INNSPUB

Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 18, No. 1, p. 102-112, 2021
http://www.innspub.net

RESEARCH PAPER OPEN ACCESS

Biodiversity of medicinal plants in Vietnam: A case study at Nui Chua National Park, Ninh Thuan province

Nguyen Van Hop[*1,2], Chen Chang Xiong[1], Nguyen Van Quy[2,3], Nguyen Duc Huy[2]

[1]*College of Forestry, Fujian Agriculture and Forestry University, Fuzhou, Fujian, China*

[2]*Faculty of Natural Resources and Environment, Vietnam National University of Forestry, Dong Nai Campus, Dong Nai, Viet Nam*

[3]*College of Forestry, Northwest Agriculture and Forestry University, Shaanxi, China*

Article published on January 30, 2021

Key words: Biodiversity, Diversity index, Forest state, Medicinal plant, Nui Chua National park

Abstract

The method of quantitative research on medicinal plants is very necessary and important but it has not been paid attention to in Vietnam. A total of 14 sample plots was established, each sample plot of 500m² (25m x 20m) and randomly distributed through tropical evergreen broad-leaved humid low mountain forest and tropical broad-leaved dry forest state. Two main contents were carried out: (i) Determine taxa diversity, life-forms, parts used, disease groups, threatened medicinal plants, (ii) identify diverse indicators of medicinal plants. The results showed that a total of 55 medicinal plant species, 50 genera, 36 families of 3 phyla was found in Nui Chua National Park. Among them, 9 threatened species was listed in the Vietnam Red Data Book (2007), and the IUCN Red List (2019). The life-forms of medicinal plants were recorded as woody plant, herbaceous, shrubs, epiphyte, and vines. Nine parts used of medicinal plant species were used to treat disease (stems, roots, barks, fruits, leaves, tubers, flowers, seeds, and sap). The frequency of use of each medicinal plant part in the tropical dry broadleaf forests is more than in the low mountain tropical humid evergreen forest. They were used to health care and disease treatment 17 disease groups. The method of quantification of species diversity and distribution by Beta (β), Shannon (H), Pielou (J'), Simpson (Cd), Margalef (d), A/F ratio, Sorensen (SI) and the relationship between species (Cluster) was used to quantify the diversity and distribution of the medicinal plant. The results indicated that the diversity of medicinal plants in tropical evergreen broad-leaved humid low mountain forest is higher than the tropical broad-leaved dry forest state.

***Corresponding Author:** Nguyễn Văn Hợp ✉ hopvfu@gmail.com

Introduction

Quantitative biodiversity research has important implications for sustainable development. This is to provide quantitative data to serve the management and conservation of natural resources. However, quantitative biodiversity researches in general and medicinal plant biodiversity, in particular, are of little interest in Vietnam. In which, the application of quantitative research in Nui Chua National Park to provide data for conservation has not been carried out.

Nui Chua National Park is the only typical sample of Vietnam's unique drought forest ecosystem and the coniferous evergreen broadleaf forest characterized by humid tropical Asia. Nui Chua is the only national park in Vietnam with three ecosystems: evergreen forest, dry forest, and adjacent marine ecosystem. Forest resources are abundant and diverse distributed at different elevations, forming many unique dry forest communities. Typical features of dry forest are mainly shrubs, thorny in stems, stems, and branches branch much, few leaves. They grow in large clusters; dense foliage grows into dust at a height of 150 m-800 m (FIPI, 1997; FIPI, 2002; Tordoff, 2002).

According to the evaluation of scientists, Nui Chua National Park had two forest ecosystems are tropical and evergreen tropical dry forest ecosystems. 1019 species of 506 genera and 130 families belonging to five phyla, of which 35 rare and precious species in the Vietnam Red Data Book (2007), many species valuable medicinal plants for health care and treatment for the community here (FIPI, 1997; FIPI, 2002; Tordoff, 2002). However, until now there has been no research work on medicinal plants in general, especially quantitative research of medicinal plants in Nui Chua National Park. Therefore, this study was carried out and is one of the approaches to provide, analyze, and quantitatively assess medicinal resource biodiversity indicators. The main research questions about the use of medicinal plants were:

- What medicinal plants, life forms, and parts of medicinal plants are used to treat diseases, which medicinal plants are threatened?
- How is medicinal plant biodiversity in the study area?

Materials and methods

The study site

The study was conducted from November 2016 to May 2017 in Nui Chua National Park, Ninh Thuan province. It has a natural area of 29.865 ha, with coordinates from 11°35'25" to 11°48'38" North latitude and 109°4'5" to 109°14'15" East longitude. Nui Chua National Park is a complex of Rocky Mountains with an elevation of 200-1000 m above sea level, the highest peak in the Co Tuy peak of 1039m. The main mountain system runs in the North-South direction. Alternating between large mountains with many low hills and small streams, some areas are valleys used by local people for wet rice cultivation. The climate is characterized by a tropical monsoon climate. Therefore, the low humidity and rainfall (71% and 691.9 mm), the annual average temperature 27°C (FIPI, 1997; FIPI, 2002; Tordoff, 2002).

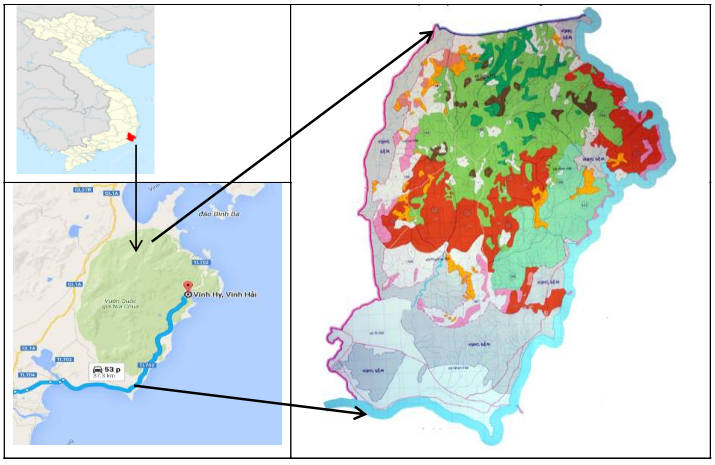

Fig. 1. Map of the study site (Source: Nui Chua National Park).

Fieldwork

After establishing the survey transects, 14 plots were established, each of 500m² (25m x 20m) (Mishra, 1968; Sharrma, 2003) randomly distributed through tropical evergreen broad-leaved humid low mountain forest (plot 1st to 7th), and tropical broad-leaved dry forest status (plot 8th to 14th). In each plot, the data information was collected, determined: (i) collecting samples, species and the number of species; (ii) Individual number, individual growth quality for each species in each plot; (iii) Data are used to calculate relative frequency and relative density.

Data analysis

The method of comparing plant morphology was used to identify the name of the medicinal plant species. The documents were used including an illustrated Flora of Vietnam (Ho, 1999-2003), Dictionary of medicinal plants in Vietnam (Chi, 2012), Vietnam Red Data Book (Ban *et al.,* 2007), and Vietnamese medicinal plants and medicine (Loi, 2005).

The diversity of medicinal plants, life forms, parts used, use-value is determined by the method of Thin (1997). Threatened medicinal plant species are identified by the Vietnam Red Data Book (Ban *et al.,* 2007), and IUCN (2019).

Quantitative biodiversity indicators were used in this study include:

**Index of beta diversity β:*

The Index of beta diversity (β) is used to describe the extent to which species composition changes when environmental conditions change.

$$\beta = S/m$$

Where:

S: Total number of species in the study area

m: Average number of species in each area

**Shannon-Weiner index (H):*

The species diversity outcome was interpreted using the description by Fernando (1998): Low (H = 1 – 2.49), Moderate (H = 2.5 – 2.90), High (H = 3 – 4).

$$H = -\sum_{i=1}^{n}(N_i/N)log_2(N_i/N)$$

Where:

H: Biodiversity index or Shannon index

Ni: Number of individuals of species i

N: The total number of individuals of all species in the study area.

**Pielou index*

The Pielou index compares the similarity in population size of the species present, measuring the relative abundance of different species, creating the wealth of an area.

The community's index "J" is calculated by the formula:

J '= H'/loge S or: J '= H'(Qsat)/H'max

Where:

H': Shannon-Weiner index

S: Total number of study species

**Concentration of dominance (Cd)*

This index is calculated by Simpson (FAO, 2002; Sharma, 2003):

$$C_d = \sum_{i=1}^{n}(N_i/N)^2$$

Where:

Cd: Concentration of dominance index or Simpson index

Ni: number of individuals/IVI of species i

N: total number of individuals/IVI of all species in the study area

**Margalef index (d)*

This index is used to determine the diversity or species abundance. Just like Fisher's index α, the Margalef index also needs to know the number of species and the number of individuals in the representative sample of the community. Margalef index (d) was determined by the formula:

$$d = \frac{s}{\sqrt{N}} \text{ or } \frac{s-1}{logN}$$

Where:

d: Margalef diverse index

S: total number of species in the sample

N: total number of individuals in the sample

**Distribution pattern (A/F ratio)*

The ratio (A/F) between the abundance (A) and the frequency (F) of each species is used to determine the

types of the spatial distribution of that species in the studied plant communities. Species have a regular pattern if A/F is less than <0,025, often encountering scenes in which competition between species occurs. Species have a random distribution if A/F ranges from 0,025 – 0,05, often in the fields subject to the effects of unstable living conditions. Species with A/F values> 0,05 are contagious. This form of distribution is most common in nature and it is common in stable sites (Sharma, 2003; Huy, 2005; Ban and Duc, 1994).

Abundance: Abundance is calculated by the formula of Curtis and Mclntosh (1950):

$$\text{Abundance (A)} = \frac{\text{Total number of individuals appearing on all plots}}{\text{Number of standard plots with research species appearing}}$$

Frequency is calculated by the follows:

$$\text{Frequency F(\%)} = \frac{\text{Number of plots having species appear}}{\text{Total number of sample plots}} \times 100$$

** Sorensen's index (SI)*

Sorensen's index (SI) on species composition between study sites is determined by the formula:

$$SI = 2C/(A + B)$$

Where:

C: Number of species appearing in both areas A and B

A: The number of species of area A

B: Number of species of area B

Data after being fully collected are processed by suitable mathematical functions and according to the statistical principles with the help of Excel software, Primer software.

** Analysis of relationships between species*

Analysis relationships between medicinal plants were conducted by Primer software version 6.5 to establish cluster branch diagram.

Results and discussion

Taxonomic diversity of medicinal plant

A total of 36 families, 50 genera and 55 species of 4 phyla were recorded in the study area. Most medicinal plants belong to Magnoliophyta (86.11% of the families, 90% of the genera, and 90,91% of the species), remaining Pteridophyta and Lycopodiophyta. In which, tropical evergreen broad-leaved humid low mountain forest 39/55 species (71%), tropical broad-leaved dry forest status 30/55 species (29%) (Table 1).

Medicinal plant species composition threatened

Out of 55 species of medicinal plants, nine species (16.36%) were identified as threatened. In which, eight species listed in the Vietnam Red Data Book (2007), and 4 species listed in the IUCN Red List (2019).

Table 1. Taxonomic diversity of medicinal plant.

Taxonomic	Family		General		Species	
	Number	Percentage	Number	Percentage	Number	Percentage
Magnoliophyta	31	86.11	45	90.00	50	90.91
Pteridophyta	3	8.33	3	6.00	3	5.45
Lycopodiophyta	2	5.56	2	4.00	2	3,64
Total	36	100	50	100	55	100

Table 2. Medicinal plant species composition threatened.

No.	Scientific name	Vietnamese name	Conservation status	
			VRDB 2007	IUCN 2019
1	*Rauvolfia verticillata* (Lour.) Baill.	Ba gạc Cam Bốt	VU	VU
2	*Drynaria bonii* Christ	Cốt toái bổ	VU	VU
3	*Helixanthera annamica* Danser	Chùm gửi Trung Bộ	VU	
4	*Balanophora laxiflora* Hemsl.	Dó đất hoa thưa	EN	
5	*Anoectochilus setaceus* Blume	Lan kim tuyến	EN	EN
6	*Psilotum nudum* (L.) P. Beauv.	Lõa tùng trần		VU
7	*Cinnamomum porrectum* (Roxb.) Kosterm.	Xá xị	CR	
8	*Canthium dicoccum* (Gaertn.) Merr.	Xương cá	VU	
9	*Selaginella tamariscina* (P.Beauv.) Spring	Quyển bá trường sanh	VU	

Note: VRDB- Vietnam Red Data Book (2007); IUCN- International Union for Conservation of Nature and Natural Resources; VU- Vulnerable; EN- Endangered; CR- Critically Endangered

Rauvolfia verticillata was used to treat dysentery, scabies, sores, rashes, hypertension, reduce arrhythmia symptoms in hyperthyroidism. *Canthium dicoccum* was used to treat fever, sharpness to treat colic for women after birth. But the most unique is *Selaginella tamariscina* species. The leaves of this species curl in the dry season look like died, but when rainy come, the leaves greenback and revive. Therefore, this tree is also known as the "immortal tree". It often uses to treat urination, blood tonic, burns. This species distribution narrow and only was found in Nui Chua National Park. Currently, the exploitation of precious medicinal plants is still happening without going along with the cultivation causing the decline of medicinal plants. Therefore, it is necessary to raise the people's sense of protection to preserve this rare and precious genetic resource.

Diversity of life-forms

Five life-forms of medicinal plants were identified including timber tree, herbaceous, shrubs, vines, and epiphytes (Table 3).

Table 3. Diversity of life-forms of medicinal plants.

No.	Life-forms	Tropical evergreen broad-leaved humid low mountain forest		Tropical broad-leaved dry forest	
		No.	Percentage	No.	Percentage
1	Woody plant	19	48.72	15	50
2	Herbaceous	7	17.95	8	26.67
3	Epiphyte	5	10.26	1	3.33
4	Shrubs	4	10.26	5	16.67
5	Vines	4	12.82	1	3.33
Total		39	100	30	100

The number of medicinal plant species in each life-form at the tropical evergreen broad-leaved humid low mountain forest is more diverse than the tropical broad-leaved dry forest status.

Diversity of medicinal plant parts used

The parts of medicinal plants can be used to take care of health and treat diseases. The frequency of use of medicinal plant parts in the tropical broad-leaved dry forest status is more than the tropical evergreen broad-leaved humid low mountain forest (Table 4).

Table 4. Diversity of medicinal plant parts used.

No.	Parts used	Tropical evergreen broad-leaved humid low mountain forest		Tropical broad-leaved dry forest	
		Number	Percentage	Number	Percentage
1	Stem	13	22.03	8	11.59
2	Root	11	18.64	13	18.84
3	Bark	10	16.95	12	17.39
4	Fruit	9	15.25	12	17.39
5	Leaves	8	13.56	15	21.74
6	Tuber	4	6.78	3	4.35
7	Flower	2	3.39	3	4.35
8	Seed	1	1.69	3	4.35
9	Sap	1	1.69		
Total		59	100	69	100

Disease groups use medicinal plants to treat diseases

A total of 17 different disease groups using medicinal plants to treat and care about health. A medicinal plant can treat many diseases, but some diseases have to use many medicinal plants to work together.

Table 5. Diversity of disease groups treated with medicinal plants.

No.	Treatment diseases group	Species*	Percentage
1	Skin diseases (infections, sores, pimples, urticaria, etc)	16	12.8
2	Digestive diseases (diarrhea, constipation, abdominal distention, abdominal pain, etc)	14	11.2
3	Women's diseases (menopause, menstrual irregularities, pregnancy control, etc)	13	10.4
4	Weather sickness (flu, sunburn, headache, sickness, fever, etc)	12	9.6
5	Respiratory diseases (cough, throat, bronchus, lung, cough, etc)	10	8
6	Osteoarthritis disease (joint pain, arthritis, bone pain, lumbar spine, etc)	9	7.2
7	Other groups of diseases	8	6.4
8	Diseases caused by animal bites (snake bite, centipede bite, etc)	6	4.8
9	Diseases of men (urinary inflammation, impotence, etc)	5	4
10	Supplement (Kidney, blood, liver, health, tonic, etc)	5	4
11	Liver diseases (hepatitis, hepatomegaly, etc)	5	4
12	Neurological diseases (sciatica, sedation, insomnia, etc)	5	4
13	Diseases of children (chrysanthemum, malnutrition, helminths, enuresis, melaleuca, etc)	4	3.2
14	Diseases of the mouth (gingivitis, tooth decay, etc)	4	3.2
15	Kidney diseases (glomerulonephritis, kidney stones, diabetes, diuretic, etc)	3	2.4
16	Eye diseases, nose (red eyes, dry eyes, nosebleeds, etc)	3	2.4
17	Stomach disease (stomach pain, stomach ulcers, colon, etc,)	3	2.4
Total		125	100

*One species may have many different uses

The group of skin diseases (infections, sores, pimples) use the most number of species (12.8%) such as *Ficus racemosa, Cratoxylum maingayi, Streptocaulon juventas*, etc. The group of children disease is the lowest of 4 species (3.2%).

Some biodiversity indicators of medicinal plants

**Species composition (S):*

The number of species fluctuating from 8 to 14 species, an average of 10 species. The number of species in plots the two forest states is relatively similar.

Table 6. Several biodiversity indicators.

Forest state	Plots	S	N	d	J'	H(loge)	H'(log10)	1-Lambda'
Tropical evergreen broad-leaved humid low mountain forest	1	11	16	3.607	0.9756	2.339	1.016	0.9583
	2	9	15	2.954	0.9642	2.119	0.9201	0.9333
	3	10	13	3.509	0.975	2.245	0.975	0.9615
	4	13	15	4.431	0.9837	2.523	1,096	0.981
	5	9	13	3.119	0.9732	2.138	0.9287	0.9487
	6	12	14	4.168	0.9823	2.441	1.06	0.978
	7	10	11	3.753	0.9867	2.272	0.9867	0.9818
Average		10,57	13.86	3.648	0.9772	2.296	0.997	0.9632
Tropical broad-leaved dry forest	8	8	14	2.652	0.9834	2.045	0.8881	0.9341
	9	8	14	2.652	0.9654	2.008	0.8719	0.9231
	10	14	15	4.801	0.9911	2.616	1.136	0.9905
	11	12	17	3.883	0.9637	2.395	1.04	0.9559
	12	10	14	3.41	0.9579	2.206	0.9579	0.9451
	13	12	16	3.967	0.9763	2.426	1.054	0.9667
	14	13	17	4.235	0.9774	2.507	1.089	0.9706
Average		11	15.287	3.657	0.9736	2.3147	1.005	0.9551

**Number of individuals (N)*

The number of individual medicinal plants varies from 11 to 17 individuals, an average of 14 individuals. The individual in tropical evergreen broad-leaved humid low mountain forest is lower than the tropical broad-leaved dry forest status.

**Beta index (β)*

The survey results showed that tropical evergreen broad-leaved humid low mountain forest 39 species (β=1.41) higher species diversity than tropical broad-leaved dry forest status 30 species (β=1.83). Thus, when environmental conditions change the number and composition of medicinal plants will change. The high beta β index indicated that the species composition between two states is less similar and vice versa.

**Shannon-Weiner index (H)*

The biodiversity index (H) in the two forest states is the negligible change from 2.008 to 2.616. Thus, the biodiversity of medicinal plants in Nui Chua National Park varies from low to moderate (Fernando, 1998). The diversity index (H) varies among forest states, reflecting the difference in species composition and uniformity of distribution or the probability of occurrence of individuals in each species. This means that the index (H) depends not only on the number of species but also on the number and probability of individuals in each species.

**Pielou index (J')*

The average Pielou index of the whole study area is 0.9754. A comparison of the (J') index between two states showed that tropical evergreen broad-leaved humid low mountain forest (J' = 0.9772) is higher than the tropical broad-leaved dry forest status (J'= 0.9736).

**The concentration of dominance (Cd)*

The dominance index (Cd=0.9231 – 0.9905) and average 0.9529. The highest of dominance index (Cd) was recorded in plot 10. Index analysis (Cd) showed that tropical evergreen broad-leaved humid low mountain forest (Cd = 0.9636) is lower than the tropical broad-leaved dry forest status (Cd = 0.9551) and no dominant species in the study area.

**Margalef index (d)*

Margalef index (d) changes through 2 states from 2.652 to 4.801, an average of 3.6529. Margalef index (d) indicated that tropical evergreen broad-leaved humid low mountain forest (d = 3.648) is more diverse than the tropical broad-leaved dry forest status (d = 3.657).

**Determine the form of space distribution (A/F)*

Fifteen species were identified at random distribution in the study area (A/F from 0.028-0.047).

They often occur in affected sites or unstable environmental conditions. Forty species were found to be distributed contagious (A/F> 0.05).

This type of distribution is most common in nature and occurs in stable environments.

Thus, most medicinal plants are distributed in relatively stable environments, little or no change in environmental conditions (Table 7).

**Sorensen's index (SI)*

Thirty-nine species only appear in the tropical evergreen broad-leaved humid low mountain forest, thirty species in the tropical broad-leaved dry forest status, and 14 species in both states (Table 7).

Table 7. The number of medicinal plants appears in both states.

No.	Scientific name	Vietnamese name
1	*Helicteres hirsuta* Lour.	An xoa
2	*Rauvolfia verticillata* (Lour.) Baill.	Ba gạc Cam Bốt
3	*Pandanus tectorius* Parkinson ex Du Roi	Dứa dại
4	*Zingiber officinale* Roscoe	Gừng
5	*Streptocaulon juventas* (Lour.) Merr.	Hà thủ ô trắng
6	*Clausena dunniana* H.Lév.	Hồng bì rừng
7	*Psilotum nudum* (L.) P. Beauv.	Lõa tùng trần
8	*Curcuma longa* L.	Nghệ
9	*Morinda tomentosa* B.Heyne ex Roth	Nhàu nhuộm
10	*Centella asiatica* (L.) Urb.	Rau má
11	*Amomum villosum* Lour.	Sa nhân
12	*Rhamnus oenopolia* L.	Táo rừng
13	*Cratoxylum maingayi* Dyer	Thành ngạnh mai ngày
14	*Mangifera minutifolia* Evrard	Xoài rừng

Index of similarity (SI = 0.4058) showed that the diversity of medicinal species in two forest states quite high. This was explanted by different ecological environment conditions (Stein *et al.,* 2014).

**Relationship between species (Cluster)*

a) The relationship between species is similar to 20%

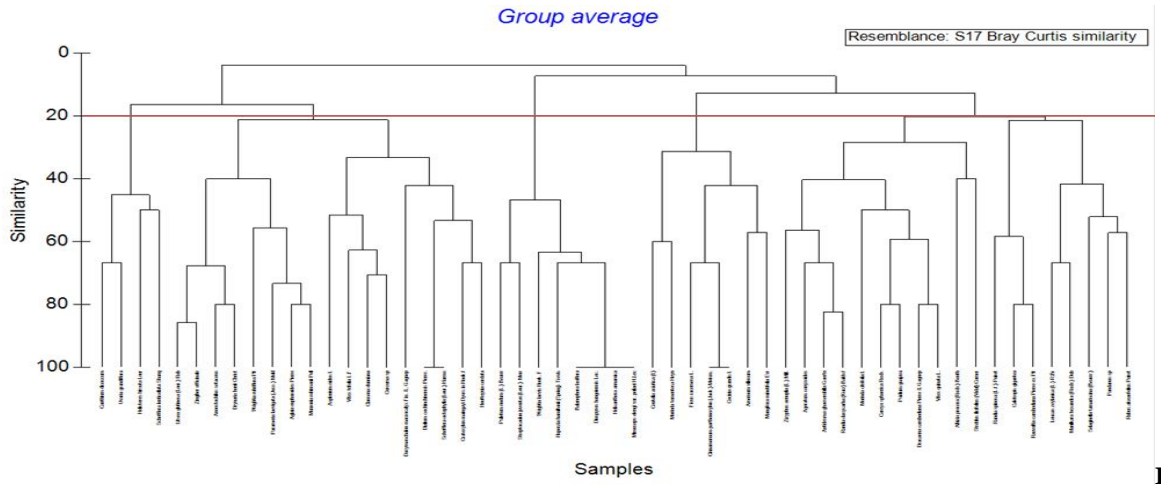

Fig. 2. Branch diagram of the relationship between species of similar level 20%.

At a similar rate of 20%, including 5 groups:

Group 1 (4 species):

Canthium dicoccum, Uvaria grandiflora, Helicteres hirsuta, Schefflera lenticellata.

Group 2 (17 species):

Litsea glutinosa, Anoectochilus setaceus, Zingiber officinale, Drynaria bonii, Parameria laevigata, Wrightia rubriflora, Aglaia spectabilis, Munronia robinsonii, Asplenium nidus, Vitex quinata, Clausena dunniana, Curcuma longa, Dasymaschalon macrocalyx, Schefflera heptaphylla, Dialium cochinchinense, Cratoxylum maingayi, Houttuynia cordata.

Group 3 (8 species):
Psilotum nudum, Streptocaulon juventas, Wrightia laevis, Huperzia hamiltonii, Balanophora laxiflora, Diospyros bangoiensis, Helixanthera annamica, Central medium beams.

Group 4 (7 species):
Centella asiatica, Morinda tomentosa, Ficus racemosa, Cinnamomum porrectum, Coccinia grandis , Amomum villosum, Mangifera minutifolia .

Group 5 (19 species):
Rhamnus oenopolia, Ageratum conyzoides, Antidesma ghaesembilla, Randia dasycarba, Morinda citrifolia, Careya sphaerica, Psidium guajava, Dracaena cambodiana, Vitex trifolia, Albizia procera, Streblus ilicifolius, Randia spinosa, Calotropis gigantea, Rauvolfia verticillata, Leucas zeylanica, Manilkara hexandra, Selaginella tamariscina, Pandanus tectorius, Rubus alceaefolius.

b. The relationship between species is similar to 50%
At a similar rate of 50%, including 19 groups:
Group 1 (2 species):
Canthium dicoccum, Schefflera lenticellata.

Group 2 (2 species):
Uvaria grandiflora, Helicteres hirsuta.

Group 3 (4 species):
Litsea glutinosa, Zingiber officinale, Anoectochilus setaceus, Drynaria bonii.

Group 4 (4 species):
Schefflera lenticellata, Parameria laevigata, Aglaia spectabilis, Munronia robinsonii.

Group 5 (4 species):
Asplenium nidus, Vitex quinata, Clausena dunniana, Curcuma longa.

Group 6 (1 species):
Dasymaschalon macrocalyx.

Group 7 (4 species):
Dialium cochinchinense, Schefflera heptaphylla, Cratoxylum maingayi, and Houttuynia cordata.

Group 8 (2 species):
Psilotum nudum, Streptocaulon juventas.

Group 9 (6 species):
Wrightia laevis, Huperzia hamiltonii, Balanophora laxiflora, Diospyros bangoiensis, Helixanthera annamica, Mimusops elengi.

Group 10 (2 species):
Centella asiatica, Morinda tomentosa.

Group 11 (3 species):
Ficus racemosa, Cinnamomum porrectum, and Coccinia grandis.

Group 12 (2 species):
Amomum villosum and Mangifera minutifolia.

Group 13 (4 species):
Rhamnus oenopolia, Ageratum conyzoides, Antidesma ghaesembilla, Randia dasycarba.

Group 14 (5 species):
Morinda citrifolia, Careya sphaerica, Psidium guajava, Dracaena cambodiana, Vitex trifolia.

Group 15 (1 species):
Albizia procera.

Group 16 (1 species):
Streblus ilicifolius.

Group 17 (3 species):
Randia spinosa, Calotropis gigantea, Rauvolfia verticillata.

Group 18 (2 species):
Leucas zeylanica and Manilkara hexandra.

Group 19 (3 species):
Selaginella tamariscina, Pandanus tectorius, Rubus alceaefolius.

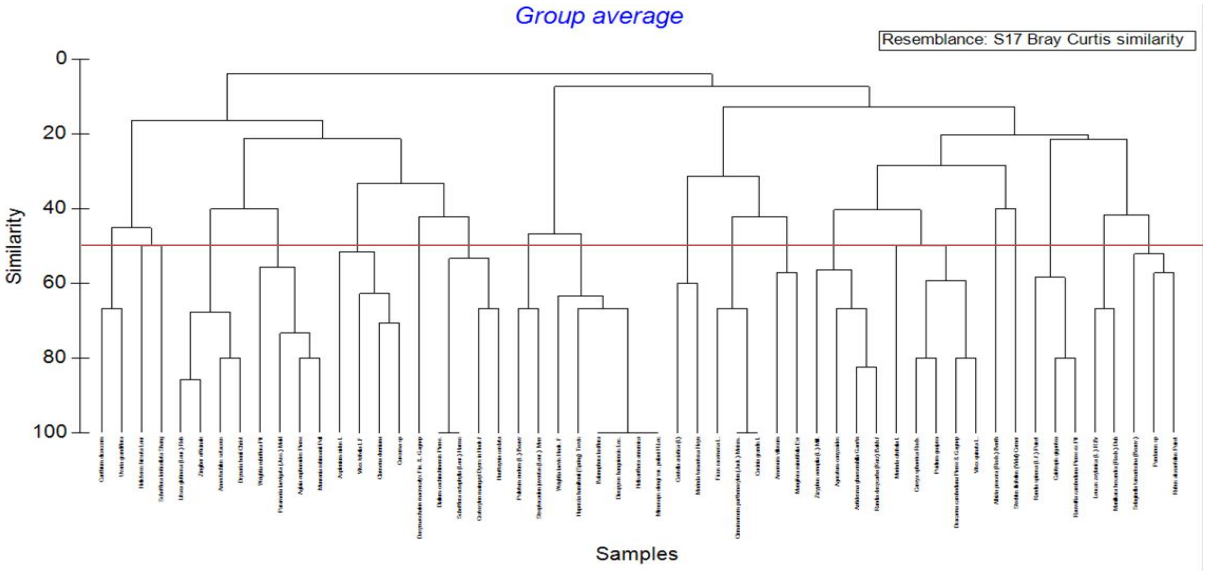

Fig. 3. Branch diagram of the relationship between species at a similar rate of 50%.

Table 8. Results of analyzing the A/F ratio of each species.

No.	Scientific name	Vietnamese name	No. of Individuals (N)	Abundance (A)	Frequency (F)	A/F ratio	Distribution type
1	*Ageratum conyzoides* (L.) L.	Ngũ sắc	8	1,600	35,714	0,045	Random
2	*Aglaia spectabilis* (Miq.) S.S.Jain & S.Bennet	Gội tía	3	1,500	14,286	0,105	Contagious
3	*Albizia procera* (Roxb.) Benth.	Sống rắng dài	3	1,500	14,286	0,105	Contagious
4	*Amomum villosum* Lour.	Sa nhân	4	1,333	21,429	0,062	Contagious
5	*Anoectochilus setaceus* Blume	Lan kim tuyến	2	1,000	14,286	0,070	Contagious
6	*Antidesma ghaesembilla* Gaertn.	Chòi mòi	7	1,400	35,714	0,039	Random
7	*Asplenium nidus* L.	Ráng ổ phụng	3	1,500	14,286	0,105	Contagious
8	*Balanophora laxiflora* Hemsl.	Dó đất hoa thưa	1	1,000	7,143	0,140	Contagious
9	*Calotropis gigantea* (L.) Dryand.	Bồng bồng	2	1,000	14,286	0,070	Contagious
10	*Canthium dicoccum* (Gaertn.) Merr.	Xương cá	1	1,000	7,143	0,140	Contagious
11	*Careya arborea* Roxb.	Vừng	6	1,200	35,714	0,034	Random
12	*Centella asiatica* (L.) Urb.	Rau má	5	1,667	21,429	0,078	Contagious
13	*Cinnamomum porrectum* (Roxb.) Kosterm.	Xá xị	1	1,000	7,143	0,140	Contagious
14	*Clausena dunniana* H.Lév.	Hồng bì rừng	9	1,500	42,857	0,035	Random
15	*Coccinia grandis* (L.) Voigt	Mồng bát	1	1,000	7,143	0,140	Contagious
16	*Cratoxylum maingayi* Dyer	Thành ngạnh	4	1,333	21,429	0,062	Contagious
17	*Curcuma longa* L.	Nghệ	8	1,333	42,857	0,031	Random
18	*Dasymaschalon macrocalyx* Finet & Gagnep.	Mao quả đài to	3	1,500	14,286	0,105	Contagious
19	*Dialium cochinchinense* Pierre	Xây	1	1,000	7,143	0,140	Contagious
20	*Diospyros bangoiensis* Lecomte	Thị ba ngòi	1	1,000	7,143	0,140	Contagious
21	*Dracaena cambodiana* Pierre ex Gagnep.	Huyết giác	4	1,000	28,571	0,035	Random
22	*Drynaria bonii* Christ	Cốt toái bổ	3	1,000	21,429	0,047	Random
23	*Ficus racemosa* L.	Sung	2	1,000	14,286	0,070	Contagious
24	*Helicteres hirsuta* Lour.	An xoa	5	1,000	35,714	0,028	Random
25	*Helixanthera annamica* Danser	Chùm gửi trung bộ	1	1,000	7,143	0,140	Contagious
26	*Houttuynia cordata* Thunb.	Nhiếp cá	2	2,000	7,143	0,280	Contagious
27	*Huperzia hamiltonii* (Spreng.) Trevis.	Thạch tùng song đính	2	2,000	7,143	0,280	Contagious
28	*Leucas zeylanica* (L.) W.T.Aiton	Mè đất	4	1,333	21,429	0,062	Contagious
29	*Litsea glutinosa* (Lour.) C.B.Rob.	Bời lời nhớt	3	1,500	14,286	0,105	Contagious
30	*Manilkara hexandra* (Roxb.) Dubard	Găng néo	2	1,000	14,286	0,070	Contagious
31	*Mangifera minutifolia* Evrard	Xoài rừng	3	1,000	21,429	0,047	Random

No.	Scientific name	Vietnamese name	No. of Individuals (N)	Abundance (A)	Frequency (F)	A/F ratio	Distribution type
32	*Mimusops elengi* L.	Sến cát	1	1,000	7,143	0,140	Contagious
33	*Morinda citrifolia* L.	Nhàu	2	2,000	7,143	0,280	Contagious
34	*Morinda tomentosa* B.Heyne ex Roth	Nhàu nhuộm	5	1,250	28,571	0,044	Random
35	*Munronia robinsonii* Pellegr.	Cán dù	2	1,000	14,286	0,070	Contagious
36	*Pandanus tectorius* Parkinson ex Du Roi	Dứa dại	12	1,714	50,000	0,034	Random
37	*Parameria laevigata* (Juss.) Moldenke	Đỗ trọng dây	3	1,500	14,286	0,105	Contagious
38	*Psidium guajava* L.	Ổi rừng	4	1,333	21,429	0,062	Contagious
39	*Psilotum nudum* (L.) P. Beauv.	Lõa tùng trần	3	1,000	21,429	0,047	Random
40	*Randia dasycarba* (Kurz) Bakh.f.	Găng nhung	10	1,429	50,000	0,029	Random
41	*Randia spinosa* (Thunb.) Poir.	Găng gai	1	1,000	7,143	0,140	Contagious
42	*Rauvolfia verticillata* (Lour.) Baill.	Ba gạc cambốt	3	1,000	21,429	0,047	Random
43	*Rubus alceaefolius* Poir.	Mâm xôi	9	1,800	35,714	0,050	Contagious
44	*Schefflera lenticellata* C.B.Shang	Chân chim bì khâu	3	1,000	21,429	0,047	Random
45	*Schefflera heptaphylla* (L.) Frodin	Chân chim 8 lá	1	1,000	7,143	0,140	Contagious
46	*Selaginella tamariscina* (P.Beauv.) Spring	Quyển bá trường sanh	5	2,500	14,286	0,175	Contagious
47	*Streblus ilicifolius* (Vidal) Corner	Ô rô núi	2	1,000	14,286	0,070	Contagious
48	*Streptocaulon juventas* (Lour.) Merr.	Hà thủ ô trắng	3	1,500	14,286	0,105	Contagious
49	*Uvaria grandiflora* Roxb. ex Hornem.	Chuối con chồng	2	1,000	14,286	0,070	Contagious
50	*Vitex trifolia* L.	Bình linh 3 lá	6	1,500	28,571	0,053	Contagious
51	*Vitex quinata* (Lour.) F.N.Williams	Bình linh 5 lá	9	1,800	35,714	0,050	Contagious
52	*Wrightia laevis* Hook.f.	Lòng mức lông	2	1,000	14,286	0,070	Contagious
53	*Wrightia dubia* (Sims) Spreng.	Chân chim	1	1,000	7,143	0,140	Contagious
54	*Zingiber officinale* Roscoe	Gừng	4	1,333	21,429	0,062	Contagious
55	*Rhamnus oenopolia* L.	Táo rừng	7	1,750	28,571	0,061	Contagious

At the similarity level of 20%, these groups are closely related. At the similarity level of 50%, many are single species and exist independently such as *Dasymaschalon macrocalyx, Albizia procera, Streblus ilicifolius*.

Conclusion

Assessment of the biodiversity of the medicinal plant species is important for their sustainable utilization, management, and conservation. The study showed that the composition of medicinal plants in Nui Chua National Park is quite diverse. Besides, abundant of life-forms, parts used, threatened species, and disease groups using the medicinal plants to care and treatment of the disease were documented. The biodiversity index of Beta (β), Shannon (H), Pielou (J'), Simpson (Cd), Margalef (d), A/F ratio, Sorensen (SI) and the relationship between species (Cluster) was analyzed. The results indicated that the biodiversity of medicinal plants in the study area change low to moderate, and tropical evergreen broad-leaved humid low mountain forest are more diverse the tropical broad-leaved dry forest. This is a research on quantitative biodiversity indicators of first time medicinal plants was conducted in the study area. It is necessary to continue to have further evaluation studies in a comprehensive way a comprehensive to build solutions for the conservation and sustainable development of biodiversity of medicinal plants in Nui Chua National Park, Ninh Thuan Province, Vietnam.

Acknowledgment

We would like to express our sincere thanks for the valuable help and support from the Board of Directors and the forestry staff, especially thanks to the help of Mr. Nguyen Thanh Trung, Nguyen Van Hung, the staff of the International Science and Cooperation Department of Nui Chua National Park. I sincerely thank all Raglay and Cham communities in the study area, gave their warm cooperation in the field survey for providing valuable information about

medicinal plants. Finally, thank you to the colleagues who participated in the comment, giving me many ideas in the process of completing this research.

Reference

Ban NT, **Duc BM.** 1994. Some edible forest vegetables in Vietnam. Military Publishing House.

Ban NT, Ly TD, Tap N, Dung VV, Thin NN, Tien NV, Khoi NK. 2007. Vietnam Red Data Book, Part II: Plant. Natural Science and Technology Publishing House, Hanoi, Vietnam.

Chi VV. 2012. Dictionary of medicinal plants in Vietnam. Hanoi Publishing House, volume 1-2, Hanoi.

FAO. 2002. Non - wood forest products in 15 countries of Tropical Asia.

Fernando E. 1998. Forest Formations and Flora of the Philippines. College of Forestry and Natural Resources. University of the Philippines Los Banos (unpublished)

FIPI. 1997. Nui Chua dry forest nature reserve project, Ninh Hai district, Ninh Thuan province.

FIPI. 2002. Report on development of a list of specimens of Nui Chua Nature Reserve.

Ho PH. 1999-2003. An illustrated Flora of Vietnam. Young publishing House, Ho Chi Minh city, Vietnam.

Huy LQ. 2005. Methods of quantitative analysis of biodiversity indicators of vegetation. Journal of Agriculture and Rural Development Science and Technology **3 + 4,** 117-121.

IUCN. 2019. The IUCN red list of threatened species [EB/OL]. http://www.iucnredlist.org.

Loi DT. 2005. Medicinal plants and medicine of Vietnam. Hanoi Publishing House, Hanoi.

Mishra R. 1968. Ecology workbook. New Delhi: Oxford & IBH Publishing Co.

Shannon CE and Wiener W. 1963. The mathematical theory of communities. Illinois. Urbana University, Illinois Press.

Sharma PD. 2003. Ecology and the environment. New Delhi, Rastogi Publication.

Simpson EH. 1949. Measurement of diversity. London, Nature.

Stein A, Gerstner K, Kreft H. 2014. Environmental heterogeneity as a universal driver of species richness across taxa, biomes and spatial scales. Ecology Letters **17,** 866-880.

Tordoff A. 2002. Important bird sanctuaries in Vietnam. BirdLife Indochina Program in Vietnam.

Thin NN. 1997. Biodiversity research handbook. Agricultural Publishing House, Hanoi.