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# SCIENTIFIC INVESTIGATIONS OF POISONOUS PLANTS USED BY ETHNIC MINORITIES IN QUANG TRI PROVINCE

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# INTRODUCTION

## Significance of the study, state of the research, and research questions

Poisonous plants are considered harmful or detrimental to the health of humans and animals. However, many plant-derived toxins have been effectively used as treatments for dangerous diseases. In most cases, the earliest information about poisonous plants originates from indigenous knowledge. Fundamental studies on the chemical composition, biological activities, and pharmacological properties of poisonous plants provide the basis for their safe exploitation and application.

Vietnam, as a tropical country, possesses a highly diverse and abundant plant resource. Throughout history and practical experiences, our ancestors accumulated extensive knowledge on the use of plants, including poisonous ones. A clear understanding of both the beneficial and harmful aspects of these species contributes significantly to the sustainable development and effective management of plant resources. Nevertheless, ethnobotanical knowledge of poisonous plants, aimed at documenting indigenous knowledge in this field, has only been systematically recorded in recent years. Basic research on the chemistry and biological activities of poisonous plants for community health purposes remains limited.

Quang Tri province lies along the East–West economic corridor, serving as a gateway to the East Sea and playing an important role in national security and defense. Its diverse terrain includes mountains, hills, plains, sand dunes, and coastal areas extending in a northwest–southeast direction along the shoreline. The province is home to three main ethnic groups: Kinh, Van Kieu, and Pa Ko. Ethnic minorities account for about 13.6% of the total population. The Van Kieu and Pa Ko peoples primarily inhabit the mountainous districts of Huong Hoa and Dakrong, which are geographically unique as transitional areas between the eastern and western

slopes of the Truong Son range. The mountainous terrain is dissected by many rivers, streams, and steep passes. Although suitable for forestry, perennial crops, and livestock farming, the area faces difficulties in transportation and limitations in infrastructure development such as healthcare, transportation networks, electricity supply, and social organization. In 2020, the natural land area of this region accounted for about 50% of the province's total area. More than 93% of Van Kieu and Pa Ko population there reside in these two districts. Once nomadic cultivators, these ethnic groups now live in settled communities, mainly in extended family groups. Each group possesses its own language and distinct cultural identity.

Due to socio-economic constraints, the Van Kieu and Pa Ko communities depend on subsistence livelihoods, with majority of the population engaged in farming and forest product collection. Social surveys have revealed that over 80% of the population depends on agriculture, forestry, and livestock farming. Their reliance on nature has shaped both a distinctive ethnic culture and an indigenous knowledge system for managing the natural resources. Today, much of this knowledge is endangered, as it is confined to a few individuals without successors and disappears with their passing. Therefore, systematic collection and preservation of traditional knowledge are urgently needed for the benefit of the community.

Although indigenous knowledge of medicinal plants among the Van Kieu and Pa Ko has been surveyed, collected, and documented, knowledge related to poisonous plant resources has not yet been comprehensively studied. Poisonous plants occurring in the wild may pose threats to the health of grazing animals and humans, but they also represent valuable resources that provide bioactive compounds with antibacterial, antifungal,

antioxidant, anti-inflammatory, and anticancer properties. Many poisonous species with medicinal potential may be lost due to unverified information and lack of research. Therefore, documenting indigenous knowledge, assessing the toxicity and bioactivities of poisonous plants, updating species inventories, and applying modern analytical techniques are crucial for their sustainable use and for effective natural resource management. The findings of this research will offer valuable guidance for the controlled utilization of poisonous plant resources, benefiting local communities in the study area and across the nation.

**Research Objectives**

- Investigate indigenous knowledge, species composition, and potential uses of poisonous plants among the Van Kieu and Pa Ko communities, aimed at supporting human livelihoods.
- Propose rational strategies for the sustainable use of poisonous plants, contributing to socio-economic development.

**Research Contents**

- Study indigenous knowledge related to poisonous plants in the study area.
- Survey species composition and current utilization of poisonous plants among ethnic minority groups in Quang Tri province.
- Investigate biological activities of selected poisonous plant species.
- Analyse chemical constituents of poisonous plants with potential applications.
- Propose rational strategies for the appropriate utilization of poisonous plant resources.

**Scientific and Practical Basis of the Study**

**Scientific Basis**

- Poisonous plant species collected from areas inhabited by the Van Kieu and Pa Ko ethnic groups in Quang Tri Province were identified based on

morphological characteristics. Information concerning toxic plant parts, symptoms of poisoning, and traditional treatments has been systematically documented.

- Toxicity screening and assays of biological activities of poisonous plants were conducted using methods optimized for laboratory conditions.
- The relative toxicity of extracts derived from poisonous plant materials was statistically determined with significant.
- This research opens up new avenues for similar studies focused on toxicity screening, biological activity assessment, and the integration of traditional knowledge with modern scientific research.

**Practical Basis**

- Provide a database contributing to the conservation and management of poisonous plant resources for use in production, daily life, and healthcare.
- The findings of this dissertation have been published in reputable national and international journals, serving as valuable reference materials for researchers in the identification and rational utilization of poisonous plants for various purposes.
- Offer a scientific foundation for subsequent studies, particularly concerning new compounds isolated in this research.

**Novel Contributions of the Dissertation**

- This study is the first comprehensive and systematic investigation of poisonous plants traditionally used by the Van Kieu and Pa Ko ethnic groups in Quang Tri Province. A total of 56 poisonous plant species belonging to 28 families and 51 genera were documented, including information on toxic plant parts, poisoning symptoms in humans and animals.
- The following findings are new and have not been reported anywhere for poisonuos plants of this study: i) relative toxicity levels of 26 methanolic

extracts obtained from 24 poisonous plant species were evaluated using the brine shrimp (*Artemia salina*) lethality bioassay; ii) antimicrobial activities of 05 poisonous plant species in Quang Tri province (*Antheroporum harmandii* Gagnep., *Strychnos vanprukii* Craib, *Sarcodum scandens* Lour., *Kibatalia laurifolia* (Ridl.) Woodson và *Millettia erythrocalyx* Gagnep.); iii) antioxidant activities of 09 poisonous plant species (*Oldenlandia pilulifera* Pit., *Antheroporum harmandii* Gagnep., *Kibatalia laurifolia* (Ridl.) Woodson, *Sarcodum scandens* Lour., *Gelsemium elegans* (Gardner & Champ.) Benth., *Vernicia montana* Lour., *Callicarpa kochiana* Makino, *Millettia erythrocalyx* Gagnep. and *Cryptolepis buchananii* R.Br. ex Roem. & Schult.), assessed using the DPPH (2,2-diphenyl-1-picrylhydrazyl) radical scavenging assay

- Three novel compounds were identified in *Strychnos vanprukii* Craib collected from Quang Trị province: (1) (+)-lyoniresinol 3α-O-β-D-allopyranoside (strychnovanoside A); (2) (-)-lyoniresinol 3α-O-β-D-allopyranoside (strychnovanoside B) and (3) 2α-[(3,5-dimethoxy-4-hydroxy)-benzoyl]-(-)-lyoniresinol-3α-O-β-D-glucopyranoside (strychnovanoside C) và 02 hợp chất lần đầu phân lập: (5) (-)-lyoniresinol 3α-O-β-D-glucopyranoside và (7) Rutin

## Chapter 1. LITERATURE REVIEW

Chapter 1 consists of 31 pages and provides the overview of five main topics: 1.1. The concept of poisonous plants and their harmful effects; 1.2. The history of the use and applications of poisonous plants; 1.3. The status of investigations and research on poisonous plants worldwide; 1.4. The status of research on poisonous plants in Vietnam. 1.5. Characteristics of the study area.

## Chapter 2. RESEARCH SUBJECTS AND METHODS

### 2.1. RESEARCH SUBJECTS

**2.1.1. Study site and research period**

The study was conducted in Dakrong and Huong Hoa districts, Quang Tri province, located between 16.3-17.167°N latitude and 106.533-107.567°E longitude. The field research was carried out during two focused periods: March–April 2021 and April–May 2022.

**2.1.2. Research subjects**

- The informants providing knowledge on poisonous plant species were members of the Van Kieu and Pa Ko ethnic groups in Quang Tri province, of whom 66.6% were male and 33.4% were female. Most of the informants were farmers, forest gatherers, veterinary workers, and traditional healers. The majority were aged between 18–44 years (41.7%) and over 65 years (33.3%). Traditional healers and village elders possessed more extensive knowledge about poisonous plant species and their medicinal uses than younger individuals. Nearly all of them had received basic education and were literate (99.5%).

- Poisonous plant species in Quang Tri

**2.2. RESEARCH METHODS**

**2.2.1. Chemicals and Equipment**

**2.2.2. Survey method**

The ethnobotanical survey method of Martin was employed. The number of samples, their storage, and the survey information in this study were inherited from the basic research project entitled “Investigation of indigenous knowledge on the use of medicinal plant resources of the Van Kieu and Pa Ko ethnic communities in Quang Tri Province, Vietnam” (code UQĐTCB.03/21-23).

**2.2.3. Plant collection and plant specimen processing**

Plant specimens were collected following standard procedures for taxonomic identification. Fresh samples (2–3 kg of leaves, bark, fruits, wood,

roots, branches with leaves, or whole plants) were obtained for laboratory analyses. Specimens for taxonomic identification were dried at 60–70 °C and mounted on herbarium sheets. Twenty kilograms of fresh *Strychnos* sp. material were collected for chemical analysis.

**2.2.4. Plant taxonomy method**

Scientific names of plant species were verified and updated based on the Checklist of Plant Species of Vietnam. Taxonomic identification was carried out using morphological methods in reference to the Flora of Vietnam, the Checklist of Plant Species of Vietnam, and the botanical research methods of Nguyen Nghia Thin, and subsequently updated according to Plants of the World Online/Kew Science.

**2.2.5. Survey data analysis**

Data analysis methods included: Recorded poisonous plant proportion (RPPP), Informant consensus factor (ICF), and Fidelity level (FL).

**2.2.6. Biological activity assays**

The biological activity assays included: Toxicity test on *Artemia salina* larvae, Cytotoxic activity assay using the MTT method, Antimicrobial activity assay against standard microbial strains by agar disk diffusion, along with determination of the Minimum Inhibitory Concentration (MIC), Antioxidant activity assay using the DPPH (2,2-diphenyl-1-picrylhydrazyl) radical scavenging method, Anti-inflammatory activity assay.

**2.2.7. Isolation of organic compounds and structural elucidation**

Isolation of organic compounds: General extraction, fractionation, and acid hydrolysis methods were employed. Structural elucidation: Chemical structures of isolated compounds were determined using HR-ESI-MS (High-Resolution Electrospray Ionization Mass Spectrometry), 1D and 2D NMR (Nuclear Magnetic Resonance spectroscopy), and ECD (Electronic Circular Dichroism) analyses conducted on specialized instruments.

# Chapter 3. RESULTS AND DISCUSSION

## 3.1. INDIGENOUS KNOWLEDGE OF POISONOUS PLANTS AMONG ETHNIC MINORITY GROUPS IN QUANG TRI

### 3.1.1. List of poisonous plants recorded from the Van Kieu and Pa Ko peoples in Quang Tri

Based on field surveys and interviews, we compiled a list of 56 plant species recognized in indigenous knowledge as poisonous to humans, animals, and insects. The documented species include the following Latin names (with their corresponding Vietnamese common names): *Annona squamosa* L. (Na); *Carica papaya* L. (Đu đủ) ; *Jatropha curcas* L. (Dầu mè); *Ricinus communis* L. (Thầu dầu); *Abrus precatorius* L. (Cam thảo dây); *Millettia erythrocalyx* Gagnep. (Thàn mát đài đỏ); *Pachyrhizus erosus* (L.) Urb. (Củ đậu); *Strophanthus divaricatus* (Lour.) Hook.& Arn. (Sừng dê); *Croton tiglium* L. (Ba đậu); *Entada phaseoloides* (L.) Merr. (Bàm bàm); *Callicarpa candicans* (Burm. f.) Hochr. (Nàng nàng); *Bombax ceiba* L. (Gạo); *Erythrophleum fordii* Oliv. (Lim xanh); *Buddleja asiatica* Lour. (Bọ chó); *Nicotiana tabacum* L. (Thuốc lá); *Datura metel* L. (Cà độc dược); *Dendrocnide urentissima (*Gagnep.) Chew (Mán voi); *Lantana camara* L. (Ngũ sắc); *Embelia tsjeriam-cottam* (Roem. & Schult.) A.DC. (Rẻ mạnh); *Solanum nigrum* L. (Lu lu đực); *Senna tora* (L.) Roxb. (Thảo quyết minh); *Tephrosia purpurea* (L.) Pers. (Cốt khí tía); *Antheroporum harmandii* Gagnep. (Mát); *Toxicodendron succedaneum* (L.) Kuntze (Sơn); *Kibatalia laurifolia* (Ridl.) Woodson (Thần linh lá quế); *Rauvolfia verticillata* (Lour.) Baill. (Ba gạc vòng); *Euphorbia tirucalli* L. (Xương khô); *Antiaris toxicaria* Lesch. (Sui); *Bidens bipinnata* L. (Đơn buốt); *Combretum indicum* (L.) DeFilipps (Dây giun); *Ficus hispida* L.f. (Ngái); *Persicaria maculosa* Gray (Nghể lá đào); *Solanum torvum* Sw. (Cà nồng); *Callicarpa kochiana* Makino (Tử châu thùy dài); *Physalis angulata* L. (Thù lù cạnh); *Vernicia montana*

Lour. (Trẩu lá xẻ); *Mucuna pruriens* (L.) DC. (Móc mèo); *Melia azedarach* L. (Xoan); *Sarcodum scandens* Lour. (Muồng dây); *Catharanthus roseus* (L.) G.Don (Dừa cạn); *Acorus gramineus* Aiton (Thạch xương bồ); *Stemona tuberosa* Lour. (Bách bộ); *Zanthoxylum avicennae* (Lam.) DC. (Muồng truổng); *Strychnos vanprukii* Craib (Mã tiền cành vuông); *Strychnos angustifolia* Benth. (Dây củ chi); *Camphora parthenoxylon* (Jack) Nees (Re hương); *Achyranthes aspera* L. (Cỏ xước); *Tabernaemontana divaricata* (L.) R.Br. ex Roem.& Schult. (Ớt rừng); *Cryptolepis buchananii* R.Br. ex Roem.& Schult. (Dây càng cua); *Ageratum conyzoides* L. (Cứt lợn); *Heliotropium indicum* L. (Vòi voi); *Euphorbia hirta* L. (Cỏ sữa lông); *Euphorbia tithymaloides* L. (Thuốc dấu); *Gelsemium elegans* (Gardner & Champ.) Benth. (Lá ngón); *Oldenlandia pilulifera* Pit. (An điền nón); *Commelina benghalensis* L. (Thài lài lông).

According to the survey results of this study, poisonous plants most commonly contain toxic substances in their fruits and seeds (46.4%), followed by leaves (23.2%), the whole plant (17.8%), latex or essential oils (14.2%), roots (10.7%), and flowers (3.5%).

**3.1.2. Commonly recorded poisonous plants**

The most commonly recorded poisonous plant species were: *G. elegans* (81.0%); following *T. succedaneum* (75.6%); *M. erythrocalyx* (45.1%); *A. harmandii* (40.0%); *C. roseus* (31.2%); *R. communis* (25.3%); *S. vanprukii* (22.9%); *R. verticillata* (15.8%); *S. scandens* (14.4%); *C. indicum* (13.4%); *K. laurifolia* (12.7%); *T. divaricata* (10.6%); *S. tuberosa* (10.1%); *E. tithymaloides, V. montana, C. buchananii, E. tirucalli, A. gramineus, B. asiatica, H. indicum, F. hispida* (5.1 - 9.6%); *M. azedarach, C. kochiana, O. pilulifera* (1- 5%). The Informant Consensus Factor (ICF) values for each disease category were analyzed from 25 poisonous plant species reported by more than 1% of the total informants (Table 3.3). The

ICF values were all close to 1, indicating that the grouping of these 25 poisonous plants into five specific categories of poisoning symptoms is reasonable, and that the toxic properties of these plants are widely recognized and relatively common among the local Van Kieu and Pa Ko peoples. The representative poisonous plant species for each disease category were identified based on their FL values.

**Table 3.3.** Informant consensus factor (ICF) and fidelity level (FL) of the information

| Category of Illness | Number of Species | Number of Records | ICF | Species Name | FL (%) |
|---|---|---|---|---|---|
| Gastrointestinal | 12 | 151 | 0,93 | *R. communis* L. (Thầu dầu) | 100 |
| | | | | *M. erythrocalyx* Gagnep. (Thàn mát đài đỏ) | 100 |
| | | | | *R. verticillata* (Lour.) Baill. (Ba gạc vòng) | 85,2 |
| | | | | *C. indicum* (L.) DeFilipps (Dây giun) | 76,6 |
| | | | | *M. azedarach* L. (Xoan) | 73,1 |
| | | | | *A. harmandii* Gagnep. (Mát) | 71,4 |
| | | | | *C. roseus* L. G.Don (Dừa cạn) | 61,8 |
| | | | | *Z. avicennae* (Lam.) DC. (Muồng truổng) | 59,9 |
| | | | | *V. montana* Lour. (Trẩu lá xẻ) | 57,4 |
| | | | | *B. asiatica* Lour. (Bọ chó) | 50,3 |
| | | | | *H. indicum* L. (Vòi voi) | 47,2 |
| | | | | *F. hispida* L.f. (Ngái) | 38,1 |
| Skin irritation | 2 | 24 | 0,96 | *R. succedanea* L. (Sơn) | 100 |
| | | | | *E. tirucalli* L. (Giao) | 68,9 |
| Eye irritation | 2 | 39 | 0,97 | *E. tithymaloides* L. (Thuốc dấu) | 66,5 |
| | | | | *K. laurifolia* (Ridl.) Woodson (Thần linh lá quế) | 45,7 |
| Respiratory/ cardiovascular | 7 | 82 | 0,92 | *G. elegans* (Gardner & Chapm.) Benth. (Lá ngón) | 100 |
| | | | | *S. vanprukii* Craib (Mã tiền cành vuông) | 100 |
| | | | | *S. scandens* Lour. (Muồng dây) | 60,9 |
| | | | | *T. divaricata* (L.) R.Br. ex Roem. & Schult. (Ớt rừng) | 57,6 |
| | | | | *C. buchananii* R.Br. ex Roem. & Schult (Dây càng cua) | 56,1 |
| | | | | *A. gramineus* Aiton (Thạch xương bồ) | 42,3 |
| | | | | *S. tuberosa* Lour. (Bách bộ) | 40,9 |
| Neuro | 2 | 31 | 0, | *C. kochiana* Makino (Tử châu thùy dài) | 58,1 |

| | | | | | |
|---|---|---|---|---|---|
| | | | 97 | *O. pilulifera* Pit. (An điền nón) | 49,7 |

## 3.2. SURVEY ON THE CURRENT USE AND SPECIES COMPOSITION OF POISONOUS PLANTS AMONG ETHNIC MINORITY GROUPS IN QUANG TRI PROVINCE

### 3.2.1. Current use of poisonous plant species

**Table 3.4.** Categories of ailments treated with poisonous plants

| TT | Category of Illness | Poisonous plants used for medicinal purposes | Total |
|---|---|---|---|
| 1 | Gastrointestinal disorders (stomach, colon, liver, hemorrhoids, helminthiasis) | *Ageratum conyzoides* L., *Achyranthes aspera* L., *Solanum nigrum* L., *Acorus gramineus* Aiton, *Combretum indicum* (L.) DeFilipps, *Entada phaseoloides* (L.) Merr., *Ficus hispida* L.f., *Heliotropium indicum* L., *Melia azedarach* L., *Oldenlandia pilulifera* Pit., *Rauvolfia verticillata* (Lour.) Baill., *Stemona tuberosa* Lour. | 12 |
| 2 | Respiratory disorders | *Stemona tuberosa* Lour., *Euphorbia tirucalli* L. | 2 |
| 3 | Dermatological conditions (boils, wounds, hemostasis) | *Strophanthus divaricatus* (Lour.) Hook. & Arn., *Rauvolfia verticillata* (Lour.) Baill., *Ageratum conyzoides* L., *Strychnos vanprukii* Craib, *Bidens bipinnata* L., *Jatropha curcas* L., *Kibatalia laurifolia* (Ridl.) Woodson, *Melia azedarach* L., *Nicotiana tabacum* L., *Tabernaemontana divaricata* (L.) R.Br. ex Roem. & Schult., *Euphorbia tirucalli* L., *Catharanthus roseus* (L.) G.Don | 12 |
| 4 | Musculoskeletal disorders | *Rauvolfia verticillata* (Lour.) Baill., *Ricinus communis* L., *Jatropha curcas* L., *Oldenlandia pilulifera* Pit., *Euphorbia tithymaloides* L. | 5 |
| 5 | Cardiovascular disorders (including hypertension) | *Buddleja asiatica* Lour., *Catharanthus roseus* (L.) G.Don | 2 |
| 6 | Reproductive and gynecological disorders (gonorrhea, breast tumors) | *Stemona tuberosa* Lour., *Rauvolfia verticillata* (Lour.) Baill., *Cryptolepis buchananii* R.Br. ex Roem. & Schult. | 3 |
| 7 | Oral and dental disorders | *Strychnos vanprukii* Craib, *Solanum torvum* Sw., *Datura metel* L., *Jatropha curcas* L., *Acorus gramineus* Aiton, *Datura metel* L., *Euphorbia tirucalli* L. | 7 |
| 8 | Neurological disorders | *Buddleja asiatica* Lour. | 1 |
| 9 | Metabolic disorders (diabetes, edema) | *Bidens bipinnata* L., *Heliotropium indicum* L. | 2 |

| | | | |
|---|---|---|---|
| 10 | Liver disorders | *Zanthoxylum avicennae* (Lam.) DC. | 1 |

Among the 56 poisonous plant species recorded, 28 species are used in the traditional remedies of the Van Kieu and Pa Ko peoples in Quang Tri. According to indigenous knowledge, the medicinal applications of these poisonous plants are classified into 10 disease categories (Table 3.4). Four rare species requiring conservation were identified, three of which are listed in the Vietnam Red Data Book: *Rauvolfia verticillata* (Lour.) Baill. (EN, B2a,b - endangered); *Kibatalia laurifolia* (Ridl.) (VU, B1a,b - potentially endangered); *Camphora parthenoxylon* (Jack) Nees (CR, A2a,c,d - critically endangered)..

### 3.2.1. Species composition, life forms, and habitats of poisonous plants

The present study identified a total of 56 angiosperm species representing 28 families and 51 genera at the research site. Among these, the family Fabaceae was the most dominant, comprising 10 species from 10 genera. This was followed by Euphorbiaceae (7 species, 5 genera), Apocynaceae (6 species, 6 genera), Solanaceae (5 species, 4 genera), Moraceae (2 species, 2 genera), and Asteraceae (2 species, 2 genera), Loganiaceae (2 species, 1 genera), and Lamiaceae (2 species, 1 genera). Within the scope of this dissertation, species names and family affiliations are cited in accordance with Plants of the World Online/ Kew science.

## 3.3. BIOACTIVITY ASSAYS OF SELECTED PLANT SAMPLES

### 3.3.1. Methanol extract preparation

Methanol extracts were prepared from 26 plant samples. The extract yield varied substantially, ranging from 2.026 to 9.566 g per 100 g of dried material. Specifically, yields were 0.612 g from 46 g of dried *A. harmandii* t seeds and 1.250 g from 86 g of dried *G. elegans* flowers.

### 3.3.2. *In vivo* toxicity of methanol extracts on *Artemia salina* larvae

The toxicity of the methanol extracts was evaluated using *Artemia salina* larvae. Based on $LC_{50}$ values (Table 3.10), the samples were

categorized into five toxicity levels: Extremely toxic ($LC_{50} \leq 10$ µg/mL): 3 samples; Highly toxic ($LC_{50}$ = 10–100 µg/mL): 10 samples; Moderately toxic ($LC_{50}$ = 100–250 µg/mL): 8 samples; Weakly toxic ($LC_{50}$ = 250–1000 µg/mL): 4 samples; Non-toxic ($LC_{50} \geq 1000$ µg/mL): 1 sample.

**Bảng 3.10**. $LC_{50}$ values of plant extracts in toxicity assessment

| No. | Samples | $LC_{50}$ (µg/mL) | No. | Samples | $LC_{50}$ (µg/mL) |
|---|---|---|---|---|---|
| 1 | TNSV06 | 128.24 ±4.68 | 14 | TNSV45 | 144.48±3.64 |
| 2 | TNSV08 | 237.90±4.15 | 15 | TNSV46 | 75.75±11.17 |
| 3 | TNSV13 | **5.40±0.96** | 16 | TNSV46H | **9.17±1.03** |
| 4 | TNSV13H | **1.03±0.06** | 17 | TNSV47 | 360.38±27.00 |
| 5 | TNSV14 | 310.68±4.82 | 18 | TNSV48 | 68.32±6.79 |
| 6 | TNSV15 | 77.69±2.76 | 19 | TNSV49 | 80.79±3.62 |
| 7 | TNSV17 | 425.34±5.46 | 20 | TNSV50 | 84.65±7.32 |
| 8 | TNSV28 | 88.24±11.92 | 21 | TNSV51 | 332.31±6.49 |
| 9 | TNSV30 | 48.97±0.85 | 22 | TNSV52 | 221.20±3.22 |
| 10 | TNSV40 | 24.12±1.60 | 23 | TNSV54 | 219.27±10.89 |
| 11 | TNSV41 | 149.22±2.88 | 24 | TNSV57 | 129.36±4.64 |
| 12 | TNSV42 | >1000 | 25 | TNSV58 | 137.60±9.11 |

These findings demonstrate the significant variability in the toxicity profiles of methanol extracts derived from poisonous plant species in the study area.

### 3.3.3. *In vitro* cytotoxicity of methanol extracts of selected plant samples against cancer cell lines

The *in vitro* cytotoxicity of eight methanol extracts derived from eight commonly used poisonous plant species was evaluated using the MTT assay against four human cancer cell lines: lung carcinoma (A549), breast adenocarcinoma (MCF-7), cervical carcinoma (HeLa), and prostate carcinoma (DU145). The methanol extract of *A. harmandii* stems and leaves (TNSV13) at a concentration of 100 µg/mL markedly reduced the viability of A549, HeLa, and DU145 cells to 29.44%, 38.05%, and 23.53%, respectively, while the effect on MCF-7 cells was less pronounced

(65.45%) (Table 3.11). Based on serial concentrations of 10, 25, 50, and 100 µg/mL, the extracts from stems, leaves, and seeds demonstrated notable cytotoxic potential against three cancer cell lines: A549 ($IC_{50}$ = 18.41 µg/mL), HeLa ($IC_{50}$ = 23.66 µg/mL), DU145 ($IC_{50}$ = 21.58 µg/mL).

**Table 3.11.** The cell survival rate (CS%) in the *in vitro* cytotoxicity assay of methanol extracts from the studied plant species against cancer cell lines.

| **Samples** | **Concentration (µg/mL)** | **The cell survival rate after 24 hours (CS%)** | | | |
|---|---|---|---|---|---|
| | | **A549** | **MCF-7** | **Hela** | **DU145** |
| Negative control | | 100.00±0.81 | 100.00±0.67 | 100.00±0.37 | 100.00±1.89 |
| | 30 | **41.13±0.77** | 68.84±0.16 | **48.03±1.43** | **43.24±1.08** |
| TNSV13 | 100 | **29.44±0.94** | 65.45±0.58 | **38.05±1.19** | **23.53±1.13** |
| | 30 | 87.89±1.90 | 83.18±0.09 | 76.79±0.30 | 92.53±0.80 |
| TNSV15 | 100 | 75.64±1.21 | 70.71±1.57 | 67.82±1.01 | 79.33±1.02 |
| | 30 | 86.54±1.06 | 83.39±1.09 | 80.66±0.50 | 82.12±1.27 |
| TNSV28 | 100 | 78.89±1.93 | 70.53±1.18 | 74.93±0.66 | 59.55±0.98 |
| | 30 | 93.00±1.18 | 78.79±0.91 | 73.53±0.90 | 90.79±1.97 |
| TNSV30 | 100 | 85.02±1.28 | 59.32±1.65 | 58.84±0.31 | 71.51±0.41 |
| | 30 | 92.27±0.59 | 89.65±0.86 | 81.37±1.02 | 78.39±0.98 |
| TNSV40 | 100 | 85.23±1.66 | 75.78±0.79 | 71.55±1.22 | 74.50±1.21 |
| | 30 | 72.54±1.85 | 82.44±0.09 | 76.11±1.67 | 62.17±1.99 |
| TNSV100 | 100 | 64.75±1.24 | 74.55±2.03 | 68.53±0.87 | 60.73±0.99 |
| | 30 | 87.98±0.87 | 90.77±1.96 | 77.51±1.60 | 94.98±1.32 |
| TNSV06 | 100 | 77.68±1.57 | 77.53±0.89 | 64.98±0.97 | 74.92±1.29 |
| | 30 | 85.57±1.10 | 83.58±1.84 | 71.69±1.17 | 92.75±1.84 |
| TNSV17 | 100 | 78.00±1.56 | 71.33±0.66 | 61.93±1.33 | 79.81±0.89 |
| Camptothecin | 0,1 | 70.64±0.67 | 55.06±0.78 | 68.57±0.46 | 55.98±0.73 |
| | 5 | 30.12±0.96 | 17.54±1.10 | 25.88±1.96 | 23.52±1.04 |

### 3.3.4. Antimicrobial activity of methanol extracts of the studied plant samples

#### 3.3.4.1. *Results of the agar disk diffusion assay*

Among the 26 methanol extracts tested, only the extract of *H. indicum* (TNSV42) did not produce any inhibition zone against

*Micrococcus luteus* at the three tested concentrations (50, 100, and 150 mg/mL) (Table 3.13).

**Table 3.13.** Antibacterial activity of methanol extracts against *M.luteus*

| TT | Samples | Concentration (mg/mL) of the extracts | | |
|---|---|---|---|---|
| | | 50 | 100 | 150 |
| | | The inhibition zones (cm) | | |
| 1 | TNSV06 | 0,15±0,00 | 0,40±0,05 | **0,63±0,02** |
| 2 | TNSV08 | 0,07±0,03 | 0,20±0,05 | 0,30±0,05 |
| 3 | TNSV13 | 0,20±0,05 | 0,33±0,03 | **0,52±0,03** |
| 4 | TNSV13H | 0,10±0,02 | 0,35±0,00 | 0,42± 0,08 |
| 5 | TNSV14 | 0 | 0,12±0,03 | 0,22±0,03 |
| 6 | TNSV15 | 0,45±0,05 | 0,55±0,00 | **0,78±0,02** |
| 7 | TNSV17 | 0,05±0,00 | 0,33 ± 0,03 | 0,40 ± 0,05 |
| 8 | TNSV28 | 0,30±0,00 | 0,60±0,00 | **0,70± 0,05** |
| 9 | TNSV30 | 0,20± 0,05 | 0,62±0,03 | **0,98±0,03** |
| 10 | TNSV40 | 0,25±0,00 | 0,37± 0,03 | **0,68± 0,03** |
| 11 | TNSV41 | 0,25±0,00 | 0,37± 0,03 | **0,55± 0,05** |
| 12 | TNSV44 | 0,50± 0,05 | 0,83 ± 0,03 | **1,10 ± 0,05** |
| 13 | TNSV42 | 0 | 0 | 0 |
| 14 | TNSV45 | 0 | 0,20± 0,05 | 0,40± 0,05 |
| 15 | TNSV46 | 0,27± 0,03 | 0,40 ± 0,05 | **0,70 ± 0,05** |
| 16 | TNSV46H | 0 | 0,15±0,00 | 0,25± 0,05 |
| 17 | TNSV47 | 0,62± 0,03 | 0,80 ± 0,05 | **0,93 ± 0,07** |
| 18 | TNSV48 | 0,50±0,00 | 0,73± 0,03 | **0,95± 0,05** |
| 19 | TNSV49 | 0,20±0,00 | 0,30±0,00 | **0,55±0,05** |
| 20 | TNSV50 | 0,07± 0,03 | 0,30± 0,05 | 0,45± 0,05 |
| 21 | TNSV51 | 0,22± 0,03 | 0,4± 0,05 | **0,65± 0,05** |
| 22 | TNSV52 | 0,15±0,05 | 0,32±0,03 | **0,50± 0,05** |
| 23 | TNSV54 | 0,23±0,02 | 0,35±0,05 | **0,77±0,03** |
| 24 | TNSV57 | 0,20±0,00 | 0,30± 0,05 | **0,55± 0,05** |
| 25 | TNSV58 | 0,60± 0,05 | 0,83± 0,02 | **0,95± 0,05** |
| 26 | TNSV100 | 0,10±0,00 | 0,25 ± 0,05 | 0,40 ± 0,05 |
| | Genta 400 µg/mL | 0,63±0,06 | | |

For *Staphylococcus aureus*, 11 out of 26 methanol extracts exhibited antibacterial activity, producing inhibition zones at a concentration of 50 mg/mL (Table 3.14). At the highest tested concentration (150 mg/mL), 12 out of 26 methanol extracts showed no inhibitory effect on *Bacillus subtilis*, while the remaining 12 extracts displayed moderate antibacterial activity, with inhibition zones ranging from 0.1 to 0.4 cm. Regarding *Escherichia*

*coli*, *Proteus vulgaris*, and *Pseudomonas aeruginosa*, 11 out of 26 methanol extracts did not demonstrate any antibacterial activity. Antifungal activity against *C. albicans* was observed only in the extract from the leaves and twigs of *Z. avicennae* at the tested concentration of 150 mg/mL.

**Bảng 3.14**. Antibacterial activity of methanol extracts against *S. aureus*

| TT | Samples | Concentration (mg/mL) of the extract | | |
|---|---|---|---|---|
| | | 50 | 100 | 150 |
| | | The inhibition zones (cm) | | |
| 1 | TNSV06 | 0 | 0 | 0 |
| 2 | TNSV08 | 0 | 0.15±0.00 | 0.30± 0.05 |
| 3 | TNSV13 | 0.13±0.03 | 0.32±0.03 | **0.62±0.03** |
| 4 | TNSV13H | 0.05± 0.01 | 0.2±0.00 | 0.47±0.03 |
| 5 | TNSV14 | 0 | 0 | 0.13±0.03 |
| 6 | TNSV15 | 0.40± 0.05 | 0.62±0.03 | **0.80± 0.05** |
| 7 | TNSV17 | 0 | 0 | 0 |
| 8 | TNSV28 | 0.15± 0.05 | 0.4±0.00 | **0.65± 0.05** |
| 9 | TNSV30 | 0 | 0 | 0.15±0.05 |
| 10 | TNSV40 | 0.20±0.00 | 0.32±0.03 | 0.45±0.05 |
| 11 | TNSV41 | 0 | 0.1 | 0.20± 0.05 |
| 12 | TNSV42 | 0.20±0.00 | 0.38±0.03 | **0.60± 0.05** |
| 13 | TNSV44 | 0.60±0.00 | 0.60± 0.05 | **0.70± 0.05** |
| 14 | TNSV45 | 0 | 0 | 0 |
| 15 | TNSV46 | 0 | 0.10±0.00 | 0.20± 0.05 |
| 16 | TNSV46H | 0 | 0 | 0 |
| 17 | TNSV47 | 0.65±0.00 | 0.70±0.00 | **0.80 ± 0.05** |
| 18 | TNSV48 | 0.20±0.00 | 0.32±0.03 | **0.50±0.05** |
| 19 | TNSV49 | 0 | 0 | 0 |
| 20 | TNSV50 | 0 | 0 | 0.15±0.00 |
| 21 | TNSV51 | 0 | 0 | 0 |
| 22 | TNSV52 | 0.10±0.00 | 0.27±0.03 | 0.43±0.03 |
| 23 | TNSV54 | 0 | 0 | 0.10±0.00 |
| 24 | TNSV57 | 0 | 0 | 0.20±0.00 |
| 25 | TNSV58 | 0.35±0.05 | 0.42±0.03 | **0.85±0.05** |
| 26 | TNSV100 | 0 | 0.10±0.00 | 0.20±0.00 |
| | Genta 200 µg/mL | 1.15±0.05 | | |

### 3.3.4.2. *Results of minimum inhibitory concentration (MIC) assays*

The MIC assays revealed that all 26 methanol extracts (26/26) exhibited antimicrobial activity against 1–6 tested bacterial strains. Specifically, all extracts (26/26) were actively against at least one Gram-

positive strain, while 14 out of 26 extracts demonstrated inhibitory effects against at least one Gram-negative strain. Notably, only the extract of TNSV58 showed antifungal activity against *C. albicans*, with MIC value of 8 mg/mL (Table 3.16).

**Table 3.16.** MIC values of methanol extracts of the studied plant samples

| Samples | MIC (mg/mL) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Gram-positive strain | | | Gram-negative strain | | | Fungi |
| | *M.luteus* | *S.aureus* | *B.subtilis* | *P.vulgaris* | *E.coli* | *P.aeruginose* | *C.albicans* |
| TNSV06 | 2 | - | - | - | - | - | N |
| TNSV08 | 8 | 8 | 8 | - | - | - | N |
| TNSV13 | 0.5 | 1 | - | - | - | - | N |
| TNSV13 H | 1 | 1 | - | - | - | - | N |
| TNSV14 | 8 | 4 | - | - | - | - | N |
| TNSV15 | 1 | **0.25** | 8 | 8 | 8 | 8 | N |
| TNSV17 | 4 | - | - | - | - | - | N |
| TNSV28 | 2 | 1 | 4 | 8 | 8 | 8 | N |
| TNSV30 | 2 | 8 | 8 | 8 | 8 | 8 | N |
| TNSV40 | 2 | 0,5 | 8 | 8 | - | 8 | N |
| TNSV41 | **0.25** | 8 | 8 | 8 | 8 | - | N |
| TNSV42 | - | 1 | 4 | 8 | - | 8 | N |
| TNSV44 | 2 | 2 | - | - | - | - | N |
| TNSV45 | 4 | - | - | 8 | - | - | N |
| TNSV46 | 4 | 8 | - | 8 | 8 | 8 | N |
| TNSV46 H | 8 | - | - | - | - | - | N |
| TNSV47 | 0.5 | 0.5 | - | - | - | 8 | N |
| TNSV48 | 2 | 0.5 | 8 | 8 | 8 | 8 | N |
| TNSV49 | 2 | - | - | 8 | - | - | N |
| TNSV50 | 2 | - | 8 | - | - | - | N |
| TNSV51 | 2 | - | - | - | - | - | N |
| TNSV52 | 4 | 1 | 8 | - | 8 | 8 | N |
| TNSV54 | 2 | 4 | - | - | - | - | N |
| TNSV57 | 4 | 4 | 8 | 8 | 8 | 8 | N |
| TNSV58 | 0,5 | 1 | 8 | - | 8 | 8 | 8 |
| TNSV100 | 8 | - | 8 | - | - | - | N |
| Gentamicin | $16 . 10^{-3}$ | $0.9 . 10^{-3}$ | $64 . 10^{-3}$ | | | | |
| Nystatin | | | | | | | $1. 10^{-3}$ |

*(-): MIC >8; (N): Không xác định giá trị MIC vì không có vòng kháng nấm ở nồng độ 150 mg/mL.*

### 3.3.5. Antioxidant activity evaluation using DPPH assay

Following the classification proposed by Setha et al., the 26 methanol extracts from 24 poisonous plant species were divided into four antioxidant activity groups: i) Very strong activity ($IC_{50}$ < 50 µg/mL): 10 extracts from 10 species; ii) Strong activity ($IC_{50}$: 50–100 µg/mL): 8 extracts from 7 species; iii) Moderate activity ($IC_{50}$: 100–200 µg/mL): 4 extracts from 4 species; iv) Weak activity ($IC_{50}$ > 200 µg/mL): 4 extracts from 4 species.

The very strong antioxidant group ($IC_{50}$ < 50 µg/mL) included 10 methanol extracts: TNSV14 (*B. asiatica*): $IC_{50}$ = 10.42 ± 0.45 µg/mL; TNSV15 (*R. communis*): $IC_{50}$ = 26.24 ± 0.88 µg/mL; TNSV28 (*C. indicum*): $IC_{50}$ = 15.28 ± 0.39 µg/mL; TNSV41 (*E. tirucalli*): $IC_{50}$ = 49.33 ± 0.67 µg/mL; TNSV44 (*K. laurifolia*): $IC_{50}$ = 7.70 ± 0.58 µg/mL; TNSV45 (*S. scandens*): $IC_{50}$ = 25.75 ± 0.83 µg/mL; TNSV46 (*G. elegans*): $IC_{50}$ = 45.30 ± 2.45 µg/mL; TNSV47 (*V. montana*): $IC_{50}$ = 5.70 ± 0.33 µg/mL; TNSV48 (*C. kochiana*): $IC_{50}$ = 7.10 ± 0.43 µg/mL; TNSV51 (*M. erythrocalyx*): $IC_{50}$ = 19.56 ± 0.74 µg/mL.

### 3.3.6. Anti-inflammatory activity evaluation

Ten poisonous plant species traditionally used to treat inflammatory-related diseases were selected for evaluation: TNSV15 (*R. communis*), TNSV48 (*C. kochiana*), TNSV44 (*K. laurifolia*), TNSV17 (*S. vanprukii*), TNSV14 (*B. asiatica*), TNSV50 (*M. azedarach*), TNSV40 (*E. tithymaloides*), TNSV58 (*Z. avicennae*), TNSV28 (*C. indicum*), TNSV30 (*S. tuberosa*). The methanol extracts of *C. indicum* (TNSV28) (83.32 ± 0.41% inhibition) and *S. vanprukii* (TNSV17) (82.37 ± 2.52% inhibition) at 100 µg/mL showed comparable anti-inflammatory activity to the positive control Cardamonin at 10 µM (82.01 ± 3.63% inhibition). These findings suggest that both species exhibit strong anti-inflammatory potential,

warranting further in-depth studies on their bioactive compounds.

## 3.4. PHYTOCHEMICAL CONSTITUENTS AND POTENTIAL APPLICATIONS OF *S. VANPRUKII* CRAIB

### 3.4.1. Extracted compounds

*Strychnos* sp. was selected for chemical compound analysis because it is commonly found in nature and is frequently used by the Van Kieu and Pa Ko ethnic groups (Quang Tri) in traditional medicine for the treatment of various diseases. Moreover, in this study, *S. vanprukii* exhibited high anti-inflammatory and antioxidant activities, showed antibacterial effects against *M. luteus* and *S. aureus*, had weak toxicity against *A. salina* larvae, and had no cytotoxicity against four human cancer cell lines. From 7.5 kg of powdered *S. vanprukii*, seven compounds were isolated: Compound 1: A new compound with molecular formula $C_{28}H_{38}O_{13}$ (M = 582), identified as (+)-lyoniresinol 3α-O-β-D-allopyranoside, named strychnovanoside A (Figure 3.30). Compound 2: A new compound with molecular formula $C_{28}H_{38}O_{13}$ (M = 582), identified as (–)-lyoniresinol 3α-O-β-D-allopyranoside, named strychnovanoside B (Figure 3.31). Compound 3: A new compound with molecular formula $C_{37}H_{46}O_{17}$ (M= 762), identified as 2α-(3,5-dimethoxy-4-hydroxy)-benzoyl]-(-)-lyoniresinol-3α-O-β-D-glucopyranoside, named strychnovanoside C (Figure 3.32). Compound 4: $C_{28}H_{38}O_{13}$ (M=582), identified as (+)-lyoniresinol 3α-O-β-D-glucopyranoside (Figure 3.33). Compound 5: $C_{28}H_{38}O_{13}$ (M=582), identified as (–)-lyoniresinol 3α-O-β-D-glucopyranoside, isolated for the first time from S. vanprukii (Figure 3.34). Compound 6: A yellowish powder, $C_{27}H_{34}N_2O_9$, identified as palicoside (Figure 3.35). Compound 7: $C_{27}H_{30}O_{15}$ (M = 594), identified as kaempferol 3-rutinoside (rutin), isolated for the first time from *S. vanprukii* (Figure 3.36).

Figure 3.30

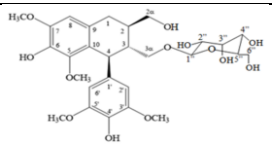


Figure 3.31

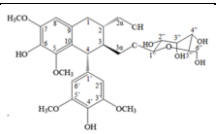


Figure 3.32

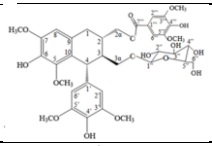


Figure 3.33

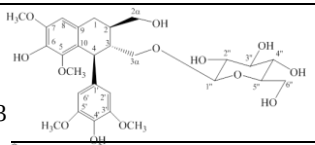


Figure 3.34

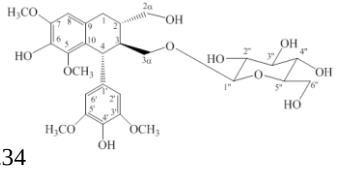


Figure 3.35

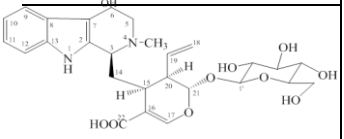
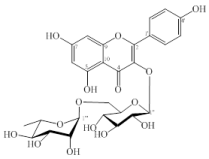


Figure 3.36



**Figures 3.30–3.36.** Chemical structures of the seven isolated compounds: (**3.30**): Strychnovanoside A; (**3.31**): Strychnovanoside B; (**3.32**): Strychnovanoside C; (**3.33**): (+)-lyoniresinol 3α- O-β-D-glucopyranoside; (**3.34**): (-)-lyoniresinol 3α-O-β-D-glucopyranoside; (**3.35**): Palicoside; (**3.36**): Rutin.

### 3.4.1. Biological activities of the isolated compounds from *S. vanprukii* Craib

Compounds (1)–(5) are derivatives of lyoniresinol. Lyoniresinol has been reported to exhibit antioxidant, anticancer, and antibacterial activities. Three new compounds (1)–(3) and four previously reported compounds (4)–(7) were shown to be non-toxic to *A. salina* larvae. Rutin (7) is a well-known non-toxic compound. The toxicity of compounds (4)–(6) has not yet been reported in the literature. Five compounds (1)–(5) exhibited strong DPPH radical scavenging activity. Compound (6) showed no antioxidant

activity. Compound (7) displayed weak antioxidant activity ($IC_{50}$ > 200 µg/mL). All seven compounds demonstrated anti-inflammatory activity.

## 3.5. PROPOSED STRATEGIES FOR THE RATIONAL UTILIZATION OF POISONOUS PLANTS

Table 3.24 summarizes the potential applications of 24 poisonous plant species collected in Quảng Trị province, based on the research findings.

**Table 3.24**. Potential utilization of common poisonous plant species

| No. | Samples | Scientific names (Common names) | Toxicity on *A. salina* | Cytotoxicity against cancer cells | Anti-microorganism activity | Scavenging activity | Anti-inflammatory activity |
|---|---|---|---|---|---|---|---|
| 1 | TNSV06 | *Oldenlandia pilulifera* Pit. (An điền nón) | ++ | - | + | + | NA |
| 2 | TNSV08 | *Acorus gramineus* Aiton (Thạch xương bồ) | ++ | NA | ++ | + | NA |
| 3 | TNSV13H | *Antheroporum harmandii* Gagnep. (Mát) | ++++ | NA | + | +++ | NA |
| 4 | TNSV13 | | ++++ | +++ | + | ++ + | NA |
| 5 | TNSV14 | *Buddleja asiatica* Lour. (Bọ chó) | + | NA | + | ++++ | + |
| 6 | TNSV15 | *Ricinus communis* L. (Thầu dầu) | +++ | - | +++ | ++++ | + |
| 7 | TNSV17 | *Strychnos vanprukii* Craib (Mã tiền cành vuông) | + | - | + | +++ | ++ |
| 8 | TNSV28 | *Combretum indicum* (L.) DeFilipps (Dây giun) | +++ | - | +++ | ++++ | + |
| 9 | TNSV30 | *Stemona tuberosa* Lour. (Bách bộ) | +++ | - | +++ | + | - |
| 10 | TNSV40 | *Euphorbia tithymaloides* L. (Thuốc dấu) | +++ | - | +++ | +++ | Đ |
| 11 | TNSV41 | *Euphorbia tirucalli* L. (Xương khô, Giao) | ++ | NA | +++ | ++++ | NA |
| 12 | TNSV42 | *Heliotropium indicum* L. (Vòi voi) | - | NA | ++ | ++ | NA |
| 13 | TNSV44 | *Kibatalia laurifolia* (Ridl.) Woodson (Thần linh lá quế) | +++ | NA | + | ++++ | Đ |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 14 | TNSV45 | *Sarcodum scandens* Lour. (Muồng dây) | ++ | NA | + | ++++ | NA |
| 15 | TNSV46 | *Gelsemium elegans* (Gardner & Champ.) Benth. (Lá ngón) | +++ | NA | +++ | ++++ | NA |
| 16 | TNSV46H | | ++++ | NA | + | + | NA |
| 17 | TNSV47 | *Vernicia montana* Lour. (Trẩu lá xẻ) | + | NA | ++ | ++++ | NA |
| 18 | TNSV48 | *Callicarpa kochiana* Makino (Tử châu thùy dài) | +++ | NA | +++ | ++++ | + |
| 19 | TNSV49 | *Rauvolfia verticillata* (Lour.) Baill. Ba gạc vòng) | +++ | NA | + | +++ | NA |
| 20 | TNSV50 | *Melia azedarach* L. (Xoan) | +++ | NA | + | ++ | + |
| 21 | TNSV51 | *Millettia erythrocalyx* Gagnep. (Thàn mát đài đỏ) | + | NA | + | ++++ | NA |
| 22 | TNSV52 | *Ficus hispida* L.f. (Ngái) | ++ | NA | +++ | ++ | NA |
| 23 | TNSV54 | *Tabernaemontana divaricata* (L.) R.Br. ex Roem. & Schult. (Ớt rừng) | ++ | NA | + | +++ | NA |
| 24 | TNSV57 | *Cryptolepis buchananii* R.Br. ex Roem. & Schult (Dây càng cua) | ++ | NA | +++ | +++ | NA |
| 25 | TNSV58 | *Zanthoxylum avicennae* (Lam.) DC. (Muồng truổng) | ++ | NA | +++ | +++ | - |
| 26 | TNSV100 | *Catharanthus roseus* (L.) G.Don (Dừa cạn) | +++ | - | + | ++ | NA |

*The symbol (–) indicates no activity, while (+) denotes the presence of activity; the greater the number of (+) symbols, the higher the level of activity observed. (NA): samples not tested.*

## CONCLUSIONS AND RECOMMENDATIONS

### CONCLUSIONS

1- The ethnobotanical survey on poisonous plants used by the Van Kieu and Pa Ko ethnic groups in Dakrong and Huong Hoa districts, Quang Tri province, recorded 25 poisonous plant species were cited by more than 1% of the informants. The most frequently reported poisonous species were *Gelsemium elegans* (Gardner & Champ.) Benth. (81.0%) and *Toxicodendron succedaneum* (L.) Kuntze (75.6%). Five major categories of poisoning symptoms in humans and animals were identified: (1) gastrointestinal disorders (ICF=0.93 and FL ranging from 38.1% to 100%),

(2) skin irritation (ICF=0.96 and FL 68.9% to 100%), (3) eye irritation (ICF=0.97 and FL 45.7% to 66.5%), (4) respiratory/cardiovascular disorders (ICF=0.92 and FL 40.9% to 100%), and (5) nervous system disorders (ICF=0.97 and FL 49.7% to 58.1%).

2- The study area exhibits considerable diversity in the composition of poisonous plant species (56 poisonous plant species belonging to 28 families and 51 genera). The Fabaceae family is predominant, represented by 10 species in 10 genera, followed by Euphorbiaceae (7 species/5 genera), Apocynaceae (6/6), Solanaceae (5/4), Moraceae (2/2), Asteraceae (2/2), Loganiaceae (2/1), and Lamiaceae (2/1). In total, 25 poisonous plant species commonly recorded in Dakrong and Huong Hoa districts (Quảng Trị Province) were described in detail with respect to their morphological characteristics.

3- The Van Kieu and Pa Ko ethnic groups in Dakrong and Huong Hoa districts, Quang Tri province, utilize poisonous plant species for various purposes such as medicine, food, ornamentals, and insect control. Among the 56 poisonous plant species recorded, 28 are used in folk remedies to treat 10 categories of ailments by the Van Kieu and Pa Ko people, including the species *Stemona tuberosa* Lour., *Jatropha curcas* L., *Rauvolfia verticillata* (Lour.)Baill., *Combretum indicum* (L.) DeFilipps, *Datura metel* L., *Acorus gramineus* Aiton, *Melia azedarach* L.,…

4- Excluding *Toxicodendron succedaneum* (L.) Kuntze, 24 poisonous plant species reported by more than 1% of informants were experimentally tested and confirmed to have varying levels of toxicity. Specifically, except for the methanol extract of *Heliotropium indicum* L. (which showed no toxicity against *Artemia salina* larvae), methanol extracts of the remaining 23 species exhibited toxicity ranging from weak to extremely toxic ($LC_{50}$ = 1–425 µg/mL). The methanol extract from the stems and leaves of

*Antheroporum harmandii* Gagnep. showed cytotoxicity against three cancer cell lines (A549, HeLa, and DU145). Furthermore, methanol extracts of all 24 poisonous plants exhibited antimicrobial activity against 1–6 out of 7 tested strains, while 21 species showed antioxidant activity against the DPPH radical ($IC_{50}$ = 5.70–195 µg/mL).

5- Seven glycoside compounds were isolated and structurally identified from *Strychnos vanprukii* Craib: (1) Strychnovanoside A, (2) Strychnovanoside B, (3) Strychnovanoside C, (4) (+)-lyoniresinol 3α-O-β-D-glucopyranoside, (5) (–)-lyoniresinol 3α-O-β-D-glucopyranoside, (6) Palicoside, and (7) Rutin. Among these, three new compounds (1–3) were identified, and two compounds (5, 7) were reported for the first time in S. vanprukii. These compounds demonstrated strong anti-inflammatory activities, with compounds (1)–(5) also exhibiting high antioxidant activity.

**RECOMMENDATIONS**

-Further phytochemical and bioactivity studies should be carried out on poisonous plant species with potential medicinal value, especially those applicable in the treatment of serious or life-threatening diseases.

-Among the poisonous plant species found in the ethnic minority areas of Quảng Trị Province, four species are highly valuable but are currently subjected to intense harvesting pressure, population decline and extinction risk in the wild, such as *Erythrophleum fordii* Oliv., *Camphora parthenoxylon* (Jack) Nees, *Rauvolfia verticillata* (Lour.) Baill., and *Kibatalia laurifolia* (Ridl.)Woodson. For these species, urgent conservation measures should be implemented, including in-situ protection, propagation, cultivation, and ex-situ conservation in gene banks.

**LIST OF THE PUBLICATIONS RELATED TO THE DISSERTATION**

1. **Nguyen Chi Mai**, Tran My Linh, Vu Huong Giang, Bui Van Thanh, Nguyen Thi Van Anh, Ninh Khac Ban, 2023, Indigenous knowledge of poisonous plants from Van Kieu and Pa Ko ethnic groups in Quang Tri province, Vietnam. *Academia Journal of Biology*, 45(2), pp. 89-103.
2. **Nguyen Chi Mai**, Ninh Khac Ban, Vu Huong Giang, Hoang Xuan Diep, Pham Thi Hoe, Nguyen Tuong Van, Tran My Linh, 2023, Antimicrobial and antioxidant activities of *Antheroporum harmandii* Gagnep. collected from Quang Tri province, *Academia Journal of Biology*, 45(2), pp. 61–69.
3. **Nguyen Chi Mai**, Nguyen Tuong Van, Pham Thi Hoe, Vu Huong Giang, Ninh Khac Ban, Tran My Linh, 2024, Optimization of brine shrimp lethality test for in vivo toxicity evaluation of poisonous plant species collected from Quang Tri province, *Academia Journal of Biology*, 46(1), pp. 55–67.
4. **Nguyen Chi Mai,** Ninh Khac Ban, Truong Quang Trung, Dinh Thien Hoang, Bui Van Thanh, Do Thi Trang, Bui Huu Tai, Phan Van Kiem, 2022, Strychnovanosides A - C, Three new lignan glycosides from *Strychnos vanprukii*, *Natural Product Communications*, 17(4), pp. 1-6. DOI:10.1177/1934578X221096173.