

# Ethnobotanical study of Acanthaceae family in Kantarawichai District, Maha Sarakham Province, Thailand

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**Abstract.** Saensouk P, Ragsasilp A, Thawara N, Boonma T, Appamaraka S, Sengthong A, Daovisan H, Setyawan AD, Saensouk S. 2024. *Ethnobotanical study of Acanthaceae family in Kantarawichai District, Maha Sarakham Province, Thailand. Biodiversitas* 25: 2570-2582. Traditional botanical knowledge plays a crucial role in the cultural and medicinal practices of indigenous communities, yet it is increasingly at risk of being lost. This study aims to document and analyze the use of Acanthaceae species by villagers in two villages in Kantarawichai District, Maha Sarakham Province, Thailand to preserve this knowledge and support sustainable resource management. Data on traditional botanical knowledge of Acanthaceae from villagers were collected using semi-structured interviews. The data were then analyzed by using Use Value (UV), Cultural Importance Index (CI), and Informant Agreement Ratio (IAR). The study found nine species with two variations belonging to seven genera in the Acanthaceae family that are used by villagers, namely *Andrographis paniculata* (Burm.f.) Wall. ex Nees, *Asystasia gangetica* (L.) T. Anderson, *Barleria prionitis* L., *Justicia adhatoda* L., *J. gendarussa* Burm.f. (Kra Duk Kai Khaw), *J. gendarussa* Burm.f. (Kra Duk Kai Dum), *Rhinacanthus nasutus* (L.) Kurz, *Ruellia tuberosa* L., and *Ru. simplex* C.Wright. They can be classified into four groups based on their uses: foods, medicine, religious plant and other uses. Species with the highest Use Value (UV) and Informant Consensus Factor (ICF) was *Rh. nasutus* (L.) Kurz which is used in many respects. The highest IAR value of 0.79 was *Thunbergia laurifolia* Lindl. followed by *An. paniculata* (Burm.f.) Wall. ex Nees (0.70) and *Rh. nasutus* (L.) Kurz (0.33), indicating the agreement among informants mentioned the plant species for particular disease. This study emphasizes the importance of transmission of traditional knowledge to prevent it from disappearing in the future and to inform natural resource management of local people for conservation and sustainable development.

**Keywords:** Acanthaceae, diversity, ethnobotany, Kantarawichai, Maha Sarakham, Thailand

## INTRODUCTION

Thailand, located in Southeast Asia, is a country positioned in the tropical zone and being divided into various distinct areas of biogeography (Junsongduang et al. 2021). The diverse ecosystems in Thailand support a wide range of natural resources, including a great diversity of flora and fauna, which have a crucial role in maintaining life of the people (Phumthum et al. 2020; Junsongduang et al. 2021; Saisor et al. 2021; Phatlamphu et al. 2021; Ragsasilp et al. 2022). Human have relied on natural resources to meet their needs of food, medicine, clothing, and housing. Various plant species are utilized to make food, flavoring, and beverages, as well as to produce clothing as in the case of cotton. Housing construction uses locally available resources like timber producing trees (Maknoi et al. 2016; Phumthum et al. 2020; Saisor et al.

2021; Ragsasilp et al. 2022; Sudchaleaw et al. 2023). Furthermore, medicinal plants are used for therapeutic reasons. These medicinal plants are frequently combined with other chemicals in accordance with specific medicine formulations to address medical conditions, supplement food, or possibly act as poisonous compounds (Pholhiamhan et al. 2018).

The use of natural resources provided by ecosystems differs geographically since it is influenced by several factors including lifestyle, cultural traditions, ancestral wisdom, transmitted perspectives and resources abundance (Pholhiamhan et al. 2018; Numpulsuksant et al. 2021; Phatlamphu et al. 2021, 2023). The collection of information regarding the uses of plants due to their beneficial properties comes from hands-on knowledge. The accumulated knowledge and experience are inherited from the older generations into the younger ones, resulting in the

development of particular traditions in each ethnic group. Currently, the utilization of plants particularly for medical purposes is still being practiced by several communities in Thailand (Pholhiamhan et al. 2018; Phumthum et al. 2020; Saisor et al. 2021; Sudchaleaw et al. 2023).

The investigation of biodiversity in Thailand highlights the importance of ethnobotanical attributes possessed by indigenous community. For bioprospection purposes, there is a greater emphasis on researching the utilization of indigenous plants acquired from their habitats in nature (Supiandi et al. 2019; Mutaqin et al. 2020; Rahman and Asha 2021; Fadhilah et al. 2023) using ethnobotany study. Ethnobotany was initially introduced by John W. Harshberger in 1895 (Phumthum et al. 2020; Junsongduang et al. 2021; Saisor et al. 2021; Ragsasilp et al. 2022; Phatlamphu et al. 2021). It is a multidisciplinary field that focuses on investigating the interactions between human and plants. It specifically examines the cultural value and utilization of plants, with a special emphasis on native plant species in the area being studied (Phumthum et al. 2020; Junsongduang et al. 2021; Numpulsuksant et al. 2021; Phatlamphu et al. 2021; Saisor et al. 2021). The plants utilized consist of both local cultivars and uncultivated (wild) species (Saensouk and Saensouk 2021).

Acanthaceae is the family of the angiosperms that have two seed leaves and produce flowers. It consists of approximately 210 genera and around 4000 species. In Thailand, there are 40 genera and 250 species of Acanthaceae family described so far (POWO 2023). The majority of these plants are tropical herbs, shrubs, or twining vines, although a few of them are epiphytes, while temperate zones host a limited number of species. The primary distribution of this family includes Indonesia, Malaysia, Africa, Brazil, and Central America. The members of the family can be found in various habitats, including dense or open forests, scrublands, wet fields and valleys, seashores and marine areas, wetlands, and

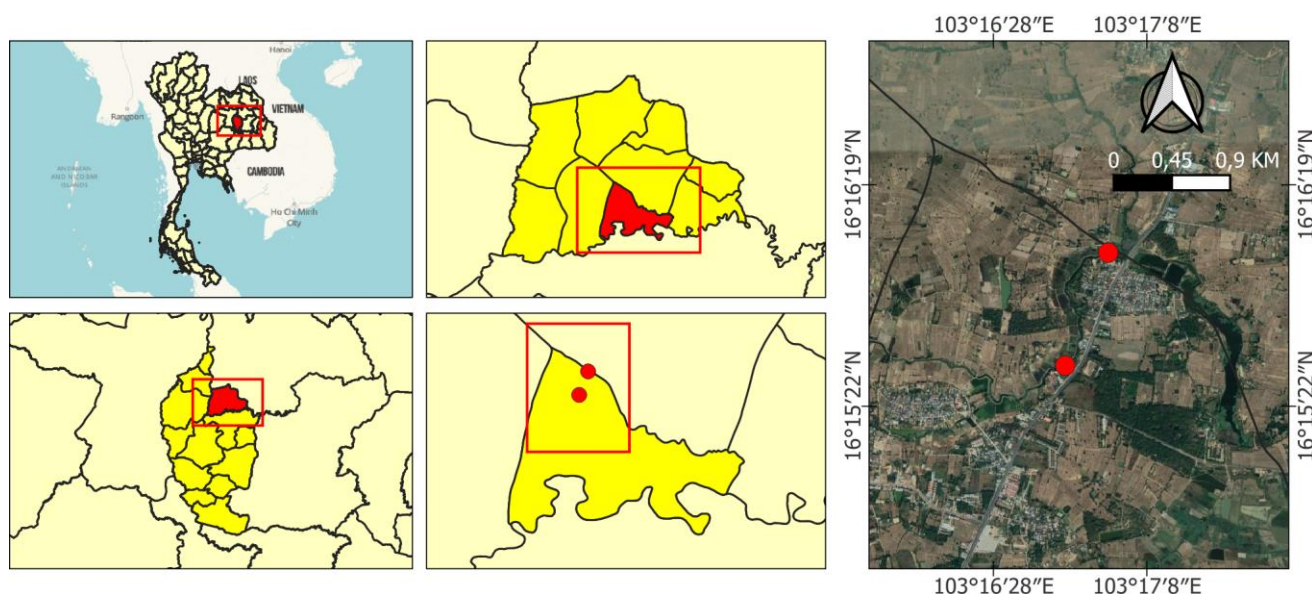
mangrove forests (POWO 2023). The plant in this family has various uses, such as being utilized as a food source, medicinal plants, ornamental plants, ritual plants, commercial crops and dye. Furthermore, some species of Acanthaceae family exhibit therapeutic properties to mitigate beriberi, paralysis, discomfort, toothache, asthma, and cough; as an expectorant and a tonic for longevity; treat abscesses, promotes blood circulation, and stimulates lymphatic fluid flow; alleviate flatulence, and treat bug bites and stings.

Kantarawichai is a district located in the northern region of Maha Sarakham Province in northeastern Thailand. The local community in this area has a long history of utilizing plants, both local cultivars and uncultivated wild and common native species. This study aimed to document the diversity and ethnobotany of Acanthaceae family utilized by local people in Ban Don Wiang Chan and Ban Hua Khua, Kantarawichai District. The results of this research will serve as an important archive of indigenous people in managing natural resources, especially plants, for the purposes of conservation and sustainable development.

## MATERIALS AND METHODS

### Study area

Two villages in Tha Khon Yang Subdistrict, Kantarawichai District, Maha Sarakham Province, Thailand were selected for the study: Ban Don Wiang Chan and Ban Hua Khua (16.19°29'N-103.17°54'E) (Figure 1). The province consists predominantly of flat terrain adorned with rice fields and is situated at an elevation ranging from 130 to 230 meters above sea level. The Chi River, which is the longest river in Thailand (Numpulsuksant et al. 2021; Saisor et al. 2021), along with its branches, runs through our study area.



**Figure 1.** Map of the study area in two villages: Ban Don Wiang Chan and Ban Hua Khua in Tha Khon Yang Subdistrict, Kantarawichai District, Maha Sarakham Province, Thailand

Ban Hua Khua and Ban Don Wiang Chan are old village that established since 1867 and 1863 respectively. They have a long historical background more than 100 years. The lifestyle of villagers remains unchanged in which they live in a simple life. Main occupation is farmer. Recently, climate change has had direct effects on these villages, particularly impacting agriculture, horticulture, and local farms. Unpredictable weather patterns, such as irregular rainfall and prolonged droughts, have disrupted traditional farming schedules, leading to reduced crop yields and affecting the availability of essential resources. These changes have also stressed horticultural practices, with some plant species struggling to adapt to altered growing conditions. The overall resilience of farming systems in these villages is being challenged, threatening both food security and livelihoods.

### Study on diversity and distribution of Acanthaceae

#### *Botanical collection and identification*

Botanical exploration was conducted and plant samples were obtained from the two villages. During January to December 2021, 3-4 plant samples were collected per month for the survey. Forests, residential areas, and other village areas were surveyed. During the survey, we validated botanical data like scientific names, native names, sources, and plant benefits and risks. Plant specimens were gathered, dried, identified, and vouchered at Mahasarakham University Herbarium, Maha Sarakham Province, Thailand. Plant identification relied on taxonomic literature, particularly The Flora of Thailand. The plant specimens have been kept in a fabric case for experts' analysis or study using identifying plant keys, books for reference, and botany databases (Rahman et al. 2014; Smitinand 2014; Thongpukdee et al. 2014; Van Welzen et al. 2014; Bongcheewin et al. 2015; Esser and Saw 2015; Paton et al. 2016; Saensouk et al. 2016; Ye and Xia 2016; Bongcheewin et al. 2017; Leeratiwong et al. 2017; Chen et al. 2018; Rather et al. 2018; Souvannakhoummane et al. 2018; Boonma and Saensouk 2019; Choopan et al. 2019; Ezedin and Weiblen 2019; Boonma et al. 2020a, b; Chen et al. 2020; Rokade et al. 2020; Esser 2021; Johnson et al. 2021; Lim et al. 2021; Kumar et al. 2021; Priscila et al. 2021; Saensouk and Saensouk 2021a, b; Saensouk et al. 2021a, b, c, d; Sattaphorn et al. 2021; Bongcheewin et al. 2022; Chantaranonthai et al. 2022; Ngernsaengsaruy et al. 2022; Ragsasilp et al. 2022; Rakarcha et al. 2022; Saensouk et al. 2022a, b; Tagane et al. 2022; Tarmizi et al. 2022; Zhang et al. 2022; Boonma et al. 2023; Inta et al. 2023; POWO 2023; Saensouk and Saensouk 2023).

#### *Distribution of Acanthaceae*

The data gathering process systematically recorded the species, categorizing them based on their location within each district, specifically differentiating between wild plants, cultivated plants, and those that were present in both locations. When assessing the geographical distribution of plant species whether they are endemic, native, or introduced, it is essential to depend on reliable sources. This includes consulting the website [powo.science.kew.org](http://powo.science.kew.org)

and referring to research publications, both in print and online, as well as relevant books. Additionally, it is crucial to utilize references that provide citations for plant specimens preserved in herbaria situated in foreign countries.

#### *Ecology of Acanthaceae*

Ecological data were also documented during the survey of the biodiversity and traditional usage of Acanthaceae in Ban Don Wiang Chan and Ban Hua Khua Villages. Plants that are purposely produced within the home or in gardens for different uses are categorized as "Cultivated".

#### *Conservation status of Acanthaceae*

The conservation status assessment is divided into two components: the initial component only evaluates the state of untamed species discovered in Ban Don Wiang Chan and Ban Hua Khua villages based on the IUCN Red List criteria. The latter part of the discussion will focus on the conservation status of plants, taking into account the conservation status provided on the website "<https://www.iucnredlist.org/>" and the conservation status mentioned in pertinent papers, which are assessed using the IUCN Red List criteria.

#### *Ethnobotanical study of Acanthaceae*

The ethnobotanical data was gathered through semi-structured interviews. Interviews were conducted with three key informants and seventeen local respondents. Names, used parts, preparation, and properties were noted and categorized according to Cook (1995). The specimens were identified using various documents, including Bongcheewin et al. (2017), Leeratiwong et al. (2017), Saensouk and Saensouk (2021a, b, 2023), Boonma et al. (2020a, b, 2021, 2023), Chantaranonthai et al. (2022), Ngernsaengsaruy et al. (2022), Ragsasilp et al. (2022), and Rakarcha et al. (2022), which are all part of the Thai flora literature.

#### *Data analysis of ethnobotanical data*

The flora data was categorized based on family group, scientific name, native name, and use in twelve distinct groups: foods and spice, drinks, herbs for medicinal purposes, toxic plants, dye plants, cosmetics and perfumery, apparel, construction materials, beliefs and rituals, fuel, ornamental plants, and industrial crops. The classification also encompassed the plant components that were utilized. The studies conducted by Pholhiamhan et al. (2018), Junsongduang et al. (2021), Numpulsuksant et al. (2021), Phatlamphu et al. (2021), and Saisor et al. (2021) involved quantitative analysis.

The quantitative data was tabulated and analyzed using Microsoft Excel 2013. The analysis involved the application of various indices, including the ethnobotanical index for calculating the Use Value (UV) (Phillips et al. 1994), the Cultural Importance Index (CI) (Sutjaritjai et al. 2019), the Informant Agreement Ratio (IAR) (Trotter and Logan 1986; Heinrich et al. 1998), and the Fidelity Level (%FL) (Friedman et al. 1986).

### Use Value (UV)

This indicator is utilized to ascertain the relative significance of the utilization of plant species "s". The index is formally defined according to Phillips et al. (1994) and calculated as follow:

$$UV = \frac{\sum UI}{N}$$

UI represents the frequency of mentions by each informant for a specific species, whereas N represents the total number of informants. A high UV score signifies the cultural significance of plant species, whilst a low score reflects a lower number of use reports mentioned by the informants.

### Cultural Importance Index (CI)

This index was utilized to assess the importance of each species. The CI is determined by summing the percentage of informants who mention the utilization of each species. The index was calculated following Tardio and Pardode-Santayana (2008):

$$CI = \sum_{(u=1)}^{NC} \sum_{(i=1)}^N \frac{NUR_{Ui}}{N}$$

The cultural significance index of the plant is denoted as CI, the utilization report in a specific utilization group is denoted as UR, the number of plant groups divided by utilization is denoted as I, the total number of usage is denoted as NC, and the number of informants is denoted as N.

### Informant Agreement Ratio (IAR)

The index is a measure used in ethnobotanical research to assess the consistency of informants' knowledge regarding the medicinal use of plants. It quantifies the degree of agreement among informants about the use of a particular species to treat specific ailments (Trotter and Logan 1986). The IAR is calculated using the formula:

$$IAR = (N_r - N_t) / (N_r - 1)$$

The variable  $N_r$  represents the total number of citations that have been recorded for each unique taxon, while  $N_t$  represents the number of sickness categories that are treated with this particular species. The IAR provides a numerical score that falls within the range of 0 to 1. The IAR value of zero signifies that the number of illness categories is equal to the number of citations. Conversely, a value of one indicates that all participants recognized the plant species for a specific ailment (Thomas et al. 2009)

## RESULTS AND DISCUSSION

### Diversity of Acanthaceae in the studied area

Nine species with two variations belonging to seven genera from Acanthaceae used by the villagers from Ban Don Wiang Chan and Ban Hua Khua in Tha Khon Yang Subdistrict, Kantarawichai, Maha Sarakham Province,

northeastern Thailand, have been recorded. These are *Andrographis paniculata* (Burm.f.) Wall. ex Nees, *Asystasia gangetica* (L.) T. Anderson, *Barleria prionitis* L., *Justicia adhatoda* L., *J. gendarussa* Burm.f. (Kra Duk Kai Khaw), *J. gendarussa* Burm.f. (Kra Duk Kai Dum), *Rhinacanthus nasutus* (L.) Kurz, *Ruellia tuberosa* L., *Ru. simplex* C.Wright, and *Thunbergia laurifolia* Lindl (Figure 2).

### Morphological characters, distribution, and conservation status

*Andrographis paniculata* (Burm.f.) Wall. ex Nees

The herbs are annual and grow up to 60 cm tall. They have a significant amount of branching. The stems have four angles and are smooth. The length of the petiole is between 0.5 and 0.9 centimeters. The leaf blade is ovate in shape, measuring 1.6-7.2 cm in length and 1.2-2.6 cm in width. It is smooth and hairless on both surfaces, with the upper surface being green and the lower surface pale green. The leaf base tapers, and the edge is smooth and without any abnormalities. The apex is acute to shortly acuminate. The inflorescences are in the form of racemes, located at the terminal end. The rachis is smooth to somewhat hairy. The bracts are triangular to needle-shaped, measuring 1.2-1.4 mm. The bracteoles are linear to needle-shaped, measuring 1.1-1.5 mm. The pedicel measures 2.2-8 mm and is covered with a sparse number of hair-like structures that have glands at their tips (gland-tipped pubescent) as well as non-glandular trichomes. The calyx is 2.6-3.1 mm and is either smooth or covered with gland-tipped hairs on the outside. The lobes of the calyx are slender and tapering. The corolla is white and is 1-1.4 cm. It is covered in gland-tipped hairs on the outside. The tube of the corolla is funnel-shaped at the base and measures 4.2-8.2 mm. The lower lip of the corolla has purple spots and measures 5.2-7.2 mm. It is upright and has lobes that are 3-4 mm long. The upper lip of the corolla measures 5.5-7.5 mm. It is reflexed and has two lobes that are 1-2 mm long. The stamens extend outwards from the corolla tube. The style measures 6.5-10.5 mm in length and is covered with scant hairs towards the base. The capsule is ellipsoid-compressed, measuring 1.6-2.2×0.4-0.45 cm. It is smooth or has few hairs with gland-tipped trichomes. The capsule contains approximately 12 seeds. The seeds are 2-3×1.5-2 mm and have a rough texture.

**Phenology:** The flowering period spans from September to December.

**Vernacular name:** The local name for the people in the research area is "Fa Thalai Chon".

**Distribution:** This species is found in tropical Asian nations. It is present in diverse environments, including plains, hillsides, beaches, as well as broken and cultivated regions like roadways and fields. The plant is a non-native species in Thailand. The plant is extensively grown in many regions of Thailand for its therapeutic properties.

**Ecology:** The village exclusively cultivates this species.

**Conservation status:** The IUCN classifies the plant as Least Concern (LC). According to POWO 2024, this is the first documented occurrence in Thailand.



*Asystasia gangetica* (L.) T. Anderson

The height of the herbs is 0.7 m, and they grow in an upward manner. The stems have four angles and are covered in fine hairs. The petiole measures 3.2-5.2 mm and is covered in fine hairs. The leaf blade is ovate to elliptic in shape, measuring 3.2-12.3 cm in length and 1.2-5.2 cm in width. It is smooth and hairless, with a truncated to rounded base, slightly wavy edges, and a pointed apex. The inflorescence racemes are located either in the axils or at the tips of the plant, and they can grow up to 15 cm in length. The bracts are triangular in shape, measuring 5-6 mm, and covered in fine hairs. The bracteoles are linear-lanceolate, measuring 1.2-2.5 mm, and also covered in fine hairs. The pedicel is 2.1-3.2 mm and is covered in fine hairs. The calyx measures 6.5-7 mm and has linear-lanceolate lobes that are 5.2-7.2 mm long and 1.2-1.3 mm wide. The outer surface of the lobes is covered in glandular hairs, and the edges are fringed with small hairs. The corolla is either yellowish or white in color, measuring 1.3-3.6 cm. The outside surface is covered in gland-tipped hairs, while the inner surface is smooth. The tube of the corolla is cylindrical at the base, measuring 3-4 mm wide for a length of 8.1-9 mm, and then gradually widens to 1-1.2 cm. The lobes of the corolla are obovate to semicircular in shape, measuring 0.8-1.4 cm in length and 0.9-1.2 cm in width. The middle lobe of the lower lip is marked with violet or maroon coloring. The stamens are present, and the filaments are smooth. The longer pair of filaments measures 5-6 mm, while the shorter pair measures 3-4 mm. The anther thecae are 3-4×1-2 mm in size. The ovary is shaped like an ellipsoid and is 3.5-4 mm. The style is 1.8-2 cm long and covered in soft hairs. The stigma is slightly rounded and has two lobes. The capsule measures 1.3-1.5×2-2.5 cm is covered in fine hairs, and is initially green but changes to brown when opened. The seeds have an irregularly obovate shape, with an outline of 3.2-5.2×0.6-3.2 mm. They are yellow-brown in color and have a tuberculate-rugose texture.

**Phenology:** The flowering period spans from January to December, including the entire year.

**Vernacular name:** The indigenous inhabitants of the research region are commonly referred to as "Om Sap".

**Distribution:** This species has widespread distribution in the tropical regions of the Old World and has been brought to the tropical Americas and Hawaii, where it has successfully established itself. The plant is a non-native species in Thailand.

**Ecology:** The community exclusively cultivates this specific species.

**Conservation status:** This species is widespread and not restricted to a particular region.

*Barleria prionitis* L.

The shrubs are 1.5-2 m tall and have spines in the lower leaf axils. They are also branching. The stems and branches are cylindrical, smooth, covered with small lens-shaped pores, and free of hair. The petiole measures 1.2-2.4 cm in length. The leaf blade is elliptic to ovate, with dimensions of 4.2-10.7×2-5.7 cm. It is covered with fine hairs on both surfaces. The base of the leaf tapers, and the edge is

smooth, and the apex is pointed. The flowers are grouped together in the axils. The bracts are oblong in shape, measuring 1.3-2.4 cm in length and 0.3-0.9 cm in width. The margins of the bracts have little hairs, and the tips are sharply pointed. The bracteoles are long and lanceolate, measuring 1.4-1.5 cm in length and 0.2-0.3 cm in width. They have a spine-like tip. The outer calyx lobes are ovate-oblong, measuring 1.5-1.6 cm in length and 0.4-0.5 cm in width, with a pointed tip. The inner calyx lobes are linear-lanceolate, measuring 1.3-1.4 cm in length and 0.2-0.3 cm in width, also with a pointed tip. The corolla of the flower is yellow to pale orange in color and is 2.5-4.2 cm. It is covered in fine hairs. The tube of the corolla has a short basal section. The lobes of the corolla are rectangular in shape and measure 8.1-10.2 mm in length and 6.3-7.2 mm in width. The lobes are curled backwards. The flower has four stamens, with the longer pair measuring 1-1.2 cm and having anthers that are 3.2-3.3 mm in size. The lesser pair of stamens measures 1.5-1.6 mm and has anthers that are 1-2 mm in size. The ovary is shaped like an oval; the stigma is slightly larger, divided into two parts, and protruding. The capsule is ovoid in shape, measuring 1.8-1.9 cm. It tapers slightly at the tip, resembling a beak, and contains two seeds. The seeds have an oval shape with an outline of 7-8×5-6 mm.

This species is typically differentiated from other *Barleria* by the presence of spines on the top of its calyx lobes and a yellowish to orange colored flower.

**Phenology:** The flowering season extends from October to December, whereas fruiting takes place from December to February.

**Vernacular name:** The native people of the study area are widely known as "Angkab Nu".

**Distribution:** The predominant species is indigenous to regions of Island and Mainland Southeast Asia, China, Indonesia, Philippines, Peninsular Malaysia, Vietnam, Thailand, Laos, Myanmar, and the Indian subcontinent. The plant is a native species in Thailand.

**Ecology:** It is found in a deciduous dipterocarp forest near the village.

**Conservation status:** This species is widespread and not restricted to a certain region.

*Justicia adhatoda* L.

The height of the shrubs is between 2 and 2.5 m. The branches become thicker and have four angles. They have small lens-shaped markings and are covered in fine hairs when young, but these hairs quickly disappear. The petiole measures 1.5-2.5 cm and has fine hairs. The leaf blade is ovate to elliptic-ovate, measuring 7.5-18.5×2.5-7.5 cm. The underside of the leaf is covered in fine hairs, while the upper side is densely covered in hair when young but becomes mostly hairless except for hair along the veins. There are 9.2-12.5 secondary veins on each side of the midvein, which meet near the margin. The base of the leaf is broadly wedge-shaped, the margin is smooth, and the apex is pointed and sometimes slightly curved. The spikes are terminal or axillary, and they have an ovoid to broadly ovoid shape, measuring 3.2-7.2 cm. The peduncle is also 3.2-7.2 cm long. The bracts are arranged in an overlapping

pattern and have an ovate-oblong shape, measuring 1.2-2.2×0.6-1.6 cm. They are covered in fine hairs and have 3-7 veins. The border of the bracts is fringed with small hairs, and the apex is pointed. The bracteoles are linear-lanceolate, measuring 1.2-1.5×0.4-0.5 cm. They are also covered in fine hairs and have 3-5 veins. The margin of the bracteoles is fringed with small hairs, and the apex is pointed. The calyx is divided into five lobes, which are long and narrow, measuring 10-12×3-4 mm. The edges of the lobes are thinly membranous and have little hairs. The Corolla is either white or pink in color, with purplish or pinkish stripes on the outside. It has a broad tubular shape, measuring 2.7-3 cm in length. The exterior of the corolla is covered in fine hairs. The base of the tube is cylindrical and measures 4-5 mm in width for 4-5 mm, before slightly expanding and curving upwards. The upper lip of the corolla is ovate-oblong in shape, measuring 1.8-2 cm in length. It stands upright and is shallowly divided into two lobes. The lower lip is oblong-circular in shape and spreads outwards. It has three lobes, with the middle lobe being subcircular and measuring 9-10×5-6 mm, and the lateral lobes being ovate and measuring 7-8×4.5-5 mm. The stamens are protruding; the filaments measure 1.5-1.6 cm and are inclined, smooth except for a silky base; the anther thecae are ellipsoid, measuring 3.5-4 mm, equal in size, stacked on top of each other, with the lower one having a spur at the base. The ovary is covered in fine hairs, particularly at the tip. The style is 2.5-2.7 cm and has a curved shape, with the lower section also covered in hairs. The stigma is uncomplicated in structure. The capsule is obovoid in shape, measuring 2.6-4.2 cm in length and 0.5-0.7 cm in width. The seeds have a round shape.

The stem displays many elongated branches that develop vertically and are positioned immediately opposite each other. The branches' bark exhibits a yellowish tint.

**Phenology:** The flowering season extends from October to December, whereas fruiting takes place from December to February.

**Vernacular name:** The native those who lived of the study area are usually known as "Sa Niat".

**Distribution:** The plant is indigenous to Afghanistan, the Indian subcontinent, Laos, Myanmar, and Vietnam. It has been introduced in another location. The plant is a non-native species in Thailand.

**Ecology:** The community mainly cultivates this particular species.

**Conservation status:** The plant is classified by the IUCN as Least Concern (LC). According to POWO 2024, this is the first documented occurrence in Thailand.

#### *Justicia gendarussa* Burm.f. "Kra Duk Kai Khaw"

The subshrubs are 0.7-1.5 m in height and have a highly branching structure. The stems are cylindrical, enlarged at the joints, green in color, and smooth. The petiole measures 3-10 mm in length. The leaf blade is narrowly lanceolate, measuring 6-10×1-1.5 cm. It is smooth and lacks hair. There are 5-8 secondary veins on each side of the midvein. The base of the leaf tapers to a wedge shape or narrows gradually. The margin of the leaf is slightly sinuous, and the apex is pointed or slightly

tapered. The spikes of this plant are terminal or axillary, measuring 3-12 cm in length. They are interrupted and typically arranged in a leafy panicle. The peduncle, or stalk of the spike, is 0.5-1.5 cm long. The bracts, which are triangular in shape, measure 2-6×1-2.5 mm. The basal bracts are longer than the calyx and gradually become smaller towards the apex, with the topmost bracts being shorter than the calyx. The margin of the bracts is ciliate, meaning it has small hairs along the edge, and the apex is acute, or pointed. The bracteoles, which are elliptic to linear-lanceolate in shape, measure approximately 3×1 mm. Like the bracts, the margin of the bracteoles is ciliate, and the apex is acute. The calyx is around 5 mm in size and has 5 lobes. The lobes are linear-lanceolate, measuring about 3-4 mm in length and approximately 0.5 mm in width. They are almost equal in size and have an acuminate apex. The Corolla is creamy white in color, measuring 1.2-1.5 cm. The tube of the corolla is cylindrical at the base, measuring 2-2.2 mm wide and 8-9 mm long. The lower lip of the corolla is violet with basal dots, and it is cuneate-obovate in shape, measuring 6-10 mm wide. The lower lip has 3 lobes that are oblanceolate in shape, measuring 3-5×3.4-3.5 mm. The upper lip of the corolla is violet with blotches, and it is triangular in shape, measuring 6.8-7×3.4-3.5 mm. The top lip is 2-cleft. The stamens are protruding; the filaments measure 3-6 mm and are smooth; the anther thecae are rectangular, measuring 1.2-1.3 mm, with one positioned above the other, and the lower one has a spur at the base while the upper one is without a spur. The ovary is smooth; the style is approximately 1 cm long and smooth; the stigma is rounded and has two small lobes. The capsule is club-shaped, measuring 1.2-1.3 cm in size.

**Phenology:** The flowering season extends from October to December, whereas fruiting takes place from December to February.

**Vernacular name:** The native those who lived of the study area are usually known as "Kra Duk Kai Khaw".

**Distribution:** The species is indigenous to India, Bangladesh, Sri Lanka, Bhutan, Indochina, Peninsular Malaysia, Sumatra, the Philippines, and New Guinea. The plant in consideration is a rapidly growing, perennial shrub that retains its leaves throughout the year. It is believed to originate from China and may be found in Sri Lanka, India, and Malaysia. The plant is a non-native species in Thailand.

**Ecology:** The cultivation of this particular plant is mainly carried out by the community.

**Conservation status:** This species shows a wide distribution and is not confined to a specific geographic area.

#### *Justicia gendarussa* Burm.f. "Kra Duk Kai Dum"

The subshrubs have a height ranging from 0.8 to 1.7 m and are characterized by extensive branching. The stems are cylindrical, enlarged at the joints, black, and smooth. The petiole measures 4-11 mm in length. The leaf blade is narrowly lanceolate, with dimensions of 6.5-10.5×1.5-2 cm. It is smooth and without hair. There are 5-8 secondary veins on each side of the midvein. The base of the leaf tapers to a wedge shape or narrows gradually. The margin

of the leaf is slightly curved inward. The apex of the leaf is pointed or slightly tapered. The spikes are found in the terminal or axillary position, measuring between 3.2 and 12.2 cm. They are interrupted and typically arranged in a leafy panicle. The peduncle is 0.6-1.6 cm long. The bracts are triangular in shape, measuring 2.2-6.2×1.5-2.5 mm. The basal bracts are longer than the calyx and gradually decrease in size towards the top, with the uppermost bracts being shorter than the calyx. The bract margin is ciliate and the apex is acute. The bracteoles are elliptic to linear-lanceolate, measuring 3.2×1.2 mm. The margin of the bracteoles is ciliate and the apex is acute. The calyx measures 5-6 mm and has 5 lobes. The lobes are linear-lanceolate in shape, measuring 3-4 mm in length and 0.5-0.6 mm in width. The lobes are almost equal in size and have an acuminate apex. The Corolla is creamy white in color and is 1.5-1.8 cm. The tube of the corolla is cylindrical at the base and is 2-3 mm wide for a length of 9-10 mm. The lower lip of the corolla is violet with basal dots, and it is cuneate-obovate in shape, measuring 6-7-10-12 mm in width. It has 3 lobes that are oblanceolate in shape and measure 3.5-6×3.8-4 mm. The upper lip of the corolla is violet with blotches and is triangular in shape, measuring 7-8×3.5-4 mm. It is divided into 2 parts. The stamens are protruding, with filaments measuring 4-6.5 mm and lacking hair. The anther thecae are rectangular, measuring 1.2-1.4 mm, arranged one above the other, with the lower one having a spur at the base and the higher one lacking a spur. The ovary is smooth; the style measures 1-1.5 cm and is also smooth; the stigma is rounded with two short lobes. The capsule is shaped like a club, measuring 1.2-1.4 cm in size.

**Phenology:** The flowering season extends from October to December, whereas fruiting takes place from December to February.

**Vernacular name:** The native those who lived of the study area are usually known as “Kra Duk Kai Dum”.

**Distribution:** The species is indigenous to India, Bangladesh, Sri Lanka, Bhutan, Indochina, Peninsular Malaysia, Sumatra, the Philippines, and New Guinea. The plant in consideration is a rapidly growing, perennial shrub that retains its leaves throughout the year. It is believed to originate from China and may be found in Sri Lanka, India, and Malaysia. The plant is a non-native species in Thailand.

**Ecology:** The cultivation of this specific plant is primarily conducted by the community.

**Conservation status:** This species shows a wide distribution and is not confined to a specific geographic area.

#### *Rhinacanthus nasutus* (L.) Kurz

The plants are subshrubs or perennial herbs, reaching a height of 1.5-1.8 m. The stems have four angles and are becoming smooth. The petiole measures 0.6-1.7 cm in length. The leaf blade is elliptic, ovate-elliptic, or occasionally lanceolate, with dimensions of 3-8×0.9-3.2 cm. The upper side of the leaf is covered in fine hairs, as is the lower surface. The base of the leaf is wedge-shaped, the margin is either smooth or slightly wavy, and the tip is sharp. The panicles are located at the end or in the axils, measuring 50-55 cm. The rachis is covered in dense hair.

The bracts are lanceolate, measuring 1.8-2×0.5-0.7 mm. The bracteoles are 1-2 mm. The flowers are either sessile or subsessile. The calyx measures 5-7 mm and is covered with fine hairs on both surfaces. The lobes of the calyx are lanceolate in shape, measuring 4-5 mm in length and 0.7-0.9 mm in width. The Corolla is greenish white and measures 2.2-2.9 cm. It is covered on the outer with fine hairs that have gland-tipped and non-glandular trichomes. The tube of the corolla measures 1.6-1.9 cm. The lower lip is 0.78-1.25 cm long, with lobes that are 2.2-4.5 mm in size and roughly equal in length. The upper lip is linear-lanceolate, measuring 6.5-7.8 mm, and stands upright. The staminal filaments are smooth and hairless. The style has little hairs. The capsule is 2-2.5×0.3-0.4 cm and is covered in fine hairs with gland-tipped structures. The seeds have a size range of 2.5-2.8 mm in length and 2.2-2.3 mm in width, and they have a rough surface texture.

**Phenology:** The flowering season extends from October to December, whereas fruiting takes place from December to February.

**Vernacular name:** The native those who lived of the study area are usually known as “Thong Phan Chang”.

**Distribution:** This species is naturally found throughout Tropical Asia. The plant is a shrub that predominantly thrives in the seasonally arid tropical habitat. The plant is a non-native species in Thailand.

**Ecology:** The cultivation of this specific plant is primarily conducted by the community.

**Conservation status:** This species has a broad distribution and is not limited to a particular geographical region.

#### *Ruellia tuberosa* L.

The herbs are perennial and upright, reaching a height of 40 cm. Roots with elongated tuberous enlargements. The stems are enlarged above the nodes and have a four-sided shape. The petiole measures up to 8 mm and is smooth. The leaf blade is oblong-obovate, measuring 4.5-8.5×1.8-4.5 cm. Both surfaces of the leaf are smooth, with a cuneate base, undulate border, and sharp apex. The flowers are arranged in clusters that grow from the leaf axils. The clusters are called inflorescences and are in the form of cymes. The stalk of the inflorescence measures 2.4-2.5 cm. The bracts, which are leaf-like structures, are oblong-lanceolate in shape and measure 3.5-9.5×1.5-3.5 mm. The bracteoles, which are smaller bracts, are linear-oblong in shape and measure 1.4-1.6 mm. The pedicel is 7-12 mm and is covered in tiny hairs. The calyx tube measures 5-6 mm and is covered with fine hair on the outside. The lobes are long and narrow, measuring 1-2.2 cm. The Corolla is a pale blue color and measures 2.3-5.7 cm. It has a hairy exterior. The lobes are nearly round and are 1.7-1.8 cm in length and 1.6-1.7 cm in width. The stamens consist of a taller pair measuring 7-8 mm and a shorter pair measuring 4-5 mm. The filaments are smooth, and the anther thecae are white and covered in hair. The ovary is smooth; the style measures 2.1-2.3 cm and has few hairs; the stigma has two lobes. The capsule is not stalked and has a long, narrow shape resembling an ellipse. It is 1.9-2.7 cm in length and 0.5-0.6 cm in width. The surface of the capsule

is smooth and hairless. It contains 20-26 seeds and has septa with retinacula connected to the inner wall even when mature. The seeds are disc-shaped, measuring 3-3.2×4-4.2 mm, and are coated with closely pressed hygroscopic trichomes.

Phenology: The flowering season extends from June to August, whereas fruiting takes place from July to October.

Vernacular name: The native people of the research region are commonly referred to as "Toi Ting".

Distribution: *R. tuberosa* L. is commonly found in environments with abundant moisture and shade. The plant predominantly flourishes in grasslands and roadsides, commonly as an undesirable species in cultivated areas, as well as in arid and disrupted environments. The plant is native to Central America, but it has successfully naturalized itself in several regions of Africa, particularly in Tanzania, as well as in South and Southeast Asia. The plant is a non-native species in Thailand.

Ecology: It is a common weed in various parts of the village.

Conservation status: This species demonstrates a broad distribution and is not confined to any particular geographical region.

#### *Ruellia simplex* C.Wright

The genus is named in honor of the French botanist Jean Ruel, while the specific name pertains to the presence of simple, rather than complex, leaves. *R. simplex* is the scientific name for a certain plant species. The species in question has been known by multiple names, including *Ruellia angustifolia* (Nees) Lindau, *Ruellia brittoniana* Leonard, and *Cryphiacanthus angustifolius* Nees. However, the oldest and most widely acknowledged name for this species is *R. simplex* C.Wright.

This plant is a perennial herb that reaches a height of 0.9-1 m. The stems are either green or purple. The leaves are dark green, arranged in an opposing pattern, and have a lance-shaped structure. They measure between 16-32 cm in length and 1.2-2.2 cm in width. The veins on the underside of the leaves are clearly visible, while the edges of the leaves are either smooth or slightly undulating. The flowers are pedunculate, trumpet-shaped, and have a diameter ranging from 4.2 to 8.2 cm. They are found singly or in clusters at the ends of the stems. The flowers are typically purple, however white and pink variations also occur. The fecund varieties possess elongated capsules that house a varying quantity of 6 to 30 seeds. Capsules demonstrate explosive dehiscence, enabling seeds to scatter over significant distances.

Phenology: The flowering season extends from June to August, whereas fruiting takes place from July to October.

Vernacular name: The indigenous residents of the research site are widely known as "Toi Ting Fa lung".

Distribution: *R. simplex* is indigenous to Mexico, the West Indies, western Bolivia, southwestern Brazil, Paraguay, Uruguay, and northern Argentina. The plant has been extensively utilized for decorative purposes and has spread beyond intentional cultivation in the United States, Australia, portions of Asia, and various Pacific Islands. It is a highly prevalent plant in the landscape of Dubai. The

plant is a non-native species in Thailand.

Ecology: The cultivation of this specific plant is primarily conducted by the community.

Conservation status: This species exhibits a wide-ranging range and is not restricted to any specific geographic area.

#### *Thunbergia laurifolia* Lindl.

The leaves of *T. laurifolia* are arranged in an opposing pattern, have a heart shape, and their edges are serrated. They gradually narrow down to a pointy tip. This species bears a striking resemblance to *T. grandiflora*, although it possesses elongated and slender leaves, and its youthful stems and leaves lack any hair. The flowers lack fragrance and are carried on drooping clusters. The hermaphrodite flower exhibits a trumpet-shaped structure, characterized by a concise and wide tube. The outer part of the flower is white, while the inner part has a yellowish hue. The corolla exhibits a pale blue hue and consists of 5-7 petals, with one petal being bigger in size compared to the others. Plants exhibit nearly continuous flowering throughout the year, with blooms blooming in the morning and wilting by dusk on the same day. Carpenter bees are common pollinators, entering flowers to collect pollen and nectar. Meanwhile, black ants are likely present as nectar scavengers. The plant forms an extensive and swollen root system.

Phenology: The flowering season extends from November to January, whereas fruiting takes place from January to February.

Vernacular name: The native people of the research region are commonly referred to as "Rang Juet".

Distribution: *T. laurifolia* is indigenous to India and Thailand, as well as the Indo-malayan region. The species inhabit the region spanning from Indochina to Malaysia. Therefore, the plant is a native species in Thailand.

Ecology: It is a common in a deciduous dipterocarp forest near the village and it is cultivated in various parts of the village. It grows in all types of soil.

Conservation status: This species demonstrates a broad distribution and is not confined to any geographical region.

#### **Ethnobotanical uses of Acanthaceae in the studied area**

Ten species of Acanthaceae family in the area research can be classified into four categories based on Cook (1995): food plant, medicinal plant, religious plant and other uses. The plant species, part used, preparation and properties are shown in Tables 1-4 and Figure 2.

Table 1 indicates that three species, specifically *Asystasia gangetica*, *R. nasutus*, and *Thunbergia laurifolia*, are utilized as food plants. The shoots and leaves of *A. gangetica* are consumed raw or boiled along with meat, while the leaves of *R. nasutus* and *T. laurifolia* are used in their raw form for food preparation.

The findings from Table 2 reveal that various parts of this plant, such as young leaves, leaves, root, and entire plant, are used for medicinal purposes. These purposes include analeptic, cancer treatment, cough relief, detoxification, prevention of motion sickness, management of diabetes mellitus, diarrhea treatment, fever reduction, gonorrhea treatment, kidney stone prevention, treatment of



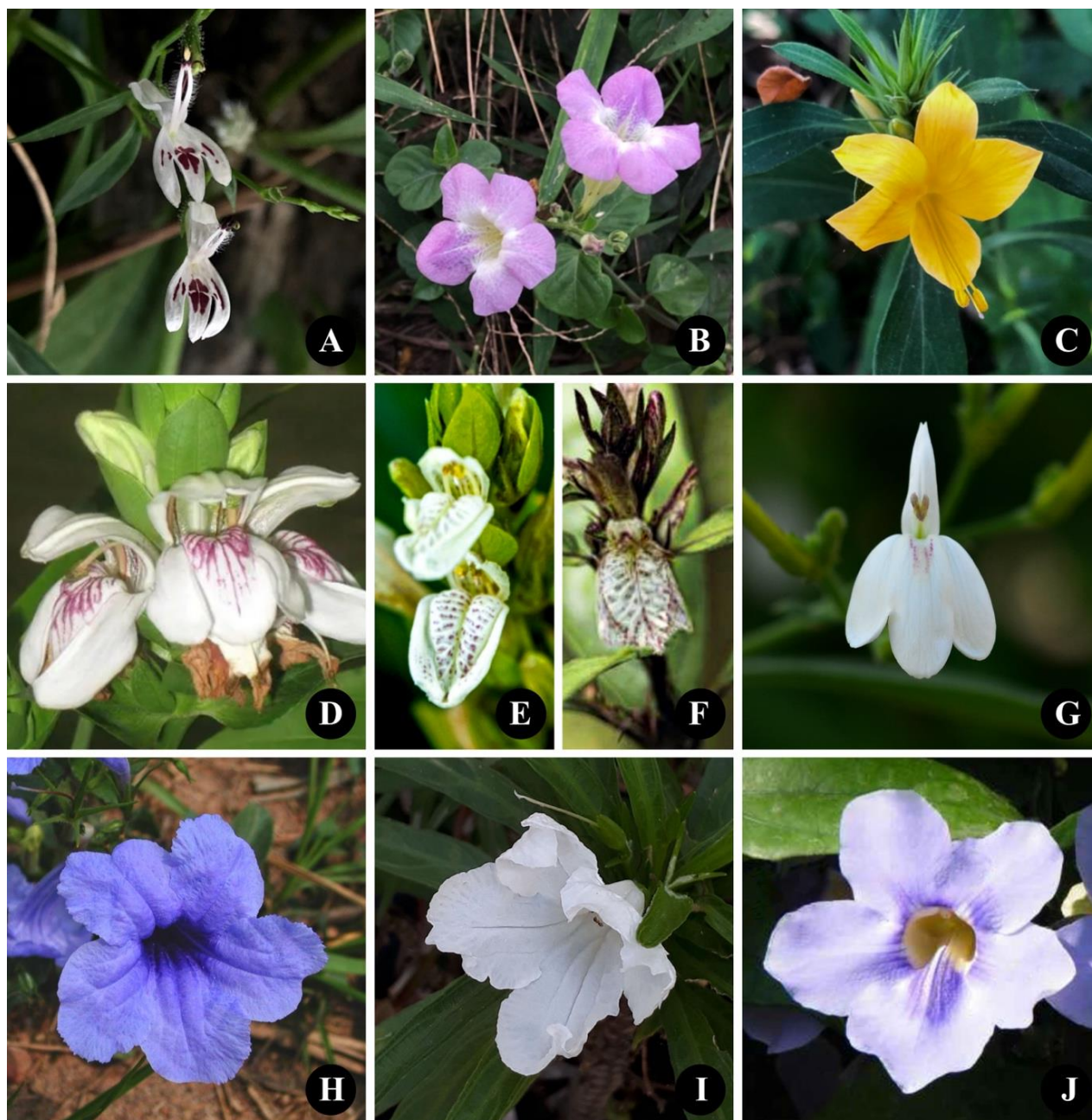
malnutrition, panchrest (a remedy for all diseases), treatment of pustules, prevention of seasickness, relief of sore throat, alleviation of stomachache, treatment of tinea capitis (a fungal infection of the scalp), and uterine tonic. Various methods of preparation were documented, including consuming the fresh young leaves, boiling them, combining them with alcohol, chewing the young leaves, brewing a tea from dried herbs, applying them externally to wounds, holding them in the mouth, crushing the leaves and applying them to the head, and mixing them with chaya.

Table 3 reveals that four species are identified as having religious significance. These plants are used for various

rituals by folk healers, such as bark, flowers, and young leaves. Additionally, two species with two variations are used to pay respect to the Buddha, while one species is used in the ritual of Khanha (accepting). There are three species used for ornamental purposes as presented in Table 4.

#### Use Value (UV) and Cultural Important Index (CI)

Ten species are shown in Table 5 and Figure 2, where ethnobotanical information on each species is calculated into 2 quantitative indices to demonstrate Use Value (UV) and Cultural Importance Index (CI) among informants.



**Figure 2.** Nine species with two variations in Acanthaceae found in Kantarawichai District, Maha Sarakham Province, Thailand: A. *Andrographis paniculata*, B. *Asystasia gangetica*, C. *Barleria prionitis*, D. *Justicia adhatoda*, E. *J. gendarussa* “Kra Duk Kai Khaw”, F. *J. gendarussa* “Kra Duk Kai Dum”, G. *Rhinacanthus nasutus*, H. *Ruellia tuberosa*, I. *Ruellia simplex*, and J. *Thunbergia laurifolia*. Photographs by Surapon Saensouk and Thawatphong Boonma

**Table 1.** Food plants of Acanthaceae family used in two villages in Kantarawichai, Maha Sarakham, Thailand

Scientific name	Local name	Part used	Preparation
<i>Asystasia gangetica</i>	Om Sap	Shoot and leaf	Raw or boiled with meat
<i>Rhinacanthus nasutus</i>	Thong Phan Chang	Leaves	Raw
<i>Thunbergia laurifolia</i>	Rang Juet	Leaves	Raw

**Table 2.** Medicinal plants of Acanthaceae family used in two villages in Kantarawichai, Maha Sarakham, Thailand

Scientific name	Local name	Part used <sup>a</sup>	Preparation	Ailments treated	IAR
<i>Andrographis paniculata</i>	Fa Thalai Chon	Yl	Young leaves are eaten fresh or boiled with Indian acalypha	Cough, fever, sore throat, detoxicant	0.70
		L	Mixed with alcohol	Fever, sore throat	
		Yl	Young leaves are chewed or boiled with pandan leaves	Analeptic	
		L	Boiled with water	Stomachache	
		L or Ep	Prepared as a tea from dried herb	Diabetes mellitus	
<i>Barleria prionitis</i>	Angkab Nu	R	Boiled with water	Detoxicant	NC
<i>Justicia gendarussa</i>	Kra Duk Kai Khaw	L	Boiled with water	Cancer	
<i>Rhinacanthus nasutus</i>	Thong Phan Chang	Ep	Prepared as powder	Panchrest (remedy for all diseases)	0.33
		L	Boiled with water	Panchrest, haematinic	
		R	Boiled with water	Cystitis	
		R	Mixed with Thao kraduengchang, Kam phaengchetchan and Kanuan bark	Gonorrhea, uterine tonic	
		R	Boiled with water and then wash the body	Malnutrition	
<i>Ruellia tuberosa</i>	Toi Ting	Yl	Boiled with water	Kidney stones	0.00
<i>Thunbergia laurifolia</i>	Rang Juet	Yl	Apply externally on wounds	Pustules	
		L	Eat the fresh eaves or boiled with water	Detoxicant	0.79
		L	Keep in the mouth	Carsick, seasick	
		L	Leaves are crushed and applied on the head	Tinea capitis	
		L	Mixed with chaya	Diarrhea	

Note: <sup>a</sup>Part used-Yl: young leaves, L: leaves, R: root, Ep: Entire plant, <sup>b</sup>IAR- Informant Agreement Ratio, <sup>c</sup>NC - not calculated (reported only by one informant)

**Table 3.** Religious plants of Acanthaceae family used in two villages in Kantarawichai, Maha Sarakham, Thailand

Scientific name	Local name	Part used	Plant use
<i>Justicia adhatoda</i>	Sa Niat	Bark	Ritual of folk healers
<i>J. gendarussa</i>	Kra Duk Kai Khaw	Flowers	Pay respect to the Buddha
<i>J. gendarussa</i>	Kra Duk Kai Dum	Flowers	Pay respect to the Buddha
<i>Rhinacanthus nasutus</i>	Thong Phan Chang	Young leaves	Ritual- Khanha (Accepting)
<i>Ruellia tuberosa</i>	Toi Ting	Flowers	Pay respect to the Buddha

**Table 4.** Other uses of plants of Acanthaceae family used in two villages in Kantarawichai, Maha Sarakham, Thailand

Scientific name	Local name	Part used	Plant use
<i>Rhinacanthus nasutus</i>	Thong Phan Chang	Entire plant	Ornament
<i>Ruellia simplex</i>	Toi Ting Fa lung	Entire plant	Ornament
<i>Ru. tuberosa</i>	Toi Ting	Entire plant	Ornament

**Table 5.** Use value and cultural importance index of plant species of Acanthaceae in Kantarawichai, Maha Sarakham Province, Thailand

Species	Local name	Plant uses				UV	CI
		Food	Medicinal	Religious	Other		
<i>Rhinacanthus nasutus</i>	Thong Phan Chang	√	√	√	√	1	1.70
<i>Andrographis paniculata</i>	Fa Thalai Chon	-	√	-	-	0.55	0.45
<i>Thunbergia laurifolia</i>	Rang Juet	-	√	-	-	0.35	0.55
<i>Ruellia tuberosa</i>	Toi Ting	-	√	-	√	0.25	0.25
<i>Asystasia gangetica</i>	Om Sap	√	-	-	-	0.15	0.15
<i>Ru. simplex</i>	Toi Ting Fa lung	-	-	√	√	0.15	0.15
<i>Justicia gendarussa</i>	Kra Duk Kai Khaw	-	√	√	-	0.1	0.1
<i>J. gendarussa</i>	Kra Duk Kai Dum	-	-	√	-	0.1	0.1
<i>Barleria prionitis</i>	Angkab Nu	-	√	-	-	0.05	0.05
<i>J. adhatoda</i>	Sa Niat	-	-	√	-	0.05	0.05

Note: UV: use value; CI: cultural important index

Plant species with the highest Use Value (UV) and Cultural Important Index (CI) was *R. nasutus* (UV=1, CI=1.05) followed by *A. paniculata* (UV=0.55, CI=0.45) and *T. laurifolia* (UV=0.35, CI=0.55). *Rh. nasutus* is used in many purposes including for food, medicine and religious uses. It is used as a side dish with spicy minced salad, and it is believed to be a Panchrest that cures all diseases, get healthier and prolong life. In addition, *Rh. Nasutus* (locally known as Thong Phan Chang) is the most popular uses in religion and ritual and it is an auspicious tree. Thus, most the villagers grow it around the fence. While *An. paniculata* and *T. laurifolia* are popular uses in medicinal plant but they are more difficult to grow than Thong Phan Chang. On the other hand, a low UV and CI value is an important plant for specific group of people, for example the healers use *J. adhatoda* or Sa Niat in ritual of folk to blow magic with the patient.

collaborations between local communities and researchers, and implementation of ex-situ conservation methods. These efforts will help protect the Acanthaceae species and the traditional knowledge supporting their use.

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The IAR indicates a consensus on the utilization of specific plant species to treat different ailments, as indicated in Table 2. The highest IAR value of 0.79 was for *T. laurifolia* followed by *A. paniculata* (0.70) and *R. nasutus* (0.33). The highest IAR rating indicates unanimous consensus among informants regarding the exclusive usage of the medicinal plant for a certain ailment. It is not 100% agreement among informants because the different part of plant species has different properties to treat ailments. Thus, one plant species can heal more than one disease. This suggests the necessity of documenting traditional knowledge to safeguard against its disappearance.

In conclusion, this study emphasizes the extensive ethnobotanical knowledge of the Acanthaceae family in Ban Don Wiang Chan and Ban Hua Khua Villages, Kantarawichai District, Maha Sarakham Province, highlighting their significant role in traditional medicine. Key species such as *R. nasutus*, *T. laurifolia*, and *A. paniculata* demonstrate high use values and informant consensus factors, emphasizing their importance in local healthcare practices. To preserve this valuable knowledge and ensure the sustainable use of these plants, conservation measures should include educational programs, promotion of sustainable harvesting practices, establishment of community-managed conservation areas, fostering

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