>Jatropha curcas</i> L.	Talunsina	Fever, itching, kidney disease, gastrointestinal disorder, fever, poison disease	TG, BE, LA, NA, KE, MA, LO, BU, BO	Herb
<i>Jatropha gossypifolia</i> L.	Talunsia mahamu	Typhoid fever, Childbirth	NA, LO	17 Shrub
<i>Pedilanthus tithymaloides</i> (L.) Poit	Bungang perak	Venomous bites	TG, LO	Herb
<i>Phyllanthus niruri</i> L.	Dukung anak	Kidney disease, poison disease	TG, LA, KE	Herb
<i>Sauropus androgenus</i> Merr	Katu	Increase breast milk	LA, NA, MA, LO	Shrub
L. 22.aceae				
<i>Coleus amboinicus</i> Lour	Tabale	Fever, fracture	BE	Herb
<i>Coleus blumei</i> Benth	Mahampusiram	Internal disease	BL, BO	Herb
<i>Coleus scutellarioides</i> (L.) Benth.	Titate	Cough, poisoning	TG, NA, KE, LO, BU, BO	Herb
<i>Coleus</i> sp.1	Panese	Cough	TG, BE, LA, LO, BU, BO	Herb
<i>Coleus</i> sp.2	Tate filipina	Cancer	TG	Herb
<i>Leucalavanduli folia</i> Smith	Haerani	Nose bleeding	LA, BO	Herb
<i>Mentha crispata</i> Rumph	Salasi	Gastrointestinal disorder	NA	Herb
<i>Ocimum basilicum</i> L.	Balakama	Scabies, headache	TG, LA, NA, KE	Herb
<i>Orthosiphon spicatus</i> B.B.S	Kumis kucing	Kidney disease, poisoning	TG, BE, NA, LO, BO	Herb
33 <i>Pogostemon cablin</i> (Blanco) Benth.	Mahangkirang	Hair care	TG, LO, BU, BO	Herb
<i>Pogostemon hedgei</i> V.S.Kumar & B.D.Sharma	Lihunu	Stomach ache	BU, BO	Herb
Lauraceae 32				
<i>Lawsonia inermis</i> L.	Lakasiang	Internal disease	BE, LA	Shrub
<i>Persea americana</i> Mill	Alpokot	Hypertension	TG, BE, LA, NA, KE, MA, LO, BU, BO	Tree
Liliaceae				
<i>Aloe vera</i> L.	Lidah buaya	Diabetes mellitus, cough, hair care	TG, LA, NA, BU, BO	Herb
<i>Coryline fruticosa</i> (L.) A Chev.	Bungang	Injury	KE	Shrub
<i>Eleutherine americana</i> Merr.	Bawang babi	Cancer	TG	Herb
Malvaceae				
<i>Abelmoschus manihot</i> Pohl.	Saroro	Diarrhea, appendix disorder, delivery	TG, BE, LA, NA, KE, MA, LO, BU, BO	Shrub
10 <i>Gossypium herbaceum</i> L.	Kapesi	Cough	LA, KE, MA, BO	Shrub
<i>Hibiscus rosa-sinensis</i> L.	Hambuanga	Ulcer	BE, LA, KE, MA, BU	Shrub
<i>Hibiscus</i> sp.	Rosi ambon	Cancer	LO	Tree
<i>Sida rhombifolia</i> L.	Rumpu sosapu	Tonsil, Rheumatism	TG, BU, BO	Shrub
Menispermaceae				
<i>Tinospora crispa</i> L.	Kapu wanehi	Diabetes mellitus	BU	30 Herb
<i>Tinospora tuberculata</i> Blume	Kapu ambong	Malaria fever, heart disease	LO, BU, BO	Herb
Mimosaceae				
<i>Leucaena glauca</i> Benth	Marawlesi	Scabies	BE, BU	Tree
<i>Mimosa pudica</i> L.	Putri malu	Cough	BU	Herb
Moringaceae				
<i>Moringa oleifera</i> Lam.	Kelor	Diabetes mellitus	LA	Tree
Musaceae				
<i>Musa paradisiaca</i> L.	Wusa manduru	Heart disease	BE, LA	Herb
<i>Musa textilis</i> Nee	Wusa hote	Kidney disease	BE	Herb
Myrtaceae				
<i>Eugenia aquea</i> Burm. f	Kapeta mahamu	Microba infection in mouth	TG, KE	Tree
<i>Psidium guajava</i> L.	Goyawas	Diarrhea, stomach ache	TG, BE, LA, NA, KE, MA, LO, BU, BO	Tree
Myristicaceae				
<i>Myristica fragrans</i> Houtt	Pala	Liver, nuasea	BE, MA	Tree
Nyctaginaceae				
31 <i>Tirabilis jalapa</i> L.	Asari	Poisoning, fever, pimples	LA, LO, BO	Herb
Oxalidaceae				
<i>Averrhoa bilimbi</i> L.	Belimbing	Odema	TG, BO	Tree
<i>Averrhoa carambola</i> L.	Belerang	Injury	LO, BU	Tree
<i>Oxalis corniculata</i> L.	Piaewehe	Fever	TG	Shrub
Oleaceae				
<i>Jasminum sambac</i> L.	Manuru	Eye infection, face tonic	TG, BE, LO	Shrub

Pandanaceae				
<i>Pandanus odoratissimus</i> L.	Pondang	Cholesterol-lowering, poisoning	TG, LA, BO	Herb
Poaceae				
<i>Andropogon nardus</i> Roxb	Watang	Increasing blood circulation	MA, LO	Herb
<i>Imperata cylindrical</i> (L.) Raeusch	Hei	Measles, kidney disease	LO, BO	Herb
<i>Saccharum officinarum</i> L.	Tuwu mahamu	Diabetes mellitus	LA, KE, LO	Herb
Papilionaceae				
<i>Crotalaria striata</i> DC	Kuhung-kuhung	Cancer	BO	Herb
<i>Derris elliptica</i> Benth	Tuwa	Poisoning, tumor	NA, LO, BU	Herb
<i>Erythrina variegata</i> L.	Bahu	Asthma	KE, MA	Tree
<i>Sesbania grandiflora</i> (L.) Pers	Turi	Sprue	BU	Shrub
Piperaceae				
<i>Piper betle</i> L.	Deling	Eye infection, fever, internal disease, baby caring	TG, BE, NA, KE, MA, BO	Herb
<i>Piper caninum</i> L.	Deling asu	Internal disease	MA	Herb
<i>Piper nigrum</i> L.	Rica Jawa	Internal disesae	BU, BO	Herb
<i>Peperomia pellucida</i> (L.) Kunth	Rumpu kakidumang	Cholesterol	TG	Herb
Plantaginaceae				
<i>Plantago lanceolata</i> L.	Mostor cina	Kidney disease	TG, LO, BO	Herb
Portulacaceae				
<i>Talinum triangulare</i> (J. wild)	Ginseng Putih	Aphrodisiac	LO	Herb
Rubiaceae				
<i>Gardenia augusta</i> Merr.	Pica piring	Liver	LA, LO, BU	Shrub
<i>Morinda citrifolia</i> L.	Seha	Hypertension, liver	TG, LA, KE, MA, LO	Tree
<i>Mussaenda pubescens</i> Dryand	Lembawua	Measles, sprue	TG, KE, LO	Shrub
Solanaceae				
<i>Capsicum annum</i> L.	Hisa	Ulcer	NA	Herb
<i>Physalis peruviana</i> L.	Letahe	Kidney disease	LA	Herb
<i>Solanum lycopersicum</i> L.	Samate	Ulcer	LO, BU	Herb
<i>Solanum melongena</i> L.	Poki-poki	Dog bite	TG, BE, LA	Shrub
<i>Solanum torvum</i> SW	Pumpanikiang	Headache	LO	Shrub
Sterculiaceae				
<i>Sterculia</i> sp.	Betadin	Injury	BU, BO	Shrub
<i>Theobroma cacao</i> L.	Coklat mahamu	Diarrhea, ulcer	LO, BO	Tree
Verbenaceae				
<i>Clerodendrum calamitosum</i> L.	Gambir	Kidney disease	TG	Tree
<i>Clerodendrum sahelangii</i> Koor Verb	Palata	Fever	KE, MA	Shrub
<i>Clerodendrum seratum</i> Spreng	Sesewanua	Fever	MA	Shrub
<i>Lantana camara</i> L.	Rumput macam	Injury	LO, BU	Shrub
<i>Strachytarpheta jamaicensis</i> (L.) Vahl.	Kali-kali meo	Kidney disease	LO, BU	Herb
Zingiberaceae				
<i>Alpinia galanga</i> (L.) Mild	Linkuasi	Scabies	TG, BT, KE, LO	Herb
<i>Curcuma longa</i> L.	Kuni	Liver, cough, body odor	TG, BE, LA, NA, KE, MA, LO, BU, BO	Herb
<i>Curcuma xanthorrhiza</i> Roxb.	Timbulawa	Liver	TG, LA, KE, MA, BO	Herb
<i>Kaempferia galanga</i> (L.) Milid	Kinsuli	Fever, hypertension, beaty care	TG, LA, KE, MA, BO	Herb
<i>Zingiber officinale</i> Rosc.	Wuho	Cough, headache	TG, BE, LA, NA, KE, MA, LO, BU, BO	Herb
<i>Zingiber purpureum</i> Rosc.	Manggele	Headache	LA	Herb

Note: BE: Batulewehe, BO: Bawo, BU: Bawoleu, KE: Kalakube, LA: Lesa, LO: Lumbo, MA: Mala, NA: Naha, TG: Tapuang

Dischidia nythesiana

Dischidia nythesiana, locally called *lintakuhi* by the Sanger tribe, is an epiphytic plant belonging to Asclepiadaceae family (Figure 5.A). The drug from this plant is prepared by boiling the tender plants along with the leaves of *D. pentandra* which is a parasite on it, to get a water extract which is consumed orally. There are no scientific reports so far on the medicinal uses and chemical content of *D. nythesiana*. Utilization of *Dischidia imbricata* and *D. nummularia* as a cure for cancer is well known to sellers of herbal medicines in the traditional market of Kabanjahe, North Sumatra (Silalahi et al. 2015b). As there are no published reports on the phytochemicals of *D. nythesiana*, this plant needs to be

subjected to phytochemical investigations and cytotoxic tests to validate its anticancerous claim.

Artemisia vulgaris

Artemisia vulgaris, locally known as *tatutup* which means 'closed leaves' in local language, is a plant belonging to Asteraceae family (Figure 5.B). Its leaves are squeezed in water to get a liquid extract which is mixed with egg yolk and honey before consumption. Honey is added to reduce bitterness, while egg yolk helps to improve the efficacy of the drug. Patients in early-stage of cancer usually take this preparation once a day while those in advanced stages of cancer are suggested to consume it three times a day.

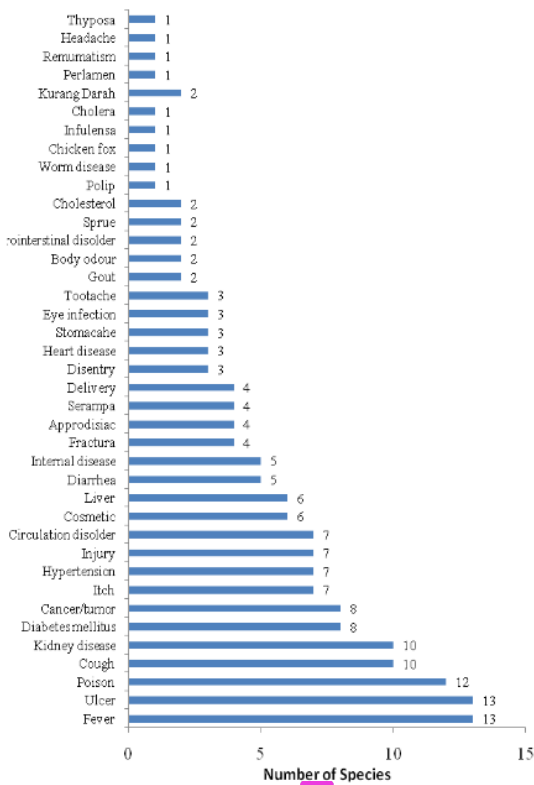


Figure 3. Diseases and number of medicinal plant species used against each disease by the Sanger tribe in the Sangihe Islands, Indonesia

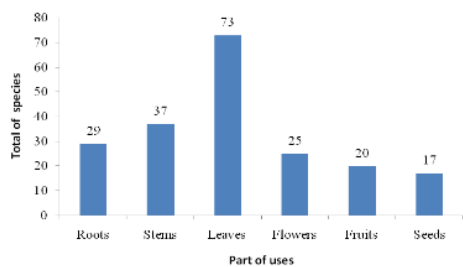


Figure 4. Number of medicinal species based on plant parts used by the Sanger tribe.

The people of Sanger tribe generally prone to smoking habit, which could be the major risk factor for oral cancer. Arundina et al. (2015) reported the potential of *A. vulgaris* as an anti-gastrointestinal cancer drug, especially against oral and breast cancers. Sucipto et al. (2014) tested the main essential oils of *A. vulgaris*, such as 3,5-dimethyl-4-ethylidene-cyclohex-2-ene-1-one, filifolone, germacrene-D, gamma-caryophyllene, eukarvone and 1,8-cineol, each with a level greater than 3%. The anticancer property of *A. vulgaris* is suspected to be associated with its essential oil

content. The action of essential oils as anti-cancer agents has been reported by Zarlaha et al. (2014), who extracted the oil of *Ocimum basilicum* and tested its anti-cancer activity in different human cell cancer cells, namely HeLa cells, adenocarcinoma cells, cervical cancer cells, FemX human melanoma cells, K562 chronic myelogenous leukemia cells and SKOV3 human ovarian cells, through *in vitro* experiments.

Crotalaria striata

Crotalaria striata or *kuhung-kuhung* in local language is a member of Fabaceae family (Figure 5.C). Sanger people consume it as a water extract obtained by boiling the whole plants. Nurrani et al. (2016) reported the potential of ethanol extract of *C. striata* leaves as an anti-cervical cancer drug. Moreover, the ethyl acetate fraction of *Crotalaria* sp. extract was found to inhibit MCF-7 breast cancer cells with the lowest IC50 value of 29.67 µg/mL, followed by the n-hexane and ethyl acetate fractions of the seed extract and the ethanol fraction of the leaf extract with IC50 values of 32.1, 44.2 and 56.7 µg/mL, respectively. The hexane and ethyl acetate fractions of the leaf and seed extracts had IC50 value of 107.14 and 170.83 µg/mL, respectively, and they are effective against the MCF-7 breast cancer cells. However, the ethanol extract of the seeds and leaves did not show inhibition of proliferation of MCF-7 breast cancer cells (Rumondor et al. 2016).

Eleutherine americana

Eleutherine americana is called *bawang babi* in Sanger dialect and *bawang Dayak* in Bahasa, Indonesia (Figure 5.D) due to its medicinal use among the Dayak ethnic group (Kuntorini and Nugroho 2010). Moreover, *E. americana* is also in use as a spice for cooking purposes among the local communities of Asia, including the Dayak tribe. It may be assumed that utilization of *E. americana* by the Sanger tribe to cure cancer was adopted from the local wisdom of the Dayak tribe who use it as a breast cancer drug. This phenomenon shows the acculturation of local wisdom from different tribes (Sujarwo and Caneva 2016). To use it as a medicine, the plant is prepared by boiling the tuberous bulbs and the water extract obtained is filtered prior to consumption.

Eleutherine americana has been widely reported as an anti-cancer drug especially for breast cancer (Kuntorini and Nugroho 2010; Saragih et al. 2014; Amelia et al. 2015). Several studies have reported that the bulb of *E. americana* contain phytochemicals such as naphthalene, anthraquinone and naphthoquinone (Insanu et al. 2014); elecanacine, eleutherine, eleutherol, and eleuthernone (Hara et al. 1997); eleutherol, eleutherinoside A and B, and the potential medicinal eleuthoside (Ieyama et al. 2011); and 6,8-dihydroxy-3,4-dimethoxy-1-methyl-anthraquinone-2-carboxylic acid methyl ester (Xu et al. 2006). Eleutherine, eleutherinone, eleutherol, isoeleutherine, eleutherinol, dihydroeleutherinol, hongconin and 6,8-dihydroxy-3,4-dimethoxy-1-methyl-anthraquinone-2-carboxylic acid methyl esters have been shown to inhibit the growth of HeLa cells (Amelia et al. 2015). The compound 6,8-dihydroxy-3,4-dimethoxy-1-methyl-anthraquinone-2-

carboxylic acid methyl ester was reported to have the ability to inhibit erythroleukemia cell line K562 with IC50 value of 49.1 µg/mL (Xu et al. 2006).

Diversity of medicinal plants across study villages

The Sanger tribe utilizes as many as 118 species of medicinal plants. The number of medicinal plants utilized by the Sanger tribe in different villages selected for the study varied from the lowest of 27 species, which was recorded from Mala Village, to the highest of 54 species recorded from Lumbo Vil. (Figure 6). This variation is influenced mainly by the diversity of plants found in the surrounding environment, the topography of the village area and its distance to the forests. A total of 7 species were found to be commonly used as medicinal in all nine research sites. They are *J. curcas*, *Abelmoschus manihot*, *Psidium guajava*, *Allium schoenoprasum*, *Persea americana*, *C. domestica*, and *Z. officinale*. These plants are usually cultivated and commonly found in various regions of Indonesia. In addition to medicinal purposes, some of them are also used for other purposes, such as edible fruits (*P. guajava*, *P. americana*), kitchen spices (*Z.*

officinale, *A. schoenoprasum*), and as hedgerow plant (*J. curcas*).

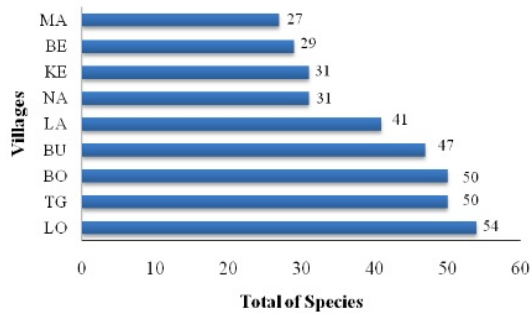


Figure 6. The number of medicinal plant species utilized by the Sanger tribe in different study villages. BE: Batulewehe, BO: Bawo, BU: Bawoleu, KE: Kalakube, LA: Lesa, LO: Lumbo, MA: Mala, NA: Naha, TG: Tapuang

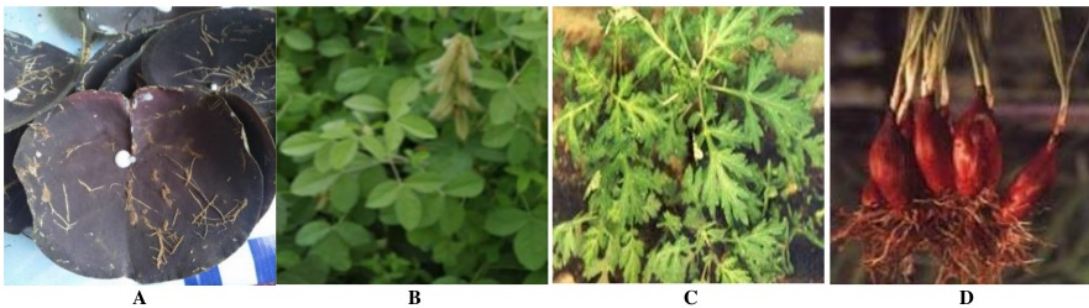


Figure 5. Traditional anti-cancer medicinal plants used by the Sanger tribe in the Sangihe Islands: A. *Dischidia nycthesiana*, B. *Crotalaria striata*, C. *Artemisia vulgaris*, and D. *Eleutherine americana*.

Table 2. The Jaccard similarity index of the medicinal plants used in different villages by the Sanger tribe in Sangihe Islands, Indonesia

	TG	BU	BE	BO	LA	LO	NA	KE	MA
TG	-	0.260	0.317	0.400	0.371	0.250	0.286	0.350	0.242
BU	0.26	-	0.394	0.342	0.236	0.500	0.262	0.242	0.189
BE	0.317	0.394	-	0.254	0.333	0.258	0.200	0.224	0.273
BO	0.400	0.342	0.254	-	0.333	0.333	0.270	0.246	0.262
LA	0.371	0.236	0.333	0.333	-	0.263	0.296	0.327	0.308
LO	0.250	0.500	0.258	0.333	0.263	-	0.250	0.219	0.227
NA	0.286	0.262	0.200	0.270	0.296	0.250	-	0.292	0.289
KE	0.35	0.242	0.224	0.246	0.327	0.219	0.292	-	0.415
MA	0.242	0.189	0.273	0.262	0.308	0.227	0.289	0.415	-

Note: BE: Batulewehe, BO: Bawo, BU: Bawoleu, KE: Kalakube, LA: Lesa, LO: Lumbo, MA: Mala, NA: Naha, TG: Tapuang

The medicinal plants used by the Sanger tribe are different across studied villages and some species are specifically used only in certain villages. For example, *Peperomia pellucida* was used only in Tapuang Village, *Talinum triangulare* only in Lumbo Village, *Alstonia scholaris* in Bawo, *Homalomena occulta* in Bawoleu, *D. nythesiana* in Lumbo and Bawo, and *Spilathes ocyimifolia* in Lumbo. The calculated Jaccard similarity indices were between 0.189 and 0.500 (Table 2). This shows that the medicinal plants used by each village were relatively different from those of other villages. The lowest similarity index of 0.189 existed between Mala (MA) and Bawoleu (BU) villages, whereas the highest similarity index of 0.500 existed between Bawoleu (BU) and Lumbo (LO) villages. Silalahi and Nisyawati (2018) found that in the Karo ethnic group, adjacent villages had higher Jaccard equality indexes than those located away from each other. Communities in neighboring villages have a wider opportunity to exchange information on the use of medicinal plants compared to more distant villages.

The Lumbo village did not have any health service facility, so the villagers used mainly traditional medicine for maintaining their health. Therefore, many medicinal plants were found in cultivation in this village. Moreover, the Lumbo village is relatively close to the forest, compared to other villages. Mala village was found to be using the lowest number of medicinal plants (27 species), as this village is near to urban area and it has proper health care facilities. Furthermore, the knowledge of medicinal plants among the villagers in Mala was found to be lower compared to that of the Lumbo village and they cultivated less than number of medicinal plants.

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