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Diversity and Traditional Utilization of the Zingiberaceae Plants in Nakhon Nayok Province, Central Thailand

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Abstract: The Zingiberaceae family boasts remarkable species diversity, with significant implications for conservation and resource management. The objective of this research is to study the diversity and traditional utilization of Zingiberaceae in Nakhon Nayok Province. Through field observations, herbarium specimens, interviews, and surveys, we documented the species, classified them into tribes, genera, and species, and analyzed their distribution across districts. The findings revealed a rich species diversity, encompassing 155 species from 16 genera and 3 tribes. The tribe Zingibereae displayed the highest species diversity (120 species), followed by Alpinieae (23 species) and Globbeae (12 species). These species were found in diverse ecosystems such as dry evergreen forests, mixed deciduous forests, and more. The study also identified the Mueang district as having the highest species count. Additionally, we explored the traditional utilization of Zingiberaceae plants in Nakhon Nayok Province, which encompasses various purposes including ornamental use, rituals, traditional medicine, and more. This research contributes valuable insights into the ecological and cultural significance of Zingiberaceae plants, identifies endangered species requiring conservation measures, and sheds light on the unique plant diversity and cultural heritage in Nakhon Nayok Province. These findings serve as a valuable resource for conservation efforts, sustainable utilization, and future research.

Keywords: biodiversity; utilization; Alpinieae; Globbeae; Zingibereae; ethnobotany

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1. Introduction

The Zingiberaceae family, or ginger family, is a fascinating family of flowering plants comprising four subfamilies, six tribes, and 57 genera, with over 1960 species dispersed across tropical and subtropical regions worldwide, including Asia, Africa, and the Americas. However, the highest diversity of species is found in Southeast Asia. Zingiberaceae plants are adapted to a variety of ecological conditions but are predominantly found in tropical rainforests and moist environments. They thrive in warm and humid biomes where they can receive abundant rainfall and sufficient shade, while some species occur in dry areas with full sunlight. The family includes both terrestrial and epiphytic species. Zingiberaceae is renowned for its remarkable richness in biodiversity and includes some of the most crucial and economically valuable plants, which have a wide range of colors, shapes, and sizes. Moreover, they have been utilized for various purposes, and the knowledge of their utilization has also been passed down for generations in human cultures, particularly in Southeast Asia [1–4].

Thailand has high species diversity in the Zingiberaceae family; a remarkable assemblage of native species can be found, including two subfamilies, four tribes, and 29 genera. Collectively, these contribute to an impressive count of over 470 species that are dispersed

throughout the country. These species can be found in both evergreen and deciduous forests, showcasing their adaptability to different types of habitats. While some species are widespread across the country, there are also certain species that are restricted to specific and limited areas, ranging from nearly mean sea level to high mountains. [1,2,5–178].

Beyond their diversity, many of these species have various traditional uses in Thailand, ranging from culinary to medicinal and cultural purposes as many have previously reported [5–22]. These reports on the diversity and utilization of Zingiberaceae indicate that *Zingiber* plays a significant role in various aspects of Thai life, and there are approximately 10 different purposes for which Zingiberaceae plants are utilized in Thailand, including food, spice, medicine, cut-flower, ornamental, commercial cultivation, fabric dye, cosmetic, rituals and other socio-religious practices [2,5–22], and some species are used as materials, such as the leaf sheath of *Amomum dealbatum* Roxb, which is used for making mats, while *Etlingera coccinea* (Blume) S. Sakai & Nagam. is used for making roofs in the Sakai ethnic group in Trang and Yala provinces [12].

In recent years, several new Zingiberaceae species have been discovered in Nakhon Nayok Province, such as *Curcuma achrae* Saensouk & Boonma, *C. chantaranothaii* Boonma & Saensouk, *C. phrayawan* Boonma & Saensouk, *C. rangsimae* Boonma & Saensouk, *Globba aranyaniae* Sangvir. & M.F. Newman, *G. chrysantha* Sangvir. & M.F. Newman, *G. hilaris* Sangvir., and *Kaempferia nigrifolia* Boonma & Saensouk [23–28]. Despite these findings, there has yet to be a comprehensive study on the species diversity and traditional uses of the Zingiberaceae family in this province.

This is the first study on the diversity of Zingiberaceae and its utilization in Nakhon Nayok Province, and no similar study has been done to date in this geographical area. By conducting this study, valuable insights can be gained to enhance our understanding of the Zingiberaceae family in Nakhon Nayok Province. Moreover, it not only enhances the understanding of regional species diversity, but also sheds light on the interplay between different geographical areas, specifically Nakhon Nayok Province. Situated in the central region of Thailand, this province shares boundaries with the eastern and southeastern floristic regions. Consequently, this research contributes to the basic knowledge needed for further studies on both regional and inter-regional species diversity and facilitates a more comprehensive understanding of the Zingiberaceae family in the context of the surrounding floristic regions.

Together with investigating the utilization of each Zingiberaceae species in Nakhon Nayok Province, we could gather valuable information, and preserve local knowledge. These data are crucial for research, conservation planning, and informed decision-making to enhance our understanding and conserve ginger plants at the region, and country levels.

This study fills crucial gaps in biodiversity research and enhances our comprehension of Zingiberaceae and the natural world. By unveiling the intricate complexities of the Zingiberaceae family, this research serves as a catalyst for further exploration and advancements in biodiversity studies. Additionally, it provides essential information for promoting sustainable utilization practices, starting with a comprehensive assessment of the status of Zingiberaceae plant populations in Nakhon Nayok Province. This assessment aims to identify species, their distribution, and conservation needs, laying a strong groundwork for conservation endeavors that safeguard these invaluable resources for future generations. Moreover, the findings from this research foster increased public engagement, encouraging local communities to take ownership and pride in protecting their natural resources, many of which are unique and endemic to their province. This knowledge not only forms the basis for effective conservation planning within Nakhon Nayok Province but also extends its benefits to regional and national levels. Furthermore, it plays a crucial role in raising awareness about the significance of biodiversity.

2. Materials and Methods

2.1. Study Area

Our study area is in Nakhon Nayok Province, Central Thailand where there has yet to be a comprehensive study on the species diversity and traditional uses of the Zingiberaceae family (Figure 1). The study area is part of the floristic region of Central Thailand according to the floristic regions proposed by the Flora of Thailand Project [29]. Neighboring provinces from the north clockwise are Saraburi, Nakhon Ratchasima, Prachin Buri, Chachoengsao, and Pathum Thani. The northern part of the province is in the Sankamphaeng Range, the southern prolongation of the Dong Phaya Yen mountains, with the highest elevation of about 1290 m-high called "Yod Khao Kiew". Most of that area is covered by the world heritage forest in Khao Yai National Park. The total forest area is about 642 km^2 or about 30 percent of the provincial area. The central part of the province is a rather flat river plain formed by the Nakhon Nayok River. The southern part of the province has acidic soil with low fertility. This province is also a source for the production and distribution of flowers, foliage plants, and ornamental plants, including large trees. In the past, the way of life of the Nakhon Nayok people was mostly rice-based agriculture. But nowadays there is a greater variety of occupations due to the immigration of people from other provinces or neighboring countries who come to live and work in this province, making the population more diverse.

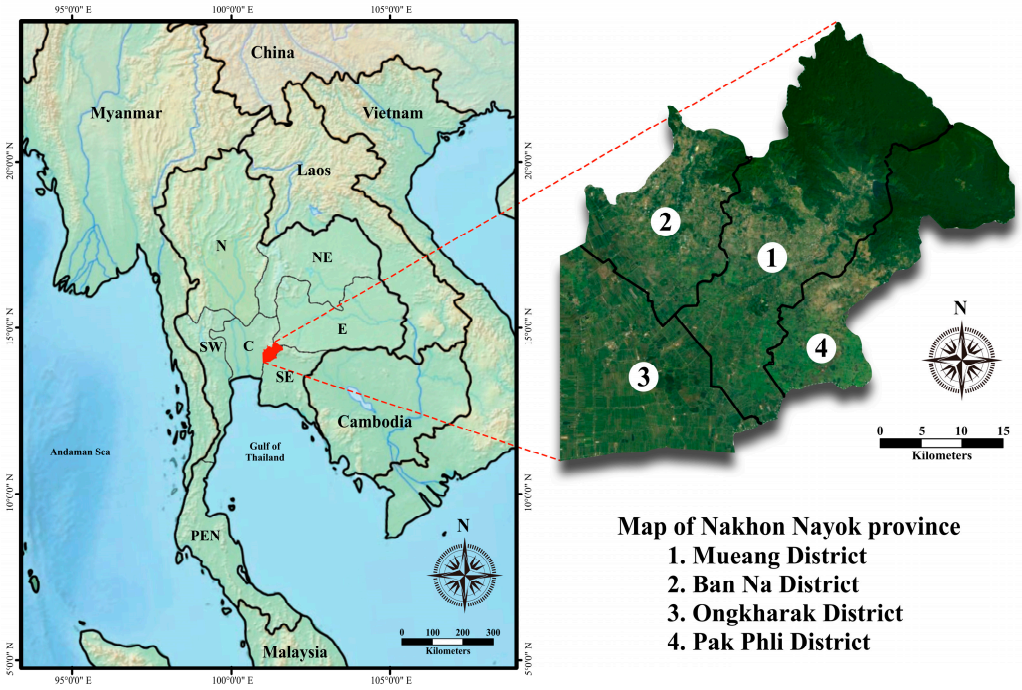

Figure 1. Map showing the location of Nakhon Nayok Province, Central Thailand (the floristic regions according to the Flora of Thailand Project; N = northern, NE = northeastern, SW = southwestern, C = central, E = eastern, SE = southeastern, and PEN = peninsular), while on the right is a map of Nakhon Nayok Province which is divided by administrative area into 4 districts: Mueang District, Ban Na District, Ongkharak District, and Pak Phli District. The map was designed and applied from https://mapswire.com/wp-content/uploads/maps/continent/asia/asia-physical-map-blannk.jpg (accessed on 1 June 2023) combined with Google Maps (2023), designed in Pixelmator Pro program (Version 3.3) by Thawatphong Boonma.

2.2. Plant Materials and Diversity Study

Survey and collect specimens of Zingiberaceae family plants in Nakhon Nayok Province, between January 2022 and January 2023, once or twice a month, surveying the forested area wherever possible to access it, including the area of houses and other areas in Nakhon Nayok Province. In the national park area, no specimen collections were

made; only photographic records and field notes were taken. Living specimens were planted at Brio Garden, Nakhon Nayok Province, and spirit specimens soaked in 70% ethyl alcohol were deposited at Mahasarakham University Herbarium, Mahasarakham University, Thailand.

The details of the plants were noted and studied under a microscope for clear morphological characteristics and to compare the data with the prototype sample or existing species type description to identify the correct species [31–179].

The morphological descriptions of plants in the Zingiberaceae family, especially species distribution in Thailand and neighboring countries, available digital images and information online, e.g., photographs of Herbarium specimens with details from Kew's Herbarium, or powo.science.kew.org (Kew Science 2022) [1], Queen Sirikit Botanic Garden Herbarium (QBG), Muséum national d'Histoire Naturelle in online (accessed through https://science.mnhn.fr/institution/mnhn/collection/p/item/search/form (accessed on 1 May 2023)), Zingiberaceae Resource Center online database (accessed through https://padme.rbge.org.uk/ZRC (accessed on 1 May 2023)), including existing published literature were also compared in this study.

2.3. Distribution Study

The data collection recorded the species separately by district, distinguishing between wild plants, cultivated plants, and those found in both areas. Such information is compiled in Table 1. While checking distribution status, whether they are native species or introduced plants by checking information from the website powo.science.kew.org and from the distribution of species reported in the research publications both printed and online, including relevant books, it is important to use reliable references that cite plant specimens deposited in abroad herbaria. Native species that are endemic to Thailand are recorded as endemic (ED) in Table 1.

2.4. Ecology Study

Ecology data were also recorded while surveying the diversity and traditional utilization of Zingiberaceae in Nakhon Nayok Province. The plant found in the forest will be documented in Table 1 along with the forest types in which the plant is found, such as evergreen forest (EGF) and dry evergreen forest (DEF). While the plants found to be grown at home or in gardens for various purposes will be recorded as "Cultivated". Other abbreviations are noted at the bottom of Table 1.

2.5. Phenology Study

Flowering and fruiting data were recorded while surveying the diversity of Zingiberaceae in Nakhon Nayok Province. Each month is assigned a number from 1 to 12, representing January to December, respectively.

2.6. Traditional Utilization Study

Utilization data for Zingiberaceae in Nakhon Nayok Province were obtained by asking 120 villagers (30 people from each district). The survey included an equal number of male and female participants, with a total of 60 individuals from each gender. The age range of the participants was between 30 and 70 years, and they all resided within the Nakhon Nayok Province in their own homes that were not rental buildings or rental rooms. Prior to asking the question, permission was sought directly from the informants, and the objective of this study was explained, ensuring their willingness to answer our question with pleasure. The question focused solely on the plant name, the part of the plant used, and the purposes for which it was used. The personal information of the participants was not asked for or collected during the survey. Therefore, research ethics request documents were deemed unnecessary for this study.

Table 1. Species diversity and traditional utilization of the Zingiberaceae in Nakhon Nayok Province.

No.	Species Name	Vernacular Name	Distribution				Distribution Status	Phenology		Ecology	Voucher Specimens	Utilization	Used Parts	Conservation Status for Wild Species	Conservation Status
			Mueang	Ban Na	Ongkharak	Pak Phli		Flowering Periods	Fruiting Periods						
1	*Alpinia galanga* (L.) Willd.	Kha, Kha Lueang	B	B	C	B	NA	4–9	7–10	DEF, MDF, Cultivated	Boonma T. NY001	FO, SP, MD, CC	Rt, Rz, Ps, Lv, In, Fs	LC	Common
2	*Alpinia laosensis* Gagnep.	Kha Ling	W	C	C	W	NA	5–8	6–10	EGF, DEF, Cultivated	Boonma T. NY002	FO, SP, MD, CC	Rt, Rz, Ps, Lv, In, Fs	—-	Rare
3	*Alpinia macroura* K. Schum.	Kha Pa, Kha Kom	B	B	–	W	NA	2–4	4–5	EGF, Cultivated	Boonma T. NY003	OR	Wp	LC	Common
4	*Alpinia mutica* Roxb.	Wan Sa Neh Haa	C	C	C	C	NA	3–5	5–8	Cultivated	Boonma T. NY004	FO, MD, RS, OR	Rz, Ps, Fs, Wp	—-	Common
5	*Alpinia nigra* (Gaertn.) Burtt	Kala	–	C	–	–	NA	7–9	8–10	Cultivated	Boonma T. NY005	FO, MD	Rz, Ps, In	LC	Rare
6	*Alpinia oxymitra* K. Schum.	Laow	W	B	–	W	NA	2–4	4–8	EGF, Cultivated	Boonma T. NY006	FO, MD	Rt, Ps, Lv, In, Fs	LC	Rare
7	*Alpinia purpurata* (Vieill.) K. Schum. [Pink Bracts]	Kha Chom Phoo, Khing Chom Phoo	C	C	C	C	IN	1–12	Not seen	Cultivated	Boonma T. NY007	MD, CF, CC, OR	Rt, Rz, In, Wp	—-	Common
	Alpinia purpurata (Vieill.) K. Schum. [Red Bracts]	Kha Daeng, Khing Daeng	C	C	C	C	IN	1–12	Not seen	Cultivated	Boonma T. NY008	CF, CC, OR	Rz, In, Wp	—-	Common
8	*Alpinia siamensis* K. Schum.	Kha Ta Daeng	C	C	C	C	NA	5–8	7–10	Cultivated	Boonma T. NY009	FO, SP, MD, CC	Rz, Ps, Lv, In	—-	Common
9	*Alpinia vittata* W. Bull [variegated leaves]	Kha Dang, Wan Kha Jued	C	C	C	C	IN	6–8	Not seen	Cultivated	Boonma T. NY010	MD, CC, RS, OR	Rt, Rz, Wp	—-	Rare

Table 1. *Cont.*

No.	Species Name	Vernacular Name	Distribution				Distribution Status	Phenology		Ecology	Voucher Specimens	Utilization	Used Parts	Conservation Status for Wild Species	Conservation Status
			Mueang	Ban Na	Ongkharak	Pak Phli		Flowering Periods	Fruiting Periods						
10	*Alpinia zerumbet* (Pers.) B.L. Burtt & R.M. Sm. [variegated leaves]	Kha Dang Bai Yai	C	C	C	C	NA	3–5	Not seen	Cultivated	Boonma T. NY011	MD, CC, OR	Rz, Ps, Lv, Wp	—-	Rare
11	*Amomum dealbatum* Roxb.	Jee Gook	–	C	–	–	NA	5–6	Not seen	Cultivated	Boonma T. NY012	FO, MD	Rz, Ps, In	—-	Rare
12	*Amomum foetidum* Boonma & Saensouk	Mang Khang	–	C	–	–	ED	1–3	Not seen	Cultivated	Boonma T. NY013	SP, CC	Wp	—-	Rare
13	*Amomum repoeense* Pierre ex Gagnep.	Raiw Pa	W	W	–	W	NA	5–7	Not seen	DEF, Cultivated	Boonma T. NY015	——	——	LC	Rare
14	*Amomum wandokthong* (Picheans. & Yupparach) Škorničk. & Hlavatá	Wan Maha Saneh	C	C	C	C	ED	1–4	Not seen	Cultivated	Boonma T. NY014	CC, RS, OR	Rz, In, Wp	—-	Common
15	*Boesenbergia collinsii* Mood & L.M. Prince	Wan Preaw	W	C	–	–	ED	6–10	Not seen	Cultivated	Boonma T. NY016	RS	Rz, In, Wp	LC	Rare
16	*Boesenbergia curtisii* (Baker) Schltr.	Kra Chai Khao	–	C	–	–	NA	7–10	Not seen	Cultivated	Boonma T. NY017	RS	Rz, In, Wp	—-	Rare
17	*Boesenbergia maxwellii* Mood, L.M. Prince & Triboun	Kra Chai Maxwell, Wan Kai Daeng	–	C	–	–	NA	7–9	Not seen	Cultivated	Boonma T. NY018	RS	Rz, In, Wp	—-	Rare
18	*Boesenbergia ochroleuca* (Ridl.) Schltr.	Kra Chai Khao Phang Nga	–	C	–	–	ED	7–9	Not seen	Cultivated	Boonma T. NY019	OR	Wp	—-	Rare

Table 1. *Cont.*

No.	Species Name	Vernacular Name	Distribution				Distribution Status	Phenology		Ecology	Voucher Specimens	Utilization	Used Parts	Conservation Status for Wild Species	Conservation Status
			Mueang	Ban Na	Ongkharak	Pak Phli		Flowering Periods	Fruiting Periods						
19	*Boesenbergia parvula* (Wall. ex Baker) Kuntze	Kra Chai Pa	W	B	–	W	NA	6–9	Not seen	EGF, Cultivated	Boonma T. NY020	OR	Wp	EN: C2a(i,ii), D1	Rare
20	*Boesenbergia petiolata* Sirirugsa	Chao Phan	W	B	–	W	NA	6–9	Not seen	EGF, DEF, Cultivated	Boonma T. NY021	RS	Wp	LC	Rare
21	*Boesenbergia rotunda* (L.) Mansf.	Kra Chai, Kra Chai Gaeng, Kra Chai Khaow	B	B	C	B	NA	6–9	Not seen	MDF, Cultivated	Boonma T. NY022	SP, MD, CC	Rt, Rz, Lv, Wp	LC	Common
22	*Boesenbergia thorelii* (Gagnep.) Loes.	Wan Phet Cha Glab	B	B	C	B	NA	7–9	Not seen	DEF, Cultivated	Boonma T. NY023	CC, RS	Rz, In, Wp	LC	Rare
23	*Conamomum pierreanum* (Gagnep.) Škorničk. & A.D. Poulsen	Kra Wan Pa	W	W	–	W	NA	3–6	Not seen	DEF	Boonma T. NY024	___	———	LC	Rare
24	*Cornukaempferia argentifolia* Boonma & Saensouk	Proh Thong Bai Ngern	–	C	–	–	ED	6–8	Not seen	Cultivated	Boonma T. NY025	OR	Wp	—-	Rare
25	*Cornukaempferia aurantiiflora* Mood & K. Larsen	Proh Thong	–	C	–	–	ED	6–8	Not seen	Cultivated	Boonma T. NY026	OR	Wp	—-	Rare
26	*Cornukaempferia kamolwaniae* Picheans.	Proh Thong Kamolwan	–	C	–	–	ED	6–8	Not seen	Cultivated	Boonma T. NY027	OR	Wp	—-	Rare
27	*Cornukaempferia larsenii* P. Saensouk	Proh Thong Larsen	–	C	–	–	NA	6–8	Not seen	Cultivated	Boonma T. NY028	OR	Wp	—-	Rare

Table 1. *Cont.*

No.	Species Name	Vernacular Name	Distribution				Distribution Status	Phenology		Ecology	Voucher Specimens	Utilization	Used Parts	Conservation Status for Wild Species	Conservation Status
			Mueang	Ban Na	Ongkharak	Pak Phli		Flowering Periods	Fruiting Periods						
28	*Cornukaempferia longipetiolata* Mood & K. Larsen	Proh Thong Gan Yaow	–	C	–	–	ED	6–8	Not seen	Cultivated	Boonma T. NY029	OR	Wp	—-	Rare
29	*Curcuma achrae* Saensouk & Boonma	Khamin Thong	W	C	–	–	ED	3–5	4–5	DEF, MDF, Cultivated	Boonma T. NY030	RS	In, Wp	CR: C2a(i,ii), D1	Rare
30	*Curcuma aeruginosa* Roxb.	Wan Maha Mek	C	C	C	C	NA	3–6	Not seen	Cultivated	Boonma T. NY031	FO, MD, RS	Rz, In, Wp	—-	Common
31	*Curcuma alismatifolia* Gagnep.	Pa Thum Ma, Kra Chiao	C	C	C	C	NA	6–9	Not seen	Cultivated	Boonma T. NY032	CF, CC, OR	In, Wp	—-	Common
32	*Curcuma amada* Roxb.	Khamin Khaow Pa	–	C	–	–	NA	6–9	Not seen	Cultivated	Boonma T. NY033	FO, CC	Rz, In	—-	Common
33	*Curcuma angustifolia* Roxb.	Kra Chiao Daeng	C	C	C	C	NA	4–9	6–10	Cultivated	Boonma T. NY034	FO, CC	Ps, In	—-	Common
34	*Curcuma aromatica* Salisb.	Wan Nang Kham	C	C	C	C	NA	3–5	Not seen	Cultivated	Boonma T. NY035	MD, RS	Rt, Rz, In, Wp	—-	Common
35	*Curcuma aruna* Maknoi & Saensouk	Kra Chiao Lueang, Kra Chiao Arun	–	C	–	–	ED	3–5	Not seen	Cultivated	Boonma T. NY036	RB, RS	In, Wp	—-	Rare
36	*Curcuma aurantiaca* Zijp	Wan Pot, Ploy Taksin	C	C	C	C	NA	6–10	Not seen	Cultivated	Boonma T. NY037	CC, OR	Wp	—-	Rare
37	*Curcuma campanulata* (Kuntze) Škorničk.	Wan Phet Noi	–	C	C	–	NA	3–5	Not seen	Cultivated	Boonma T. NY038	RS	In, Wp	—-	Rare
38	*Curcuma candida* (Wall.) Techapr. & Škorničk.	Dok Din Mueang Kan	–	C	–	–	NA	3–5	Not seen	Cultivated	Boonma T. NY039	FO, RS	In, Wp	—-	Rare

Table 1. *Cont.*

No.	Species Name	Vernacular Name	Distribution				Distribution Status	Phenology		Ecology	Voucher Specimens	Utilization	Used Parts	Conservation Status for Wild Species	Conservation Status
			Mueang	Ban Na	Ongkharak	Pak Phli		Flowering Periods	Fruiting Periods						
39	*Curcuma chantaranothaii* Boonma & Saensouk	Khamin Noi, Wan Kuum Rotjana, Wan Dok Thong Tua Mea	–	C	–	–	ED	5–8	Not seen	Cultivated	Boonma T. NY040	RS	In, Wp	—-	Rare
40	*Curcuma charanii* Boonma & Saensouk	Kha Chiao Lop Buri	–	C	–	–	ED	6–9	Not seen	Cultivated	Boonma T. NY041	OR	Wp	—-	Rare
41	*Curcuma cinnabarina* Škorničk. & Soonthornk.	Kra Chiao Usa	–	C	–	–	ED	6–9	7–10	Cultivated	Boonma T. NY042	RS, OR	Wp	—-	Rare
42	*Curcuma comosa* Roxb.	Wan Chak Mot Luk	C	C	C	C	NA	3–5	Not seen	Cultivated	Boonma T. NY043	MD, OR	Rz, Wp	—-	Common
43	*Curcuma cordata* Wall.	Khamin Muang, Khamin Mae Hong Son	–	C	–	–	NA	6–9	Not seen	Cultivated	Boonma T. NY044	FO, OR	In, Wp	—-	Rare
44	*Curcuma eburnea* Škorničk., Suksathan & Soonthornk.	Wan Thep Prasit	–	C	–	–	ED	6–8	Not seen	Cultivated	Boonma T. NY045	RS,	In, Wp	—-	Rare
45	*Curcuma fimbriata* Škorničk. & Soonthornk.	Kra Chiao Keaw	–	C	–	–	ED	6–9	Not seen	Cultivated	Boonma T. NY046	OR	Wp	—-	Rare
46	*Curcuma flaviflora* S.Q.Tong	Kra Chiao Lueang	–	C	–	–	NA	3–5	Not seen	Cultivated	Boonma T. NY047	RS,	In, Wp	—-	Rare
47	*Curcuma globulifera* Škorničk. & Soonthornk.	Wan Salika	C	C	C	C	ED	3–5	Not seen	Cultivated	Boonma T. NY048	MD, RS	Rz, In, Wp	—-	Rare

Table 1. *Cont.*

No.	Species Name	Vernacular Name	Distribution				Distribution Status	Phenology		Ecology	Voucher Specimens	Utilization	Used Parts	Conservation Status for Wild Species	Conservation Status
			Mueang	Ban Na	Ongkharak	Pak Phli		Flowering Periods	Fruiting Periods						
48	*Curcuma gracillima* Gagnep.	Kra Chiao Noi	–	C	–	–	NA	6–9	8–10	Cultivated	Boonma T. NY049	OR	Wp	—-	Rare
49	*Curcuma harmandii* Gagnep.	Chor Morrakot	W	B	C	W	NA	6–9	Not seen	DEF, MDF, Cultivated	Boonma T. NY050	OR	Wp	LC	Common
50	*Curcuma latifolia* Rosc.	Wan Maha Gum Lang	C	C	C	–	NA	3–6	Not seen	Cultivated	Boonma T. NY051	MD	Rz	—-	Common
51	*Curcuma lithophila* Škorničk. & Soonthornk.	Ma Nee Kan	–	C	–	–	ED	6–9	8–10	Cultivated	Boonma T. NY052	OR	Wp	—-	Rare
52	*Curcuma longa* L.	Khamin Chan	C	C	C	C	IN	6–9	8–10	Cultivated	Boonma T. NY053	FO, SP, MD, CC, CM	Rt, Rz, In, Wp	—-	Common
53	*Curcuma macrochlamys* (Baker) Škorničk.	Wan Phet Noi Daeng	–	C	C	–	NA	3–6	Not Seen	Cultivated	Boonma T. NY054	MD, RS	Rz, Wp	—-	Rare
54	*Curcuma mangga* Valeton & Zijp	Wan Muang, Khamin Khaow	C	C	C	C	IN	3–6	Not Seen	Cultivated	Boonma T. NY055	FO, SP, MD, CC	Rz, In	—-	Common
55	*Curcuma micrantha* Škorničk. & Soonthornk.	Kra Chiao Chocolate	–	C	–	–	ED	6–9	Not Seen	Cultivated	Boonma T. NY056	OR	Wp	—-	Rare
56	*Curcuma myanmarensis* (W.J. Kress) Škorničk.	Bua Khem, Kra Chiao Phamar	–	C	–	–	IN	6–9	Not Seen	Cultivated	Boonma T. NY057	OR	Wp	—-	Rare

Table 1. *Cont.*

No.	Species Name	Vernacular Name	Distribution				Distribution Status	Phenology		Ecology	Voucher Specimens	Utilization	Used Parts	Conservation Status for Wild Species	Conservation Status
			Mueang	Ban Na	Ongkharak	Pak Phli		Flowering Periods	Fruiting Periods						
57	*Curcuma nakhonphanomensis* Boonma, Saensouk & P. Saensouk	Kra Chiao Nakhon Phanom	–	C	–	–	ED	6–9	Not Seen	Cultivated	Boonma T. NY058	RS	In, Wp	—-	Rare
58	*Curcuma papilionacea* Soonthornk., Ongsakul & Škorničk.	Wan Klom Nang Non Tai	–	C	–	–	ED	6–9	8–10	Cultivated	Boonma T. NY059	RS, OR	Wp	—-	Rare
59	*Curcuma parviflora* Wall.	Kra Chiao Khaow, Wan Thep Rum Luek	B	B	C	B	NA	6–9	Not Seen	DEF, Cultivated	Boonma T. NY060	RS, OR	Rz, Wp	LC	Common
60	*Curcuma peramoena* Souvann. & Maknoi	Wan Hua Noi	–	C	–	–	NA	5–7	Not Seen	Cultivated	Boonma T. NY061	RS	In, Wp	—-	Rare
61	*Curcuma petiolata* Roxb.	Bua Chan, Wan Thep Prachumpohn	B	B	C	B	NA	7–9	8–10	Cultivated	Boonma T. NY062	RS, OR	Wp	—-	Common
62	*Curcuma phrayawan* Boonma & Saensouk	Phra Ya Wan	C	C	C	C	ED	7–9	Not Seen	Cultivated	Boonma T. NY063	MD, RB, RS	Rz, Wp	—-	Rare
63	*Curcuma pierreana* Gagnep.	Maha Udom Daeng, Kra Chiao Sam See	–	C	–	–	NA	7–9	Not Seen	Cultivated	Boonma T. NY064	RS	In, Wp	—-	Rare
64	*Curcuma plicata* Wall. ex Baker	Kra Chiao Isan	–	C	–	–	NA	3–8	Not Seen	Cultivated	Boonma T. NY065	OR	Wp	—-	Rare
65	*Curcuma prasina* Škorničk.	Kra Chiao Jew	–	C	–	–	ED	7–9	8–9	Cultivated	Boonma T. NY066	OR	Wp	—-	Rare

Table 1. *Cont.*

No.	Species Name	Vernacular Name	Distribution				Distribution Status	Phenology		Ecology	Voucher Specimens	Utilization	Used Parts	Conservation Status for Wild Species	Conservation Status
			Mueang	Ban Na	Ongkharak	Pak Phli		Flowering Periods	Fruiting Periods						
66	*Curcuma puangpeniae* Boonma & Saensouk	Kra Chiao Phuangpen, Wan Thep Rak Sa	C	C	C	C	ED	6–9	Not Seen	Cultivated	Boonma T. NY067	RS, OR	In, Wp	—-	Rare
67	*Curcuma purpurata* Boonma & Saensouk	Wan Thep Rak Sa Pa	–	C	–	–	ED	6–9	Not Seen	Cultivated	Boonma T. NY068	RS, OR	In, Wp	—-	Rare
68	*Curcuma putii* Maknoi & Jenjitt.	Um Nong, Kra Chiao Lueng	–	C	–	–	ED	6–9	8–10	Cultivated	Boonma T. NY069	RS, OR	Wp	—-	Rare
69	*Curcuma rangjued* Saensouk & Boonma	Rang Jued Khamin, Wan Rang Jued	C	C	C	C	ED	6–9	8–10	Cultivated	Boonma T. NY070	MD	Rz	—-	Rare
70	*Curcuma rangsimae* Boonma & Saensouk	Bussarakham, Maha Udom Nakhon Nayok	B	B	C	B	ED	5–9	7–10	DEF, MDF, Cultivated	Boonma T. NY071	RS	In, Wp	EN: C2a(i,ii), D1	Rare
71	*Curcuma rhabdota* Sirirugsa & M.F. Newman	Bua Lai Ubon	C	C	C	C	NA	7–9	8–10	Cultivated	Boonma T. NY072	CF, OR	In, Wp	—-	Rare
72	*Curcuma roscoeana* Wall.	Kra Chiao Som	C	C	C	C	NA	7–9	Not seen	Cultivated	Boonma T. NY073	MD, OR	Rz, Wp	—-	Rare
73	*Curcuma rosea* P. Saensouk, Saensouk & Boonma	Wan Maha Udom Umawadi	–	C	C	–	ED	6–9	8–10	Cultivated	Boonma T. NY074	RS	Rz, In, Wp	—-	Rare
74	*Curcuma rubescens* Roxb.	Wan Maha Prab	C	C	C	C	NA	3–6	Not seen	Cultivated	Boonma T. NY075	MD RS, OR	Rz, In, Wp	—-	Common

Table 1. *Cont.*

No.	Species Name	Vernacular Name	Distribution				Distribution Status	Phenology		Ecology	Voucher Specimens	Utilization	Used Parts	Conservation Status for Wild Species	Conservation Status
			Mueang	Ban Na	Ongkharak	Pak Phli		Flowering Periods	Fruiting Periods						
75	*Curcuma rubrobracteata* Škorničk., M.Sabu & Prasanthk.	Wan Ngu Hao	–	C	–	–	NA	7–9	Not seen	Cultivated	Boonma T. NY076	RS	Wp	—-	Rare
76	*Curcuma rufostriata* Škorničk. & Soonthornk.	Bua Lai Pra Chin,	–	C	–	–	ED	6–9	8–10	Cultivated	Boonma T. NY077	OR	Wp	—-	Rare
77	*Curcuma sabhasrii* Saensouk, Maknoi, Wongnak & Rakarcha	Wan Din Sor Pi Chai	–	C	C	–	ED	6–9	Not seen	Cultivated	Boonma T. NY078	RS	Wp	—-	Rare
78	*Curcuma saraburiensis* Boonma & Saensouk	Saraburi Rum Luek, Wan Klom Nang Non	–	C	C	–	ED	6–9	8–10	Cultivated	Boonma T. NY079	RS, OR	Wp	—-	Rare
79	*Curcuma siamensis* Saensouk & Boonma	Khamin Siam,	–	C	–	–	ED	5–9	8–10	Cultivated	Boonma T. NY080	RS	In, Wp	—-	Rare
80	*Curcuma singularis* Gagnep.	Dok Din, Kra Chiao Khaow	C	C	C	C	NA	3–5	4–6	Cultivated	Boonma T. NY081	FO, RS	Rz, Ps, In, Wp	—-	Rare
81	*Curcuma sparganiifolia* Gagnep.	Kra Chiao Bua	C	C	C	C	NA	7–9	Not seen	Cultivated	Boonma T. NY082	OR	Wp	—-	Rare
82	*Curcuma stenochila* Gagnep.	Wan Phet Mah	–	C	–	–	NA	7–9	Not seen	Cultivated	Boonma T. NY083	MD, RS	Rz, In, Wp	—-	Rare
83	*Curcuma suphanensis* P. Saensouk, Boonma, Rakarcha, Maknoi, Wongnak & Saensouk	Kra Chiao Suphan	–	C	C	–	ED	7–9	8–10	Cultivated	Boonma T. NY084	RS	Rz, Wp	—-	Rare

Table 1. *Cont.*

No.	Species Name	Vernacular Name	Distribution				Distribution Status	Phenology		Ecology	Voucher Specimens	Utilization	Used Parts	Conservation Status for Wild Species	Conservation Status
			Mueang	Ban Na	Ongkharak	Pak Phli		Flowering Periods	Fruiting Periods						
84	*Curcuma supraneeana* (W.J. Kress & K. Larsen) Škorničk.	Kra Chiao Supranee, Wan Khao Phan Sa	–	C	–	–	ED	7–9	Not seen	Cultivated	Boonma T. NY085	OR	Wp	—-	Rare
85	*Curcuma thorelii* Gagnep.	Kra Chiao Khaow Pak Muang	C	C	C	C	NA	7–9	Not seen	Cultivated	Boonma T. NY086	CF, RS, OR	In, Wp	—-	Common
86	*Curcuma wanenlueanga* Saensouk, Thomudtha & Boonma	Wan En Lueang	C	C	C	C	ED	7–9	Not seen	Cultivated	Boonma T. NY087	MD, RS,	Rz, In, Wp	—-	Common
87	*Curcuma zedoaria* (Christm.) Roscoe	Khamin Kuen	C	C	C	C	IN	3–5	Not seen	Cultivated	Boonma T. NY088	MD	Rz	—-	Common
88	*Etlingera araneosa* (Baker) R.M. Sm.	Pud Daeng, Nor Cook	W	–	–	W	NA	3–6	Not seen	EGF, DEF	Boonma T. NY089	FO	Ps	DD	Rare
89	*Etlingera elatior* (Jack) R.M. Sm. [pink variant]	Da Lah Chom Phoo	C	C	C	C	NA	1–12	8–12	Cultivated	Boonma T. NY090	FO, MD, CF, CC, RS, OR	Rz, Ps, Lv, In, Wp	—-	Common
	Etlingera elatior (Jack) R.M. Sm. [red variant]	Da Lah Daeng	C	C	C	C	NA	1–12	8–12	Cultivated	Boonma T. NY091	CF, CC, RS, OR	Rz, Ps, Lv, In, Wp	—-	Common
	Etlingera elatior (Jack) R.M. Sm. [white variant]	Da Lah Khaow	C	C	C	C	NA	1–12	8–12	Cultivated	Boonma T. NY092	CF, CC, RS, OR	Rz, Ps, Lv, In, Wp	—-	Common
90	*Etlingera pavieana* (Pierre ex Gagnep.) R. M. Sm. [subsp. pavieana]	Raiw Homm	W	C	–	W	NA	2–6	5–9	DEF, Cultivated	Boonma T. NY093	SP, CC	Rz, In	DD	Rare

Table 1. *Cont.*

No.	Species Name	Vernacular Name	Distribution				Distribution Status	Phenology		Ecology	Voucher Specimens	Utilization	Used Parts	Conservation Status for Wild Species	Conservation Status
			Mueang	Ban Na	Ongkharak	Pak Phli		Flowering Periods	Fruiting Periods						
91	*Gagnepainia godefroyi* (Baill.) K. Schum	Gum Ber Keaw, Wan Phet Na Thang	–	C	–	–	NA	4–5	Not seen	Cultivated	Boonma T. NY094	RS, OR	Rz, In, Wp	—-	Rare
92	*Gagnepainia harmandii* (Baill.) K. Schum	Gum Ber Khaow, Wan Phet Na Thang	W	B	–	W	NA	4–5	Not seen	DEF, MDF, Cultivated	Boonma T. NY095	RS, OR	Rz, Wp	EN: C2a(i,ii), D1	Rare
93	*Geostachys smitinandii* K. Larsen	Pud Ajarn Tem	W	–	–	W	ED	4–6	Not seen	EGF, DEF	Photograph only	___	———	EN: C2a(i,ii), D1	Rare
94	*Globba aranyaniae* Sangvir. & M.F. Newman	Hong Hern, Khao Phan Sa	W	–	–	W	NA	6–9	Not seen	DCF near steams	Boonma T. NY097	___	———	LC	Rare
95	*Globba chrysantha* Sangvir. & M.F. Newman	Hong Hern, Khao Phan Sa	W	W	–	W	ED	6–9	Not seen	DEF	Boonma T. NY098	___	———	LC	Rare
96	*Globba chrysochila* Sangvir. & M.F. Newman	Dok Khao Phan Sa	W	C	–	W	ED	6–9	Not seen	DEF, Cultivated	Boonma T. NY099	OR	Wp	LC	Rare
97	*Globba geoffrayi* Gagnep.	Hong Hern Khaow Muang, Wan Thong	W	C	–	W	NA	6–9	8–10	DEF, Cultivated	Boonma T. NY100	OR	Wp	EN: C2a(i,ii), D1	Rare
98	*Globba hilaris* Sangvir.	Hong Hern Puang Khaow	B	B	–	W	NA	6–9	8–10	DCF, Cultivated	Boonma T. NY101	OR	Wp	EN: C2a(i,ii), D1	Rare

Table 1. *Cont.*

No.	Species Name	Vernacular Name	Distribution				Distribution Status	Phenology		Ecology	Voucher Specimens	Utilization	Used Parts	Conservation Status for Wild Species	Conservation Status
			Mueang	Ban Na	Ongkharak	Pak Phli		Flowering Periods	Fruiting Periods						
99	*Globba obscura* K. Larsen	Khao Phan Sa Khao Yai	W	–	–	W	ED	6–9	Not seen	DEF, MDF	Boonma T. NY102	——	——	EN: C2a(i,ii), D1	Rare
100	*Globba schomburgkii* Hook.f.	Khao Phan Sa	B	B	C	B	NA	6–9	8–10	Cultivated	Boonma T. NY103	RS, OR	Rz, Wp	LC	Common
101	*Globba thorelii* Gagnep.	Hong Hern, Khao Phan Sa	W	–	–	W	NA	6–9	Not seen	EGF	Boonma T. NY104	——	——	EN: C2a(i,ii), D1	Rare
102	*Globba williamsiana* M.F. Newman & Sangvir	Dok Khao Phan Sa	B	B	C	B	ED	6–9	Not seen	DCF, Cultivated	Boonma T. NY105	CC, OR	Wp	EN: C2a(i,ii), D1	Rare
103	*Globba xantholeuca* Craib	Hong Hern, Khao Phan Sa	W	W	–	W	ED	6–9	Not seen	DEF	Boonma T. NY106	——	——	EN: C2a(i,ii), D1	Rare
104	*Hedychium coronarium* J. Koenig	Maha Hong Khaow	C	C	C	C	NA	6–12	Not seen	Cultivated	Boonma T. NY107	MD, CC, RS, OR	Rz, Wp	—-	Common
105	*Hedychium flavescens* Carey ex Roscoe	Maha Hong Lueang	–	C	C	–	NA	6–12	Not seen	Cultivated	Boonma T. NY108	CC, OR	Wp	—-	Rare
106	*Hedychium gardnerianum* Sheppard ex Ker Gawl.	Maha Hong Himalai	–	C	–	–	NA	6–12	Not seen	Cultivated	Boonma T. NY109	OR	Wp	—-	Rare
107	*Kaempferia angustifolia* Roxb.	Wan Prab Sa Mut	C	C	C	C	NA	6–9	Not seen	Cultivated	Boonma T. NY110	MD, CC, RS	Rt, Rz, Wp	—-	Rare

Table 1. *Cont.*

No.	Species Name	Vernacular Name	Distribution				Distribution Status	Phenology		Ecology	Voucher Specimens	Utilization	Used Parts	Conservation Status for Wild Species	Conservation Status
			Mueang	Ban Na	Ongkharak	Pak Phli		Flowering Periods	Fruiting Periods						
108	*Kaempferia elegans* Wall.	Wan Nok Khum	C	C	C	C	NA	6–10	Not seen	Cultivated	Boonma T. NY111	MD, CC, RS, OR	Rz, Wp	—-	Common
109	*Kaempferia galanga* L.	Proh Hom	–	C	C	–	NA	6–9	Not seen	Cultivated	Boonma T. NY112	CC, MD	Rz, Ps, Lv, In, Wp	—-	Common
110	*Kaempferia gilbertii* W. Bull	Wan Maha Ni Yom	C	C	C	C	IN	6–9	Not seen	Cultivated	Boonma T. NY113	CC, RS, OR	Wp	—-	Common
111	*Kaempferia grandifolia* Saensouk & Jenjitt.	Proh Bai Yai	–	C	–	–	ED	6–9	Not seen	Cultivated	Boonma T. NY114	OR	Wp	—-	Rare
112	*Kaempferia isanensis* Saensouk & P. Saensouk	Proh Isan, Toob Moob Isan	–	C	–	–	ED	6–8	Not seen	Cultivated	Boonma T. NY115	OR	Wp	—-	Rare
113	*Kaempferia jenjittikuliae* Noppornch.	Proh Lai Tang Mo Yai	–	C	C	–	ED	3–5	Not seen	Cultivated	Boonma T. NY116	OR	Wp	—-	Rare
114	*Kaempferia koratensis* Picheans.	Proh Ko Rat	–	C	–	–	ED	6–9	Not seen	Cultivated	Boonma T. NY117	FO	Lv	—-	Rare
115	*Kaempferia larsenii* Sirirugsa	Proh Ra Sri	–	C	–	–	ED	6–9	Not seen	Cultivated	Boonma T. NY118	RS	Rz, In, Wp	—-	Rare
116	*Kaempferia lopburiensis* Picheans.	Proh Bai Yai	–	C	–	–	ED	3–5	Not seen	Cultivated	Boonma T. NY119	OR	Wp	—-	Rare
117	*Kaempferia minuta* Jenjitt. & K. Larsen	Proh Lai Tang Mo Lek	–	C	C	–	ED	6–9	8–10	Cultivated	Boonma T. NY120	OR	Wp	—-	Rare
118	*Kaempferia maculifolia* Boonma & Saensouk	Proh Bai Lai Jut	–	C	–	–	ED	6–9	8–10	Cultivated	Boonma T. NY121	RS, OR	Wp	—-	Rare

Table 1. *Cont.*

No.	Species Name	Vernacular Name	Distribution				Distribution Status	Phenology		Ecology	Voucher Specimens	Utilization	Used Parts	Conservation Status for Wild Species	Conservation Status
			Mueang	Ban Na	Ongkharak	Pak Phli		Flowering Periods	Fruiting Periods						
119	*Kaempferia marginata* Carey ex Roscoe	Proh, Toob Moob	W	C	–	B	NA	5–7	Not seen	DDF, Cultivated	Boonma T. NY122	FO, MD	Rz, Lv	LC	Common
120	*Kaempferia napavarniae* Saensouk, P. Saensouk & Boonma	Proh Napavarn, Proh Bai Lai Jud	–	C	–	–	ED	6–9	Not seen	Cultivated	Boonma T. NY123	RS, OR	Wp	—-	Rare
121	*Kaempferia nigrifolia* Boonma & Saensouk	Nillakan, Proh Bai Dam	W	B	–	W	ED	6–9	8–10	MDF, Cultivated	Boonma T. NY124	FO, RS, OR	Lv, Wp	EN: C2a(i,ii), D1	Rare
122	*Kaempferia pardi* K. Larsen & Jenjitt.	Proh Suea Dao	–	C	C	–	ED	6–9	Not seen	Cultivated	Boonma T. NY125	CC, OR	Wp	—-	Rare
123	*Kaempferia parviflora* Wall. ex Baker	Kra Chai Dam	C	C	C	C	NA	6–9	Not seen	Cultivated	Boonma T. NY126	MD, CC, RS	Rz, Wp	—-	Common
124	*Kaempferia phuphanensis* Saensouk & P. Saensouk	Proh Phu Phan	–	C	–	–	ED	6–9	Not seen	Cultivated	Boonma T. NY127	OR	Wp	—-	Rare
125	*Kaempferia pseudoparviflora* Saensouk & P. Saensouk	Kra Chai Dam Tiam	–	C	–	–	NA	6–9	Not seen	Cultivated	Boonma T. NY128	OR	Wp	—-	Rare
126	*Kaempferia pulchra* Ridl.	Proh Pa	–	C	–	–	NA	6–9	Not seen	Cultivated	Boonma T. NY129	OR	Wp	—-	Rare
127	*Kaempferia roscoeana* Wall.	Proh Pa	–	C	C	–	NA	6–9	Not seen	Cultivated	Boonma T. NY130	FO, MD, OR	Rz, Lv, Wp	—-	Rare

Table 1. *Cont.*

No.	Species Name	Vernacular Name	Distribution				Distribution Status	Phenology		Ecology	Voucher Specimens	Utilization	Used Parts	Conservation Status for Wild Species	Conservation Status
			Mueang	Ban Na	Ongkharak	Pak Phli		Flowering Periods	Fruiting Periods						
128	*Kaempferia rotunda* L.	Thip Pha Ya Net	B	B	C	B	NA	3–5	Not seen	MDF, Cultivated	Boonma T. NY131	MD, CC, RS, OR	Rz, Lv, In, Wp	EN: C2a(i,ii), D1	Common
129	*Kaempferia sakonensis* Saensouk, P. Saensouk & Boonma	Proh Sakon, Wan Kai Kuk	–	C	–	–	ED	6–9	Not seen	Cultivated	Boonma T. NY132	RS	Rz, In, Wp	—-	Rare
130	*Kaempferia saraburiensis* Picheans.	Proh Saraburi	–	C	–	–	ED	6–9	Not seen	Cultivated	Boonma T. NY133	OR	Wp	—-	Rare
131	*Kaempferia simaoensis* Y.Y.Qian	Wan Haow Norn	–	C	–	–	NA	3–5	Not seen	Cultivated	Boonma T. NY134	OR	Wp	—-	Rare
132	*Kaempferia sipraiana* Boonma & Saensouk	Proh Siprai	–	C	–	–	ED	3–5	Not seen	Cultivated	Boonma T. NY135	OR	Wp	—-	Rare
133	*Kaempferia sisaketensis* Picheans. & Koonterm	Proh Hu Kra Tai	–	C	–	–	ED	6–8	Not seen	Cultivated	Boonma T. NY136	OR	Wp	—-	Rare
134	*Kaempferia spoliata* Sirirugsa	Proh Hu Kra Tai Khaow	–	C	–	–	NA	6–8	Not seen	Cultivated	Boonma T. NY137	RS, OR	Wp	—-	Rare
135	*Kaempferia takensis* Boonma & Saensouk	Proh Muang Tak, Phra Ya Nok Khum	–	C	–	–	ED	3–5	Not seen	Cultivated	Boonma T. NY138	RS, OR	Wp	—-	Rare
136	*Kaempferia udonensis* Picheans. & Phokham	Proh Udon, Proh Hu Chang	–	C	–	–	ED	3–5	Not seen	Cultivated	Boonma T. NY139	OR	Wp	—-	Rare
137	*Meistera koenigii* (J.F.Gmel.) Škorničk. & M.F. Newman	Raiw Puang A-Ngun	W	W	–	W	NA	4–6	Not seen	EGF	Boonma T. NY140	___	———	LC	Rare

Table 1. *Cont.*

No.	Species Name	Vernacular Name	Distribution				Distribution Status	Phenology		Ecology	Voucher Specimens	Utilization	Used Parts	Conservation Status for Wild Species	Conservation Status
			Mueang	Ban Na	Ongkharak	Pak Phli		Flowering Periods	Fruiting Periods						
138	*Meistera tomrey* (Gagnep.) Škorničk. & M.F. Newman	Raiw	W	W	–	W	NA	4–6	Not seen	DEF, DCF	Boonma T. NY141	___	———	LC	Rare
139	*Monolophus pedemontanus* (Triboun & K. Larsen) Veldk. & Mood	Proh Phu Nang Rong	W	–	–	–	ED	6–9	Not seen	DEF	Photograph only	___	———	EN: C2a(i,ii), D1	Rare
140	*Monolophus saxicola* (K. Larsen) Veldk. & Mood	Proh Phu Khao Yai	W	–	–	W	ED	6–9	Not seen	DEF	Photograph only	———	———	EN: C2a(i,ii), D1	Rare
141	*Wurfbainia testacea* (Ridl.) Škorničk. & A.D. Poulsen	Kra Wan	B	C	C	B	NA	3–6	Not seen	DEF, Cultivated	Boonma T. NY096	FO, SP, MD, CC	Rz, Ps, In, Fs, Wp	LC	Common
142	*Wurfbainia uliginosa* (J. Koenig) Giseke	Raiw, Kra Wan Pa	W	B	–	W	NA	4–7	Not seen	DEF, MDF, Cultivated	Boonma T. NY145	SP, MD	Rt, Lv, In, Fs	LC	Rare
143	*Zingiber citriodorum* Theilade & Mood	Ta Krai Pran, Khing Mang Da	–	C	–	–	ED	5–7	Not seen	Cultivated	Boonma T. NY146	FO, MD, RS	Rt, Rz, Ps, Wp	—-	Rare
144	*Zingiber gramineum* Noronha ex Blume	Plai Nok	W	B	–	W	NA	6–8	Not seen	DEF, Cultivated	Boonma T. NY147	OR	Wp	EN: C2a(i,ii), D1	Rare
145	*Zingiber junceum* Gagnep.	Khing Kra Tai	B	C	–	B	NA	7–9	Not seen	DEF, Cultivated	Boonma T. NY148	FO, OR	In, Wp	EN: C2a(i,ii), D1	Rare
146	*Zingiber mekongense* Gagnep.	Khing Mae Kong	–	C	–	–	NA	4–6	Not seen	Cultivated	Boonma T. NY149	FO, MD	Rz, In	—-	Rare

Table 1. *Cont.*

No.	Species Name	Vernacular Name	Distribution				Distribution Status	Phenology		Ecology	Voucher Specimens	Utilization	Used Parts	Conservation Status for Wild Species	Conservation Status
			Mueang	Ban Na	Ongkharak	Pak Phli		Flowering Periods	Fruiting Periods						
147	*Zingiber niveum* Mood & Theilade	Khing Kai Mook	–	C	–	–	NA	7–8	Not seen	Cultivated	Boonma T. NY150	OR	Wp	—-	Rare
148	*Zingiber officinale* Roscoe	Khing	C	C	C	C	IN	7–10	Not seen	Cultivated	Boonma T. NY142	FO, SP, MD, CC, CM	Rt, Rz, Ps, Lv, In, Fs	—-	Common
149	*Zingiber ottensii* Valeton	Plai Dam	C	C	C	C	IN	7–10	Not seen	Cultivated	Boonma T. NY143	MD, CC, RS, OR	Rz, In, Wp	—-	Common
150	*Zingiber pellitum* Gagnep.	Khing Cha Nee	W	B	–	W	NA	7–9	Not seen	DEF, Cultivated	Boonma T. NY151	OR	Wp	EN: C2a(i,ii), D1	Rare
151	*Zingiber purpureum* Roscoe	Plai, Plai Lueang	C	C	C	C	IN	6–9	Not seen	Cultivated	Boonma T. NY152	MD, CC, RS, CM	Rt, Rz, Ps, Lv, In, Wp	—-	Common
	Zingiber purpureum Roscoe (Variegated)	Plai Dang	C	C	C	C	IN	6–9	Not seen	Cultivated	Boonma T. NY153	CC, RS	Rz, In, Wp	—-	Common
152	*Zingiber pyroglossum* Triboun & K. Larsen	Khing Kra Tai Yai	W	C	–	W	ED	7–9	Not seen	DEF, Cultivated	Boonma T. NY154	MD, OR	Rt, Rz, Wp	EN: C2a(i,ii), D1	Rare
153	*Zingiber spectabile* Griff.	Kra Tue Pi Lat	C	C	C	C	NA	5–9	Not seen	Cultivated	Boonma T. NY155	CC, OR	Wp	—-	Rare
154	*Zingiber thorelii* Gagnep.	Dok Din, Ta Kha Pa	W	B	–	W	NA	7–9	Not seen	DEF, Cultivated	Boonma T. NY144	FO,	Ps, In	EN: C2a(i,ii), D1	Rare

Table 1. *Cont.*

No.	Species Name	Vernacular Name	Distribution				Distribution Status	Phenology		Ecology	Voucher Specimens	Utilization	Used Parts	Conservation Status for Wild Species	Conservation Status
			Mueang	Ban Na	Ongkharak	Pak Phli		Flowering Periods	Fruiting Periods						
155	*Zingiber zerumbet* (L.) Roscoe ex Sm.	Kra Tue	B	B	C	B	NA	6–10	Not seen	MDF, Cultivated	Boonma T. NY156	FO, MD, CC, RS	Rz, Ps, Lv, In, Wp	LC	Common
	Zingiber zerumbet (L.) Roscoe ex Sm. (Variegated)	Kra Tue Dang, Wan Pha Ya Mue Lek	C	C	C	C	NA	6–10	Not seen	Cultivated	Boonma T. NY157	CC, RS, OR	Rz, In, Wp	—-	Rare

Abbreviations: **Distribution**: W = found only in the wild; C = found only in cultivation; B = found both habitats. **Distribution status**: NA = native; ED = endemic; IN = introduced species. **Phenology**: 1 = January; 2 = February; 3 = March; 4 = April; 5 = May; 6 = June; 7 = July; 8 = August; 9 = September; 10 = October; 11 = November; 12 = December. **Ecology**: DCF = deciduous Forest; DDF = deciduous dipterocarp forest; MDF = mix deciduous forest; EGF = evergreen Forest; DEF = dry evergreen forest. **Utilization**: FO = foods; SP = spices; MD = medicines; CF = cut flower; CC = commercial cultivation; RS = rituals and other socio-religious practices; OR = ornamental; CM = cosmetics. **Used parts**: Rt = roots; Rz = rhizomes; Ps = pseudostems; Lv = leaves; In = inflorescences (including flowers); Fs = fruits and seeds; Wp = whole plant. IUCN assessment status for wild species in this study by IUCN Red List Ver. 15.1 (July 2022): CR = critically Endangered; EN = endangered; LC = least concern; NT = near threatened; DD = data deficient.

2.7. Vernacular Name Study

The vernacular name of the Zingiberaceae plant in Nakhon Nayok Province was asked about by the local people during the survey area.

2.8. Conservation Status

The conservation status assessment is divided into two parts: the first part assesses only the status of wild species found in Nakhon Nayok Province. The assessment was based on the IUCN Red List criteria [179]. The second part will cover the conservation status of plants based on the conservation status reported on the website https://www.iucnredlist.org/ and the conservation status that is reported in relevant documents, which are assessed using the IUCN Red List criteria.

3. Results

3.1. The Diversity of the Zingiberaceae in Nakhon Nayok Province

In Nakhon Nayok Province, the Zingiberaceae family represented by 3 tribes, 16 genera, 155 species, and 5 variants, was recognized. Among these numbers, there are 23 species of tribe Alpinieae, 12 species of tribe Globbeae, and 120 species of tribe Zingibereae, as shown in Figure 2, where the colors of the bar graph represent the placement of the genera in each tribe.

In the tribe Alpinieae, the highest diversity is observed in *Alpinia* with 10 species, followed by 4 *Amomum* spp. and 3 *Etlingera* spp. In the tribe Globbeae, *Globba* exhibits the highest diversity with 10 species, while *Gagnepainia* is found to have 2 species. In the tribe Zingibereae, *Curcuma* is the most diverse with 59 species, followed by 30 *Kaempferia* spp., and 13 *Zingiber* spp. Details of the Zingiberaceae species found in Nakhon Nayok Province are provided in Table 1.

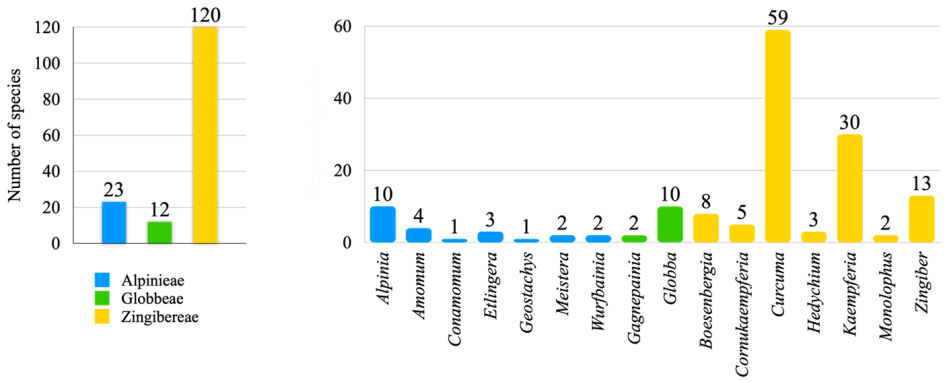

Figure 2. Species diversity of Zingiberaceae found in Nakhon Nayok Province classified by tribe and genus.

3.2. Distribution of Zingiberaceae in Nakhon Nayok Province

The distribution of species of Zingiberaceae found in Nakhon Nayok Province is categorized into three groups: plants found in the wild, plants found in cultivation, and plants found in both areas.

In the area of the Mueang district, 45 species were found in the wild, 51 species were found in cultivation, and 14 species were found in both situations. Among these are 31 species found only in the wild and not in cultivation, while 37 species found only in cultivation are not found in the wild. In the Ban Na district, 28 species were found in the wild, 142 species were found in cultivation, and 22 species were found in both situations. Among these, 6 species are found only in the wild and not in cultivation, while 120 species are found only in cultivation and not in the wild. In the Ongkharak district, 62 species were found in cultivation; no wild species were found. And in the Pak Phli district, 42 species were found in the wild, 49 species were found in cultivation, and 13 species were found in

both situations. Among these are 29 species found only in the wild and not in cultivation, while 36 species found only in cultivation are not found in the wild.

In the overview of Nakhon Nayok Province, 45 species were found in the wild, 142 species were found as cultivated plants, and 32 species were found both in the wild and in cultivation. Among these are 13 species found only in the wild and not in cultivation, while 110 species found only in cultivation are not found in the wild. The categorization is further presented for each district, with an overall summary provided for the province in Figure 3.

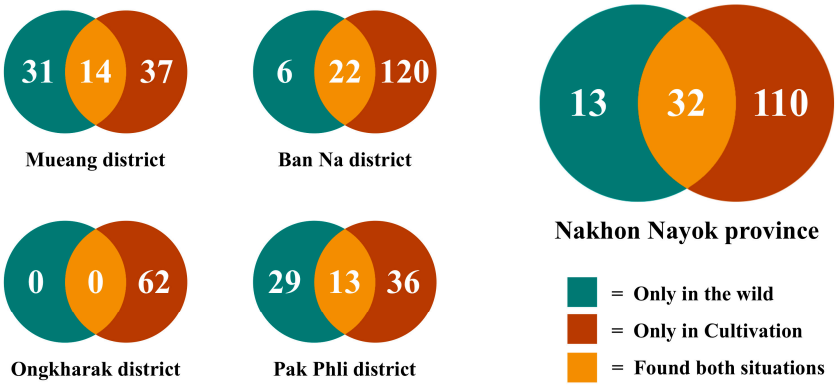

Figure 3. Illustrated chart shows the number of species encountered, categorized into three groups: plants found only in the wild, plants found in cultivation, and plants found in both situations.

At the genus level, it is found that the *Globba* genus has the highest number of wild species, followed by 6 *Zingiber* spp. *Boesenbergia* and *Curcuma* each have 5 species, 4 *Alpinia* spp., 3 *Kaempferia* spp. *Etlingera*, *Meistera*, *Monolophus*, and *Wurfbainia* each have 2 species. *Amomum*, *Conamomum*, *Gagnepainia*, and *Geostachys* each have one species, while *Cornukaempferia* and *Hedychium* are not found in the wild of Nakhon Nayok Province.

The highest number of cultivated species is the genus *Curcuma* with 59 species, followed by 30 *Kaempferia* spp., 13 *Zingiber* spp., 10 *Alpinia* spp., and 8 *Boesenbergia* spp. *Cornukaempferia* and *Globba* each have 5 species. *Amomum* and *Hedychium* each have 3 species. *Etlingera*, *Gagnepainia*, and *Wurfbainia* each have 2 species. While *Conamomum*, *Geostachys*, *Meistera*, and *Monolophus* are not found cultivated in Nakhon Nayok Province.

The highest number of species found in both situations are the genus *Zingiber* with 6 species, followed by *Boesenbergia*, *Curcuma*, and *Globba* each have 5 species. Four *Alpinia* spp., three *Kaempferia* spp., and two 2 *Wurfbainia* spp. *Amomum*, *Etlingera*, and *Gagnepainia* each have one species. An informative chart (Figure 4) has been prepared to compare the species diversity of Zingiberaceae found in the forest with the number of species found in cultivation in Nakhon Nayok Province. The chart categorizes the data by genus, providing a clear visual representation of the differences in species distribution between the two habitats at the genus level.

The results of the species diversity and distribution of Zingiberaceae plants in Nakhon Nayok Province could be used to analyze the similarities between wild and cultivated plants found in each district of Nakhon Nayok Province, as shown in Figure 5.

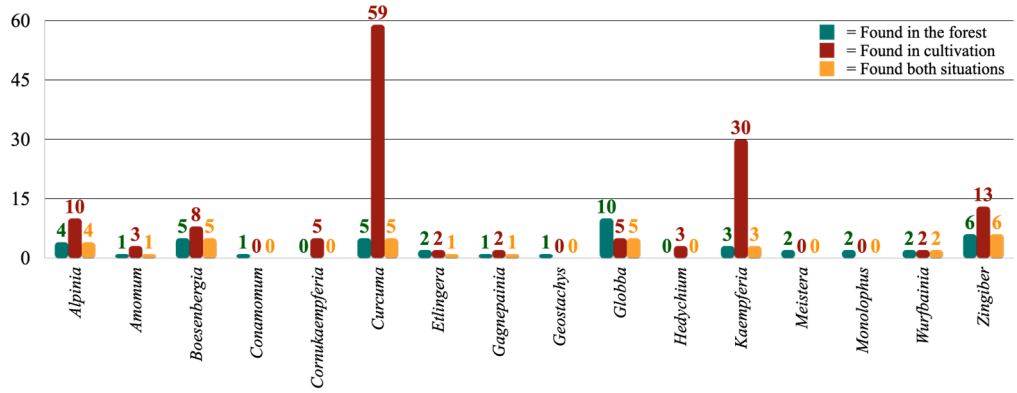

Figure 4. Comparison chart presenting the species diversity of Zingiberaceae found in the forest and the number of species found in cultivation, and the number of species found in both situations in Nakhon Nayok Province, categorized by genus.

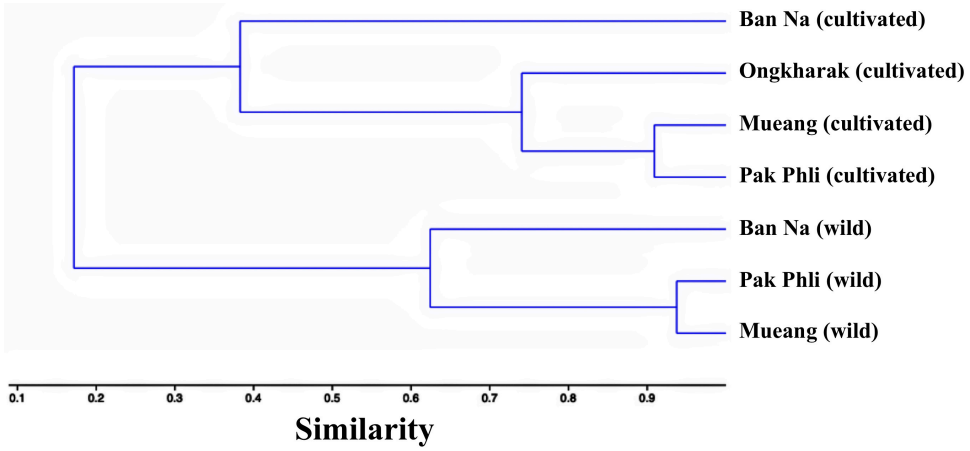

Figure 5. UPGMA cluster analysis dendrogram of Zingiberaceae plants found in Nakhon Nayok Province, similarity index based on Jaccard Index, with cophenetic correlation = 0.9955.

The UPGMA cluster analysis dendrogram reveals the similarity of Zingiberaceae plants found in Nakhon Nayok Province. The dendrogram indicates that Zingiberaceae plants in the wild from the Mueang district, Pak Phli district, and Ban Na district form the same group, indicating the presence of similar species that could be attributed to the continuous forest areas and similar forest characteristics in these districts. These districts are predominantly comprised of evergreen forests mixed with deciduous forests. Notably, the Mueang district and Pak Phli district exhibit a higher level of species similarity compared to other districts, with Ban Na district following closely in terms of similarity. Even though the Ban Na district shares a border with the Mueang district, it has a smaller forest area. Consequently, it has lower species diversity compared to the Mueang district and Pak Phli district. On the contrary, the absence of wild areas in the Ongkharak district, which predominantly consists of plains, is the primary reason for the lack of wild species found there. As a result, only cultivated species are present in the Ongkharak district. Therefore, the similarity analysis of species diversity excludes wild species from the Ongkharak district from the dendrogram.

Another branch of dendrograms also indicated the similarity of cultivated plants found in different districts. It was revealed that the Ban Na district was very different from other districts and thus was initially isolated from the group of cultivated Zingiberaceae plants found in Nakhon Nayok Province. Since many of the plants found in Ban Na district are different from those in other districts, most of them are found in Brio Garden, which was planted for research on the diversity of the Zingiberaceae family, especially in the Zingibereae tribe. Following that, the Ongkharak district was found to be less similar

to the cultivated plants in the Pak Phli district and Mueang district. This difference can be attributed to the Ongkharak district being a district with a flower and plant market, resulting in a variety of differently grown plants compared to those in the Mueang and Pak Phli districts.

3.3. Distribution Status

Of all 155 species of Zingiberaceae found in Nakhon Nayok Province, 145 are native to Thailand, while 63 are endemic to Thailand. Among these numbers, 13 endemic species to Thailand are found in the forest of Nakhon Nayok Province including *Boesenbergia collinsii* Mood & L.M. Prince, *Curcuma achrae* Saensouk & Boonma, *C. rangsimae* Boonma & Saensouk, *Geostachys smitinandii* K. Larsen, *Globba chrysantha* Sangvir. & M.F. Newman, *G. chrysochila* Sangvir. & M.F. Newman, *G. obscura* K. Larsen, *G. williamsiana* M.F. Newman & Sangvir., *G. xantholeuca* Craib, *Kaempferia nigrifolia* Boonma & Saensouk, *Monolophus pedemontanus* (Triboun & K. Larsen) Veldk. & Mood, *M. saxicola* (K. Larsen) Veldk. & Mood, and *Zingiber pyroglossum* Triboun & K. Larsen.

There are 10 introduced species, including *Alpinia purpurata* (Vieill.) K. Schum., *A. vittata* W. Bull., *Curcuma longa* L., *C. mangga* Valeton & Zijp, *C. myanmarensis* (W.J. Kress) Škorničk., *C. zedoaria* (Christm.) Roscoe, *Kaempferia gilbertii* W. Bull, *Zingiber officinale* Roscoe, *Z. ottensii* Valeton, and *Z. purpureum* Roscoe.

3.4. Ecology

Out of the 45 species that were found exclusively in the wild, the majority (29 species) were discovered in dry evergreen forests, followed by 11 species in mixed deciduous forests, 9 species in evergreen forests, 4 species in deciduous forests, and 1 species in deciduous dipterocarp forests. While 142 species are found cultivated in home gardens, shops, and residential areas, either in pots or directly in the ground, some species are grown on large plots for commercial purposes such as *Alpinia galanga* (L.) Willd., *A. siamensis* K. Schum., *Boesenbergia rotunda* (L.) Mansf., *Curcuma amada* Roxb., *C. longa* L., *C. mangga* Valeton & Zijp, and *Z. purpureum* Roscoe.

3.5. Phenology

The Zingiberaceae plants found in Nakhon Nayok Province exhibited the highest flowering period between June and September. In most cases found in all three tribes, it was observed that the plants bloomed after the maturation of their pseudostems.

Another group of plants was found to flower from February to May. These plants often produce flowers before the emergence of their pseudostems. For example, in the Zingibereae tribe, certain species produced lateral inflorescences directly from the rhizome prior to the emergence of new shoots after their dormancy period. Examples of such species include *Curcuma achrae* Saensouk & Boonma, *C. aeruginosa* Roxb., *C. mangga* Valeton & Zijp, *C. rubescens* Roxb., and *Kaempferia rotunda* L. Some species were found to produce both lateral and terminal inflorescences both before and after the production of new pseudostems, such as *C. angustifolia* Roxb.

Furthermore, certain species belonging to the Alpinieae tribe, which typically do not undergo dormancy in the dry season, also produced inflorescences during this period. Examples of such species include *Alpinia mutica* Roxb., *A. oxymitra* K. Schum., and *Amomum wandokthong* (Picheans. & Yupparach) Škorničk. & Hlavatá. Additionally, there were species capable of producing inflorescences and flowering throughout the year, such as *Alpinia purpurata* (Vieill.) K. Schum. and *Etlingera elatior* (Jack) R.M. Sm.

From the survey conducted in this study, it was observed that only 34 plants from the Zingiberaceae family in Nakhon Nayok Province were found to bear fruits. Most of these plants exhibited fruiting between August and October, which corresponds to the species that bloom from June to September. Additionally, from April to July, the fruiting of another group of plants was observed, which typically blooms from February to May. Figure 6 illustrates that most plants belonging to the Zingiberaceae family in Nakhon

Nayok Province enter a dormant phase during the winter. It is rare to observe flowering and fruiting between November and February.

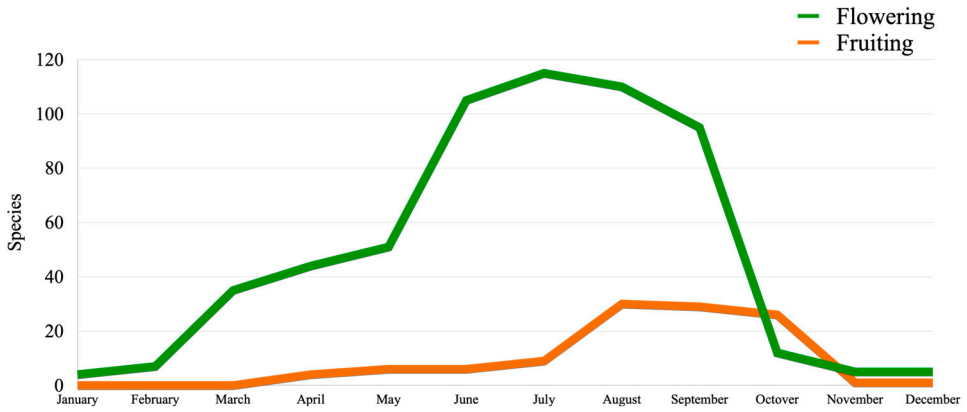

Figure 6. Phenology range of Zingiberaceae plants in Nakhon Nayok Province.

3.6. Conservation Status

The IUCN assessment status for the wild species in this study, based on the IUCN Red List Ver. 15.1 (July 2022) [179], reveals some concerning findings. *Curcuma achrae* Saensouk & Boonma is classified as critically endangered. This species has a critically low population, with fewer than 50 mature individuals existing within restricted areas of Nakhon Nayok Province. The risk of extinction for this species is particularly high. Additionally, 19 species are categorized as Endangered, indicating a significant risk of extinction in the wild. These species face various threats and require immediate conservation attention to prevent their decline. On a more positive note, 22 species have been assessed as least concern, suggesting that they currently have a relatively low risk of extinction. However, continued monitoring and conservation efforts are necessary to ensure their long-term survival. Lastly, two species fall under the category of data deficient, meaning that there is insufficient information available to evaluate their conservation status accurately. Further research and data collection are needed to assess the level of risk they may face and implement appropriate conservation measures. Overall, these assessment results highlight the urgent need for conservation action to protect endangered and critically endangered species and promote their long-term viability in the wild.

This study has revealed the existence of numerous species previously unrecorded in their distribution within the captivating landscapes of Nakhon Nayok Province. These findings hold significant importance as they have brought to light a collection of endemic species found exclusively in this region. The researchers remain hopeful that further exploration within the abundant World Heritage forests of Nakhon Nayok Province may uncover more hidden species.

Based on this study, certain species in Nakhon Nayok Province do not have a specific conservation category assigned by the IUCN. Therefore, we provide fundamental information about the conservation status of these species, thus supporting conservation efforts within the province. This information also holds significance for the conservation of these species at the national and global levels. It is crucial to prioritize the protection of endemic species exclusively found in Nakhon Nayok Province. For instance, *Curcuma achrae* Saensouk & Boonma, endemic to Thailand and solely found in Nakhon Nayok Province, have not been reported in nearby provinces for several years since their discovery as a new species. Similarly, *Curcuma rangsimae* Boonma & Saensouk is endemic to the Sankamphaeng Mountain range in Thailand. However, it is crucial to acknowledge the vulnerability of these remarkable species. They might face imminent threats that could lead to their extinction if their habitats are disrupted, such as encroachment on the forest perimeters or the construction of additional reservoirs and dams in the World Heritage Forest, especially in the Sankamphaeng Mountains range. These circumstances have a

direct and detrimental impact on the natural habitats of these species. To ensure the future preservation and sustainable management of invaluable forest resources, comprehensive evaluations must be conducted. Additionally, tailored conservation plans need to be developed, placing a high priority on protecting these unique plant species in Nakhon Nayok Province not only the Zingiberaceae plant but also other natural resources.

3.7. Traditional Utilization of the Zingiberaceae in Nakhon Nayok Province

Three tribes, 12 genera, and 142 species of Zingiberaceae in Nakhon Nayok Province are utilized for food, spices, medicinal purposes, ornamental purposes, cut flowers, commercial cultivation, rituals and other socio-religious practices (Table 1). It has been found that the genus with the highest utilization is *Curcuma*, with 59 species. Followed by 30 *Kaempferia* spp., 13 *Zingiber* spp., 10 *Alpinia* spp., 8 *Boesenbergia* spp., 5 *Cornukaempferia* spp., 5 *Globba* spp., 3 *Amomum* spp., 3 *Hedychium* spp., 2 *Etlingera* spp., 2 *Gagnepainia* spp., and 2 *Wurfbainia* spp. When comparing the number of utilized species to the number of species found in the forest, it is evident that many genera have a higher number of utilized species than the number found in the forest. Additionally, it is noted that two genera, *Cornukaempferia* and *Hedychium*, are not found in the forests of Nakhon Nayok Province but are still utilized locally. These genera originate from other provinces in Thailand. And several species of the Zingiberaceae family have been brought from other provinces to be cultivated for their benefits (Figure 4, Table 1). At the same time, some genera are found in the forest but are not utilized locally or within communities. These include *Amomum repoeense* Pierre ex Gagnep., *Conamomum pierreanum* (Gagnep.) Škorničk. & A.D. Poulsen, *Etlingera araneosa* (Baker) R.M. Sm., *Geostachys smitinandii* K. Larsen, *Globba aranyaniae* Sangvir. & M.F. Newman, *G. chrysantha* Sangvir. & M.F. Newman, *G. obscura* K. Larsen, *G. thorelii* Gagnep., *G. xantholeuca* Craib, *Meistera koenigii* (J.F.Gmel.) Škorničk. & M.F. Newman, *M. tomrey* (Gagnep.) Škorničk. & M.F. Newman, *Monolophus pedemontanus* (Triboun & K. Larsen) Veldk. & Mood and *M. saxicola* (K. Larsen) Veldk. & Mood.

3.7.1. Used as Foods

The study conducted in Nakhon Nayok Province reveals that there are 28 species from the Zingiberaceae family that are utilized as food. These species belong to two tribes. Tribe Alpinieae with 10 species in 4 genera, and tribe Zingibereae, with 18 species in 3 genera, while no plants from the tribe Globbeae are used as food.

The genus *Curcuma* has the highest number, with eight species including *C. aeruginosa* Roxb., *C. amada* Roxb., *C. angustifolia* Roxb., *C. candida* (Wall.) Techapr. & Škorničk., *C. cordata* Wall., *C. longa* L., and *C. mangga* Valeton & Zijp. However, not all of them are wild species. Followed by *Alpinia* and *Zingiber*, each with six species, but only two species of *Alpinia*, namely *Alpinia galanga* (L.) Willd. and *A. oxymitra* K. Schum., and three species of *Zingiber*, namely *Z. junceum* Gagnep., *Z. thorelii* Gagnep., and *Z. zerumbet* (L.) Roscoe ex Sm. are found in the wild of Nakhon Nayok Province. As for *Kaempferia*, four species were used as food, but only two species, namely *K. marginata* Carey ex Roscoe and *K. nigrifolia* Boonma & Saensouk, are found in the wild of Nakhon Nayok Province. In the *Etlingera* genus, *Etlingera araneosa* (Baker) R.M.Sm. and *E. pavieana* (Pierre ex Gagnep.) R.M. Sm. are found in the wild. Lastly, there is one species of *Wurfbainia* namely *W. testacea* (Ridl.) Škorničk. & A.D. Poulsen.

The most preferred edible parts of these plants are the young inflorescences (45%), followed by the young pseudostems (31%), rhizomes (10%), leaves (10%), fruits and seeds (4%), respectively (Figure 7). These species and their mentioned parts are commonly consumed either fresh or boiled as side dishes. They are often enjoyed with chili paste, adding a spicy flavor to the dish. Moreover, the rhizome of *Zingiber officinale* Roscoe Ginger can also be made into pickled ginger by taking peeled ginger rhizomes, slicing them, soaking them in brine, and setting them aside. If using old ginger rhizomes, they should be squeezed several times in brine until the ginger has reduced its spiciness. In the meantime, simmer the vinegar, sugar, salt, and water together until it boils, and the sugar is completely

dissolved. Turn off the heat and let it sit until it is warm. Then, squeeze out the brine from the ginger soaked in brine and add it to the prepared ginger pickle mixture. Stir well and add the juice of one lemon (at this step, the ginger will turn light pink). Stir well again and store the pickled ginger in a container with a tight-fitting lid. If using young ginger, it can be eaten right away, or it can be refrigerated for about 1 h before serving for an even more delicious flavor. Typically, villagers collect these plants from their home gardens. However, in cases where a larger quantity is needed or during special events and celebrations, they may purchase them from the market, such as *Alpinia galanga* (L.) Willd., *A. siamensis* K. Schum., *Curcuma longa* L., *C. mangga* Valeton, and *Zingiber officinale* Roscoe.

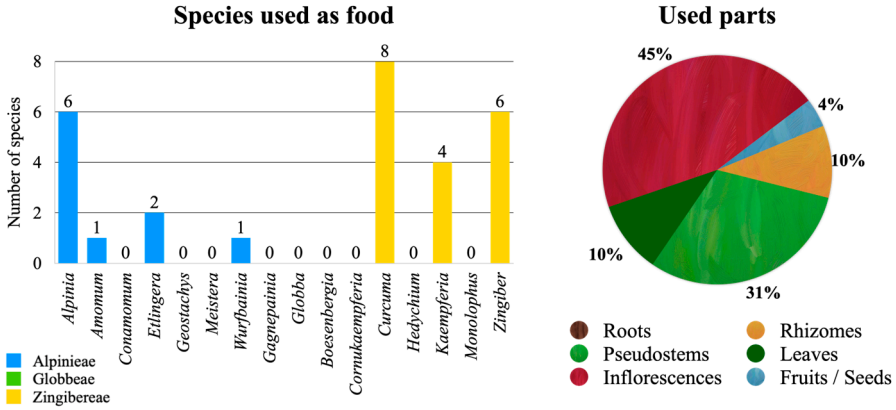

Figure 7. Species diversity and used parts of Zingiberaceae plants as food in Nakhon Nayok Province.

3.7.2. Used as Spices

There are 11 species in the Zingiberaceae family that are used as spices to enhance the flavor, aroma, and color of food. These species belong to two tribes. Tribe Alpinieae with 7 species in 4 genera, and tribe Zingibereae with 4 species in 3 genera, including *Alpinia galanga* (L.) Willd., *A. laosensis* Gagnep. *A. siamensis* K. Schum., *Amomum foetidum* Boonma & Saensouk, *Boesenbergia rotunda* (L.) Mansf., *Curcuma longa* L., *C. mangga* Valeton & Zijp, *Etlingera pavieana* (Pierre ex Gagnep.) R.M. Sm., *Wurfbainia testacea* (Ridl.) Škorničk. & A.D. Poulsen, *W. uliginosa* (J. Koenig) Giseke, and *Zingiber officinale* Roscoe. While no plants from the tribe Globbeae are used as spices in Nakhon Nayok Province (Figure 8).

In the tribe Alpinieae, 3 *Alpinia* spp. were used as spices: Cut fresh rhizomes into thin slices or mash and mix into a curry paste; or finely ground old rhizomes, roasted until they turn yellow, added to the fish porridge to help extinguish the fishy taste and smell; or sliced, used as a spice ingredient in foods such as Tom Kha Gai (Thai coconut milk soup with chicken), Tom Yum (spicy soup), Tom Klong Pla Tu (sour and spicy smoked dry fish soup). In the case of *Amomum foetidum*, the whole plant is used as a substitute for stink bugs (*Tessaratoma papillosa* Drury) to make "Mangkang chili paste". The rhizome of *Etlingera pavieana* (Pierre ex Gagnep.) R. M. Sm. is used as a spice in noodle soup, just as the fruits and seeds of *Wurfbainia testacea* (Ridl.) Škorničk. & A.D. Poulsen are utilized as spices in massaman curry, stewed sweet brown sauce, and boat noodles. While in tribe Zingibereae; the roots of *Boesenbergia rotunda* (L.) Mansf. are commonly used alongside its rhizome by thoroughly pounded or roughly pounded rhizomes and tuberous roots as a spice in making curry sauce called "Nam Ya" in Thai, usually eaten with Thai rice noodles well known as "Khanom Jeen". The rhizome of *Curcuma longa* L. is an essential ingredient in Thai curry pastes, particularly yellow curry paste. It imparts a vibrant golden hue and an earthy flavor. Prepare the yellow curry paste by combining the rhizome of *C. longa* with other spices such as coriander root, cumin, and chili. Pound them together and pulverize them into a homogeneous mass. For stir-fried dishes, enhance the flavor of vegetables or meat by adding a small amount of *C. longa* L. powder. It contributes to the dish's aroma and color and pairs well with ingredients such as ginger, garlic, and lemongrass. Moreover, it can be used to infuse steamed or fried rice, adding flavor and a pleasant golden color. Incorporate

a pinch of turmeric powder during the cooking process. The rhizomes of *Curcuma mangga* Valeton & Zijp are thinly sliced and used as a spice to neutralize the fishy smell in fish curry, eel curry, or spicy stir-fried eel. While the rhizomes of *Zingiber officinale* Roscoe are used as spices in many dishes such as slicing them into small strips for stir-fried ginger with chicken dishes.

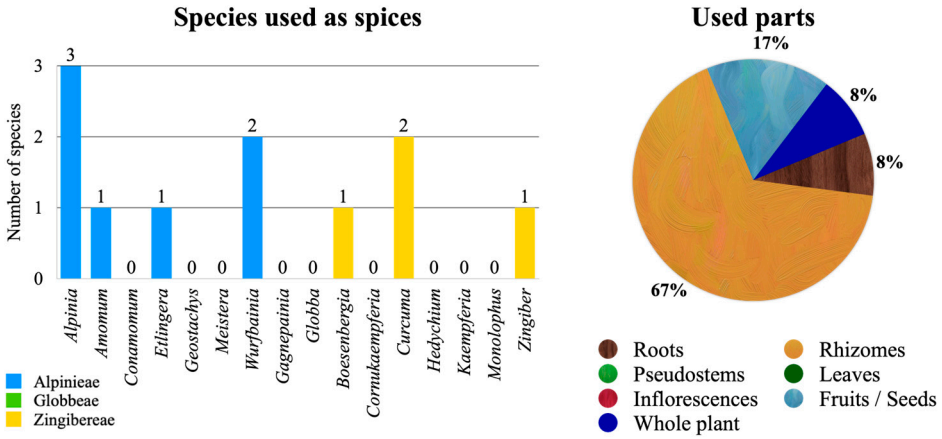

Figure 8. Species diversity and used parts of Zingiberaceae plants as spices in Nakhon Nayok Province.

The rhizomes are the most preferred parts used as spices (67%). Followed by fruits/seeds (17%), roots (8%), and whole plant (8%). Villagers typically collect these plants, which they cultivate in their own home gardens. However, if they do not have a sufficient quantity, they may also purchase them from the market.

3.7.3. Used as Medicines

In Nakhon Nayok Province, 44 species of Zingiberaceae plants have been used as remedies for various conditions in traditional folk medicine. Among them, 13 species belong to the tribe Alpinieae, consisting of 9 *Alpinia* spp., *Amomum* and *Etlingera* each with 1 species, and 2 *Wurfbainia* spp. While 31 species belong to the tribe Zingibereae which consisted of 1 species of *Boesenbergia*, 15 *Curcuma* spp., 1 species of *Hedychium*, 7 *Kaempferia* spp., and 7 *Zingiber* spp. However, there are no species belonging to the tribe Globbeae that are used as medicinal plants.

Among these numbers, the genus *Curcuma* has the highest number with 15 species, followed by 9 *Alpinia* spp., 7 *Kaempferia* spp., and 7 *Zingiber* spp. The most commonly used parts of the plants used for medicinal purposes are the rhizomes (44%), followed by the roots (15%), leaves (14%), pseudostems (10%), inflorescences (10%), fruits and seeds (6%), and the whole plant (2%) (Figure 9).

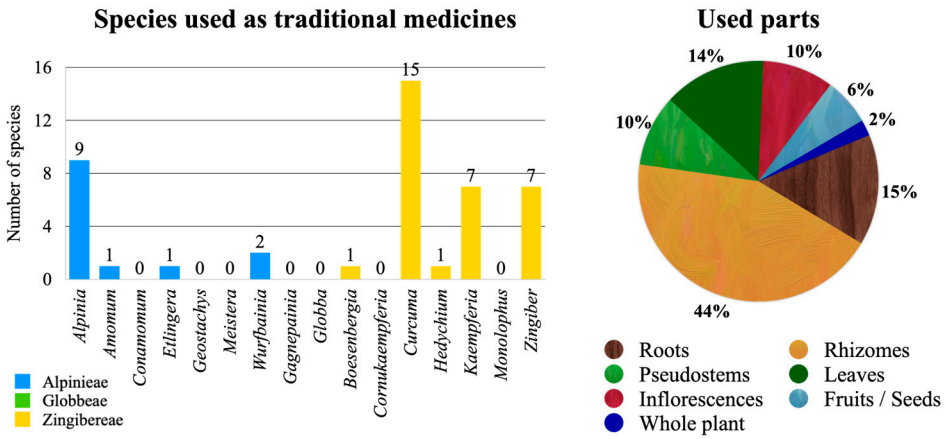

Figure 9. Species diversity and used parts of Zingiberaceae plants as traditional medicines in Nakhon Nayok Province.

Zingiberaceae plants in Nakhon Nayok Province were used as traditional medicines to treat various groups of symptoms. Among these, the gastro-intestinal group showed the highest utilization, with 32 species of Zingiberaceae plants being used (c. 23% of species used for medicinal purposes), including *Alpinia galanga* (L.) Willd., *A. laosensis* Gagnep., *A. mutica* Roxb., *A. oxymitra* K. Schum., *A. purpurata* (Vieill.) K. Schum., *A. siamensis* K. Schum., *A. zerumbet* (Pers.) B.L. Burtt & R.M. Sm., *Boesenbergia rotunda* (L.) Mansf., *Curcuma aeruginosa* Roxb., *C. aromatica* Salisb., *C. comosa* Roxb., *C. globulifera* Škorničk. & Soonthornk., *C. latifolia* Rosc., *C. longa* L., *C. mangga* Valeton & Zijp, *C. roscoeana* Wall., *C. zedoaria* (Christm.) Roscoe, *Etlingera elatior* (Jack) R.M. Sm., *Kaempferia angustifolia* Roxb., *K. galanga* L., *K. marginata* Carey ex Roscoe, *K. parviflora* Wall. ex Baker, *K. roscoeana* Wall., *K. rotunda* L., *Wurfbainia testacea* (Ridl.) Škorničk. & A.D. Poulsen, *W. uliginosa* (J. Koenig) Giseke, *Zingiber citriodorum* Theilade & Mood, *Z. officinale* Roscoe, *Z. ottensii* Valeton, *Z. purpureum* Roscoe, *Z. pyroglossum* Triboun & K. Larsen and *Z. zerumbet* (L.) Roscoe ex Sm.

Following the skin system group are 21 species of Zingiberaceae plants being used (c. 15% of species used for medicinal purposes), including *Alpinia galanga* (L.) Willd., *A. laosensis* Gagnep., *A. nigra* (Gaertn.) Burtt, *A. oxymitra* K. Schum., *A. siamensis* K. Schum., *A. vittata* W. Bull, *A. zerumbet* (Pers.) B.L. Burtt & R.M. Sm., *Boesenbergia rotunda* (L.) Mansf., *Curcuma aromatica* Salisb., *C. longa* L., *C. macrochlamys* (Baker) Škorničk., *C. phrayawan* Boonma & Saensouk, *C. rangjued* Saensouk & Boonma, *Etlingera elatior* (Jack) R.M. Sm., *Kaempferia angustifolia* Roxb., *K. elegans* Wall., *K. galanga* L., *K. parviflora* Wall. ex Baker, *Wurfbainia uliginosa* (J. Koenig) Giseke, *Zingiber officinale* Roscoe, and *Z. pyroglossum* Triboun & K. Larsen.

In the musculoskeletal and joint diseases group, 15 species of Zingiberaceae plants are being used (c. 11% of species used for medicinal purposes), including *Alpinia galanga* (L.) Willd., *A. purpurata* (Vieill.) K. Schum., *A. zerumbet* (Pers.) B.L. Burtt & R.M. Sm., *Curcuma aromatica* Salisb., *C. longa* L., *C. macrochlamys* (Baker) Škorničk., *C. rubescens* Roxb., *C. stenochila* Gagnep., *C. wanenlueanga* Saensouk, Thomudtha & Boonma, *C. zedoaria* (Christm.) Roscoe, *Hedychium coronarium* J. Koenig, *Kaempferia parviflora* Wall. ex Baker, *Zingiber mekongense* Gagnep., *Z. ottensii* Valeton, and *Z. purpureum* Roscoe.

In the obstetrics, gynecology and urinary disorders group, 15 species of Zingiberaceae plants are being used (c. 11% of species used for medicinal purposes), including *Alpinia galanga* (L.) Willd., *A. oxymitra* K. Schum., *Boesenbergia rotunda* (L.) Mansf., *Curcuma aeruginosa* Roxb., *C. aromatica* Salisb., *C. comosa* Roxb., *C. latifolia* Roscoe, *C. longa* L., *C. wanenlueanga* Saensouk, Thomudtha & Boonma, *Hedychium coronarium* J. Koenig, *Kaempferia angustifolia* Roxb., *K. galanga* L., *Wurfbainia uliginosa* (J. Koenig) Giseke, *Zingiber pyroglossum* Triboun & K. Larsen, and *Z. zerumbet* (L.) Roscoe ex Sm.

In the nutrition and blood group, 14 species of Zingiberaceae plants are being used (c. 10% of species used for medicinal purposes), including *Alpinia galanga* (L.) Willd., *A. oxymitra* K. Schum., *A. purpurata* (Vieill.) K. Schum., *Boesenbergia rotunda* (L.) Mansf., *Curcuma latifolia* Roscoe, *C. rangjued* Saensouk & Boonma, *Kaempferia angustifolia* Roxb., *K. galanga* L., *K. parviflora* Wall. ex Baker, *K. rotunda* L., *Wurfbainia testacea* (Ridl.) Škorničk. & A.D. Poulsen, *Zingiber officinale* Roscoe, *Z. ottensii* Valeton, and *Z. purpureum* Roscoe.

In the respiratory system group, 12 species of Zingiberaceae plants are being used (c. 8% of species used for medicinal purposes), including *Alpinia galanga* (L.) Willd., *A. laosensis* Gagnep., *A. oxymitra* K. Schum., *A. siamensis* K. Schum., *Amomum dealbatum* Roxb., *Curcuma aromatica* Salisb., *C. longa* L., *Kaempferia galanga* L., *K. roscoeana* Wall., *Wurfbainia uliginosa* (J. Koenig) Giseke, *Zingiber purpureum* Roscoe, and *Z. pyroglossum* Triboun & K. Larsen.

The antipyretics group includes 12 species of Zingiberaceae plants (c. 8% of species used for medicinal purposes), including *Alpinia galanga* (L.) Willd., *A. oxymitra* K. Schum., *Boesenbergia rotunda* (L.) Mansf., *Curcuma longa* L., *Kaempferia galanga* L., *Kaempferia marginata* Carey ex Roscoe, *K. roscoeana* Wall., *K. rotunda* L., *Zingiber officinale* Roscoe, *Z. purpureum* Roscoe, *Z. pyroglossum* Triboun & K. Larsen, and *Z. zerumbet* (L.) Roscoe ex Sm.

In the cardiovascular system group, 8 species of Zingiberaceae plants are being used (c. 6% of species used for medicinal purposes), including *Alpinia galanga* (L.) Willd., *A.*

siamensis K. Schum., *Boesenbergia rotunda* (L.) Mansf., *Curcuma comosa* Roxb., *C. longa* L., *Zingiber mekongense* Gagnep., *Z. officinale* Roscoe, and *Z. purpureum* Roscoe.

In the eyes group, 5 species of Zingiberaceae plants are being used (c. 4% of species used for medicinal purposes), including *Alpinia oxymitra* K. Schum., *Kaempferia angustifolia* Roxb., *K. galanga* L., *K. rotunda* L., and *Zingiber officinale* Roscoe.

In the poisoning and toxicology group, 5 species of Zingiberaceae plants are being used (c. 4% of species used for medicinal purposes), including *Curcuma aeruginosa* Roxb., *C. longa* L., *C. rangjued* Saensouk & Boonma, *Zingiber officinale* Roscoe, and *Z. ottensii* Valeton.

In the infections group, 2 species of Zingiberaceae plants are being used (c. 1% of species used for medicinal purposes), including *Curcuma longa* L., and *Zingiber officinale* Roscoe.

In the central nervous system group, 1 species of Zingiberaceae plants is being used (c. 1% of species used for medicinal purposes), *Zingiber zerumbet* (L.) Roscoe ex Sm.

Mostly used to treat gastrointestinal (c. 23%), skin system (c. 15%), obstetrics, gynecology, and urinary disorders (c. 11%), and musculoskeletal and joint diseases (c. 11%), respectively. Moreover, it is used to nourish nutrition and blood (c. 10%), treat respiratory system conditions (c. 8%), serve as antipyretics (c. 8%), treat cardiovascular system (c. 6%), handle poisoning and toxicology cases (c. 4%), treat the eyes (c. 4%), cure infections (c. 1%), and address central nervous system disorders (c. 1%) (Figure 10).

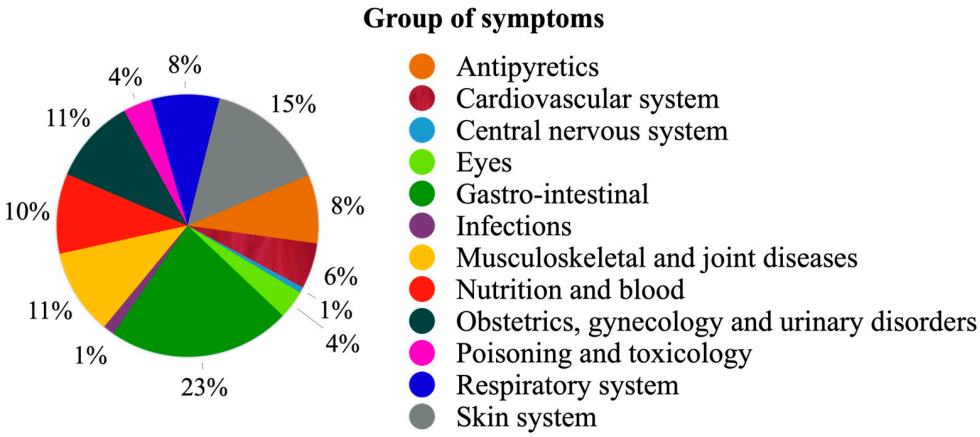

Figure 10. The utilization of Zingiberaceae plants as medicines in Nakhon Nayok Province, categorized by symptom groups.

3.7.4. Used as Cut Flowers

Due to their captivating beauty, wide range of vibrant colors, and impressive durability of their inflorescences, numerous species of Zingiberaceae plants possess immense potential for the development of diverse varieties, making them a highly favorable choice for cut flowers.

One of the key reasons for their popularity is the remarkable longevity of their inflorescences when displayed in a vase, as they can retain their freshness for an astonishing period of two to three weeks. Surprisingly, in the enchanting Nakhon Nayok Province, where nature's bounty thrives, the cultivation of Zingiberaceae plants for cut flowers remains limited to just a handful of dedicated gardens, with the majority of local agriculturists preferring to focus their efforts on selling ornamental flowers, lush foliage plants, and a plethora of other botanical delights.

Within the captivating landscapes of Nakhon Nayok Province, five distinct species of Zingiberaceae plants have been cultivated and used for their suitability as cut flowers (Figure 11). Among them, two species belong to the Alpinieae tribe, namely *Alpinia purpurata* (Vieill.) K. Schum., with its enchanting red and pink variants, and *Etlingera elatior* (Jack) R.M. Sm., which boasts captivating pink, red, and white variations. Additionally, three species belong to the Zingibereae tribe, showcasing the diversity within this captivating family of plants. These species include *Curcuma alismatifolia* Gagnep., *C. rhabdota* Sirirugsa

& M.F. Newman, and *C. thorelii* Gagnep., each possessing its own unique charm and visual appeal. However, all of them were not originated in Nakhon Nayok Province; 4 species of them were originated in other provinces in Thailand and cultivated in Nakhon Nayok Province, except for *Alpinia purpurata* (Vieill.) K. Schum which is an introduced species for Thailand, and is native to the Bismarck Archipelago, Maluku, New Caledonia, New Guinea, Solomon Island, and Vanuatu [1]. Nevertheless, they have been used in the area of Nakhon Nayok Province for more than 20 years.

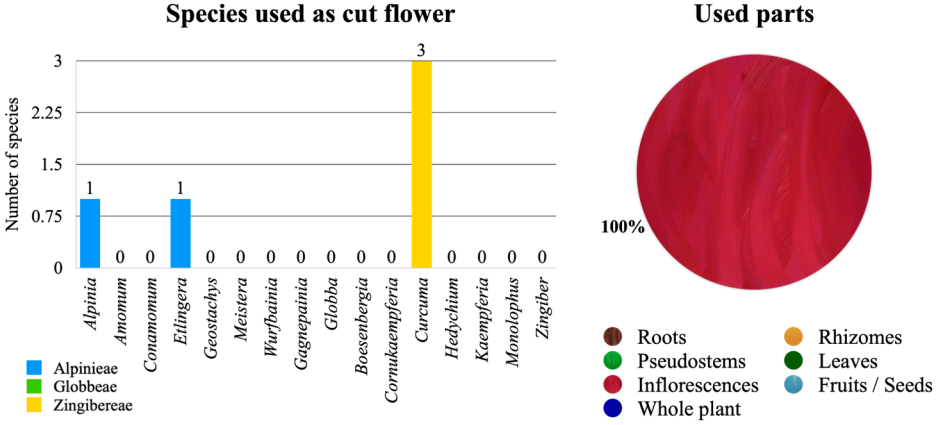

Figure 11. Species diversity and used parts of Zingiberaceae plants as cut flower in Nakhon Nayok Province.

3.7.5. Used as Ornamental Plants

The captivating Zingiberaceae plants naturally enrich the landscapes and tropical gardens of Nakhon Nayok Province and are renowned for their ornamental appeal. With vibrant colors, unique floral displays, and diverse species, these plants effortlessly enhance the beauty of their surroundings, captivating the hearts of locals and visitors alike. Zingiberaceae plants of various species can be found both planted in pots and used for planting and decorating the gardens of houses, buildings, resorts, and hotels, as well as various tourist attractions, especially in the rainy season. There are 82 species recognized as ornamental plants that belong to three tribes, including 7 species belonging to the tribe Alpinieae, which comprises 5 *Alpinia* spp., along with 1 species each of *Amomum* and *Etlingera*.

Another 7 species belonged to the tribe Globbeae, which consists of 2 *Gagnepainia* spp. and 5 *Globba* spp. The remaining 68 species belong to the tribe Zingibereae, which comprises 2 *Boesenbergia* spp., 5 *Cornukaempferia* spp., 28 *Curcuma* spp., 3 *Hedychium* spp., 22 *Kaempferia* spp., and 8 *Zingiber* spp. Among these numbers, the genus *Curcuma* has the highest number of species used as ornamental plants, followed by *Kaempferia*, and *Zingiber* respectively (Figure 12).

A number of Zingiberaceae species are used in the field of ornamental plants. The plants belonging to the Alpinieae tribe, which are found in Nakhon Nayok Province, mostly possess upright pseudostems and grow tall, often forming large clumps that require ample space. Therefore, it is not suitable for gardens or homes that do not have much space. However, certain species within this tribe, such as *Alpinia purpurata* (Vieill.) K. Schum. and *Etlingera elatior*, are notable for their attractive inflorescence, while others such as *Alpinia vittata* W. Bull and *Alpinia zerumbet* (Pers.) B.L. Burtt & R.M. Sm. exhibit variegated leaves, therefore being planted to decorate the house.

In contrast, the Zingibereae tribe is more favored than any other tribe due to its compact morphological characteristics. Many species in this tribe possess potential that makes them well suited for potted plants, contributing to their popularity, such as plants in the *Curcuma* and *Kaempferia* genera.

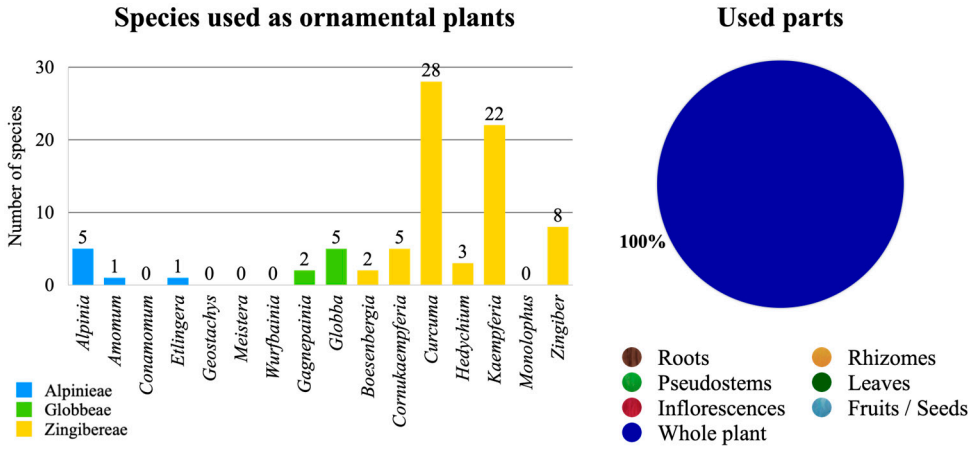

Figure 12. Species diversity and used parts of Zingiberaceae plants as ornamental plants in Nakhon Nayok Province.

Another tribe, Globbeae, is also commonly cultivated as an ornamental plant since it can be grown in pots similar to numerous species in the Zingibereae tribe. However, the number of species from the Globbeae tribe found in the province is limited, resulting in fewer applications in this field compared to the Zingibereae tribe. The sale of plants from this tribe in Nakhon Nayok's ornamental markets is not as popular as the plants from the genus *Curcuma*, which have inflorescences with fascinating colorful and patterned bracts. Since it is grown as an ornamental plant, it therefore uses 100% of the whole plant.

3.7.6. Used in Commercial Cultivation

In addition to villagers in Nakhon Nayok Province growing Zingiberaceae plants for their own use, a total of 34 species belonging to three tribes including Alpinieae, Globbeae, and Zingibereae tribes, are being cultivated for commercial purposes.

The tribe Alpinieae consists of 11 species: 6 of *Alpinia*, 2 of *Amomum*, 2 of *Etlingera*, and one species of *Wurfbainia*. The tribe Globbeae consists of 1 species of *Globba*. While the tribe Zingibereae consists of 2 species of *Boesenbergia*, 6 of *Curcuma*, 2 of *Hedychium*, 7 of *Kaempferia*, and 5 species of *Zingiber* (Figure 13).

Among these genera, *Kaempferia* stands out, with seven species being cultivated for commercial purposes. The next highest number of species comes from the genera *Alpinia* and *Curcuma*, each with six species. The genus *Zingiber* follows closely with five species, while *Amomum*, *Boesenbergia*, *Etlingera*, and *Hedychium* have two species each. Meanwhile, *Globba* and *Wurfbainia* each have one species.

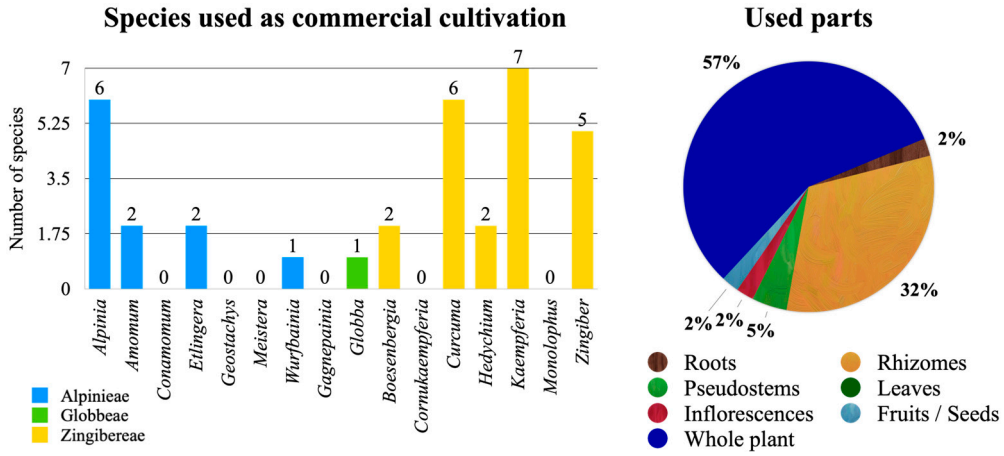

Figure 13. Species diversity and used parts of Zingiberaceae plants as commercial cultivation in Nakhon Nayok Province.

Most of these commercially cultivated Zingiberaceae plants are grown for two main purposes. Firstly, the whole plant parts (57%) are often sold as seedlings or potted plants for further planting in other areas, including 25 species namely *Alpinia purpurata* (Vieill.) K. Schum., *A. vittata* W. Bull, *A. zerumbet* (Pers.) B.L. Burtt & R.M. Sm. [variegated leaves], *Amomum foetidum* Boonma & Saensouk, *A. wandokthong* (Picheans. & Yupparach) Škorničk. & Hlavatá, *Boesenbergia rotunda* (L.) Mansf., *B. thorelii* (Gagnep.) Loes., *Curcuma alismatifolia* Gagnep., *Curcuma aurantiaca* Zijp., *Etlingera elatior* (Jack) R.M. Sm. [red, pink, and white variants], *Globba williamsiana* M.F. Newman & Sangvir., *Hedychium coronarium* J. Koenig, *H. flavescens* Carey ex Roscoe, *Kaempferia angustifolia* Roxb., *K. elegans* Wall., *K. galanga* L., *K. gilbertii* W. Bull, *K. pardi* K. Larsen & Jenjitt., *K. parviflora* Wall. ex Baker, *K. rotunda* L., *Wurfbainia testacea* (Ridl.) Škorničk. & A.D. Poulsen, *Zingiber ottensii* Valeton, *Z. purpureum* Roscoe, *Z. spectabile* Griff., and *Z. zerumbet* (L.) Roscoe ex Sm. [variegated leaves].

Secondly, the rhizomes and other parts of these plants (43%) are primarily used for food and spices. Several species have gained popularity in commercial cultivation, including *Alpinia galanga* (L.) Willd., *A. siamensis* K. Schum., *Boesenbergia rotunda* (L.) Mansf., *Curcuma longa* L., and *C. mangga* Valeton. These species have garnered attention due to their demand for culinary applications, which are used in daily life more frequently than other categories of use.

In the details of commercial cultivation, 14 species (32% of those used for commercial cultivation) are cultivated for selling their rhizomes including *Alpinia galanga* (L.) Willd., *A. laosensis* Gagnep., *A. siamensis* K. Schum., *Boesenbergia rotunda* (L.) Mansf., *Curcuma amada* Roxb., *C. longa* L., *C. mangga* Valeton & Zijp, *Etlingera pavieana* (Pierre ex Gagnep.) R.M. Sm. [subsp. *pavieana*], *Kaempferia parviflora* Wall. ex Baker, *K. rotunda* L., *Wurfbainia testacea* (Ridl.) Škorničk. & A.D. Poulsen, *Zingiber officinale* Roscoe, *Z. purpureum* Roscoe, and *Z. zerumbet* (L.) Roscoe ex Sm.

Additionally, the cultivation of *Alpinia galanga* (L.) Willd. and *A. siamensis* K. Schum. also focuses on the production and sale of their pseudostems, which constitute 5% of the overall commercial cultivation.

Furthermore, *Boesenbergia rotunda* (L.) Mansf., in the context of commercial cultivation, is distinctive as it not only sells its rhizomes but also its tuberous roots, well known as finger roots, which constitute approximately 2% of the overall commercial cultivation. This species is unique in that it offers both roots and rhizomes for use as spices and cooking ingredients.

While *Curcuma angustifolia* Roxb. is cultivated for selling its young inflorescences, *Wurfbainia testacea* (Ridl.) is cultivated for selling its fruits/seeds, each of which constitutes approximately 2% of the overall commercial cultivation.

3.7.7. Used in Rituals and Other Socio-Religious Practices

Beyond their practical applications, numerous species of the Zingiberaceae family hold significant roles in rituals and other socio-religious practices. In Nakhon Nayok Province, a remarkable discovery has been made, revealing the presence of 63 ritual and other socio-religious practices plants belonging to 10 genera within three tribes, including the Alpinieae, Globbeae, and Zingibereae tribes.

Four species belonged to the tribe Alpinieae which consists of two species of *Alpinia*, while *Amomum* and *Etlingera* each have one species. Three species belonged to the tribe Globbeae consisting of two species of *Gagnepainia* and one species of *Globba*. Fifty-six species belonged to the tribe Zingibereae, consisting of 5 *Boesenbergia* spp., 34 *Curcuma* spp., 1 species of *Hedychium*, 12 *Kaempferia* spp., and 4 *Zingiber* spp. (Figure 14).

Among these tribes, the Zingibereae tribe exhibited the highest number of species. The genus *Curcuma* stood out with an impressive count of 34 species, followed by 12 *Kaempferia* spp., 5 *Boesenbergia* spp., 4 *Zingiber* spp., *Alpinia* and *Gagnepainia* each with 2 species. Additionally, *Amomum*, *Etlingera*, *Globba*, and *Hedychium* each have one species represented.

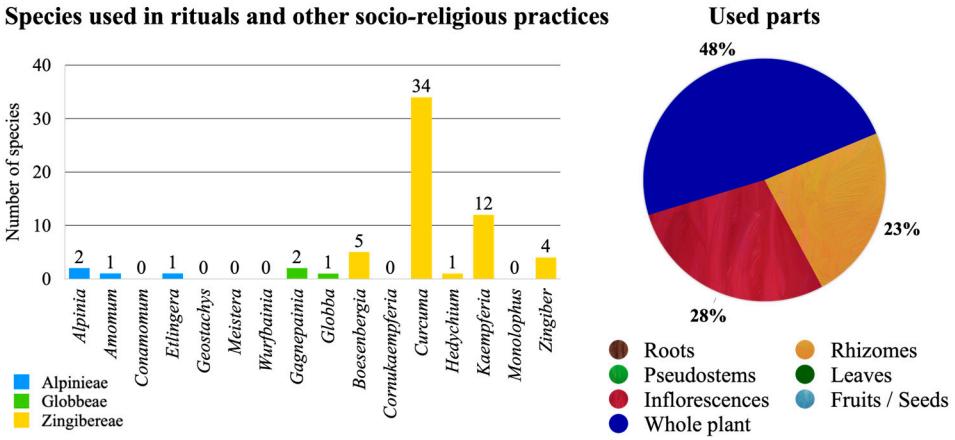

Figure 14. Species diversity and used parts of Zingiberaceae plants as rituals and other socio- religious practices in Nakhon Nayok Province.

Notably, during surveys, the most frequently observed species were *Amomum wandokthong* (Picheans. & Yupparach) Škorničk. & Hlavatá, found planted in pots, believed to enhance the charm for most growers. These pots are usually placed in front of stores, with the belief that they will help attract customers. *Curcuma rubescens* Roxb. was found planted both in pots and in the ground, with the belief that it would protect the grower and the house from all dangers, making them invincible, curbing superstition, and warding off evil spirits. *Kaempferia rotunda* L. was found planted in a pot, with the belief that it would enhance luck in trading, bring prosperity, and bestow good fortune. It is also believed to empower people with awe and discourage bullying. Growers usually place these pots or grow these plants in front of houses or buildings.

These plants, renowned for their distinctive qualities and aromatic properties, are embraced in spiritual ceremonies and cultural practices. In Thailand, they are commonly referred to as "Wan," which is often used as a prefix denoting the specific names of the plants that are utilized in rituals and other socio-religious practices. References to "Wan" can be found in ancient Thai textbooks, meticulously detailing their properties and applications. Various species from the Zingiberaceae family have been identified as Wan and are employed in diverse rituals and other socio-religious practices. These beliefs encompass a wide spectrum, encompassing attributes such as facilitating prosperous trade, attracting good fortune, exuding charm, compassion, and popularity, granting invincibility, offering protection against malevolent forces, possessing the ability to neutralize toxins, and even serving as herbal remedies [30].

Mostly, the whole plant was considered sacred and grown as an auspicious plant according to their beliefs. The flowers and inflorescences of 35 species (28% of used parts for rituals and other socio-religious practices) (Figure 14) were soaked in sandalwood oil and carried around, believed to enhance charm, benevolence, and popularity. Including *Amomum wandokthong* (Picheans. & Yupparach) Škorničk. & Hlavatá, *Boesenbergia collinsii* Mood & L.M. Prince, *B. curtisii* (Baker) Schltr., *B. maxwellii* Mood, L.M. Prince & Triboun, *B. thorelii* (Gagnep.) Loes., *Curcuma achrae* Saensouk & Boonma, *C. aeruginosa* Roxb., *C. aromatica* Salisb., *C. aruna* Maknoi & Saensouk, *C. campanulata* (Kuntze) Škorničk., *C. candida* (Wall.) Techapr. & Škorničk., *C. chantaranothaii* Boonma & Saensouk, *C. eburnea* Škorničk., Suksathan & Soonthornk., *C. flaviflora* S.Q.Tong, *C. globulifera* Škorničk. & Soonthornk., *C. nakhonphanomensis* Boonma, Saensouk & P. Saensouk, *C. peramoena* Souvann. & Maknoi, *C. pierreana* Gagnep., *C. puangpeniae* Boonma & Saensouk, *C. purpurata* Boonma & Saensouk, *C. rangsimae* Boonma & Saensouk, *C. rosea* P. Saensouk, Saensouk & Boonma, *C. rubescens* Roxb., *C. siamensis* Saensouk & Boonma, *C. singularis* Gagnep., *C. stenochila* Gagnep., *C. thorelii* Gagnep., *C. wanenlueanga* Saensouk, Thomudtha & Boonma, *Gagnepainia harmandii* (Baill.) K. Schum., *Kaempferia larsenii* Sirirugsa, *K. rotunda* L., *K. sakonensis* Saensouk, P. Saensouk & Boonma, *Zingiber ottensii* Valeton, and *Z. purpureum* Roscoe [variegated leaves].

While the inflorescences of *Etlingera elatior* (Jack) R.M. Sm. used to tie into a bouquet to pay respect, offer Buddha statues at temples or pay homage to deceased ancestors.

Furthermore, the rhizome of these plants was used as a material to create amulets and sacred objects. Of the 63 species used in ceremonies and beliefs, 29 species (23% of used parts for rituals and other socio-religious practices) (Figure 14) were found to be part of "Wan 108 species", which used their rhizomes as materials to make sacred objects, including *Alpinia vittata* W. Bull, *Amomum wandokthong* (Picheans. & Yupparach) Škorničk. & Hlavatá, *Boesenbergia collinsii* Mood & L.M. Prince, *B. curtisii* (Baker) Schltr., *B. maxwellii* Mood, L.M. Prince & Triboun, *B. thorelii* (Gagnep.) Loes., *Curcuma aeruginosa* Roxb., *Curcuma aromatica* Salisb., *Curcuma globulifera* Škorničk. & Soonthornk., *C. macrochlamys* (Baker) Škorničk., *C. parviflora* Wall., *C. phrayawan* Boonma & Saensouk, *C. rosea* P. Saensouk, Saensouk & Boonma, *C. rubescens* Roxb., *C. suphanensis* P. Saensouk, Boonma, Rakarcha, Maknoi, Wongnak & Saensouk, *C. wanenlueanga* Saensouk, Thomudtha & Boonma, *Gagnepainia godefroyi* (Baill.) K. Schum, *G. harmandii* (Baill.) K. Schum, *Globba schomburgkii* Hook.f., *Hedychium coronarium* J. Koenig, *Kaempferia angustifolia* Roxb., *K. elegans* Wall., *K. larsenii* Sirirugsa, *K. parviflora* Wall. ex Baker, *K. rotunda* L., *K. sakonensis* Saensouk, P. Saensouk & Boonma, *Zingiber ottensii* Valeton, *Z. purpureum* Roscoe, and *Z. zerumbet* (L.) Roscoe ex Sm. [variegated leaves].

3.7.8. Used as Cosmetics

Among the Zingiberaceae plants found in Nakhon Nayok Province, there are three notable species that play a significant role in the production of cosmetics. These species, namely *Curcuma longa* L., *Zingiber officinale* Roscoe, and *Z. purpureum* Roscoe, all belong to the tribe Zingibereae and utilize their rhizomes as essential ingredients in various cosmetic formulations. The versatility of these rhizomes is evident as they are utilized in the creation of a wide range of cosmetic products, including bar soap, liquid bath soap, shampoo, and skin care items.

In contrast, no species belonging to the tribes Alpinieae and Globbeae were utilized as cosmetics or incorporated into cosmetic products in Nakhon Nayok Province.

The remarkable aspect of these species lies in the fact that the rhizomes serve as the sole part used for cosmetic purposes, accounting for 100% of the utilized part of the plant. This highlights the importance and concentration of beneficial properties found within the rhizomes of these species (Figure 15).

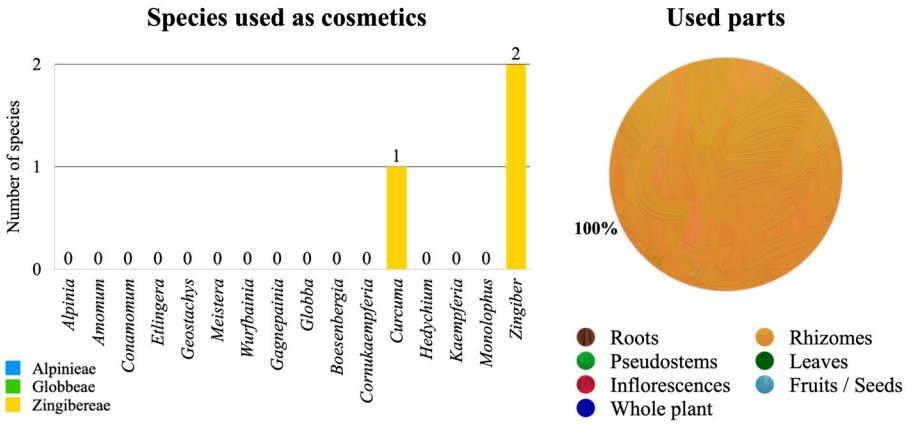

Figure 15. Species diversity and used parts of Zingiberaceae plants as cosmetics in Nakhon Nayok Province.

The Zingiberaceae family in Nakhon Nayok Province has been utilized for various purposes. The majority of eighty-two species (30.37% of all uses), were utilized as ornamental plants. Additionally, sixty-three species (23.33% of all uses) were associated with rituals and other socio-religious practices. Forty-four species (16.30% of all uses) were used for traditional medicines. Thirty-four species (12.59% of all uses) were cultivated

for commercial purposes. Twenty-eight species (10.37% of all uses) were utilized as food. Eleven species (4.07% of all uses) were used as spices. Five species (1.85% of all uses) were used as cut flowers, and three species (1.11% of all uses) were used in cosmetics.

The most used part of the plant was the whole plant, accounting for 41.95% of all uses, followed by the rhizome at 19.46%. The inflorescences, including bracts and flowers, constituted 19.46% of all uses, while the pseudostem, leaves, roots, fruits and seeds contributed to 6.38%, 5.70%, 4.70%, and 2.35% of all uses, respectively (Figure 16).

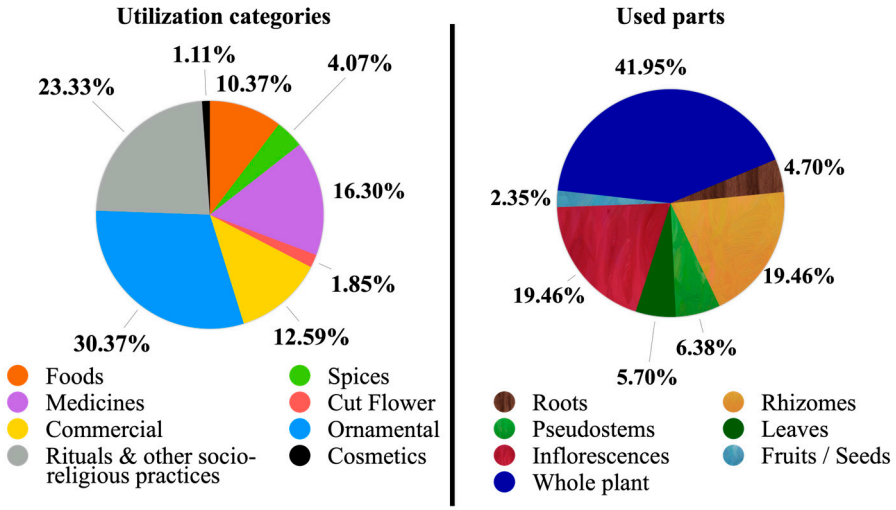

Figure 16. Comparison of pie charts illustrating various categories of utilization, and the used parts of the Zingiberaceae plants in Nakhon Nayok Province.

While 13 species have no use report, including *Amomum repoeense* Pierre ex Gagnep., *Conamomum pierreanum* (Gagnep.) Škorničk. & A.D. Poulsen, *Etlingera araneosa* (Baker) R.M. Sm., *Geostachys smitinandii* K. Larsen, *Globba aranyaniae* Sangvir. & M.F. Newman, *G. chrysantha* Sangvir. & M.F. Newman, *G. obscura* K. Larsen, *G. thorelii* Gagnep., *G. xantholeuca* Craib, *Meistera koenigii* (J.F.Gmel.) Škorničk. & M.F. Newman, *M. tomrey* (Gagnep.) Škorničk. & M.F. Newman, *Monolophus pedemontanus* (Triboun & K. Larsen) Veldk. & Mood., and *M. saxicola* (K. Larsen) Veldk. & Mood.

As presented herein, we proudly showcase a diverse collection of the Zingiberaceae family, comprising 40 out of the 45 species found in the enchanting forest area of Nakhon Nayok Province, depicted in Figures 17 and 18.

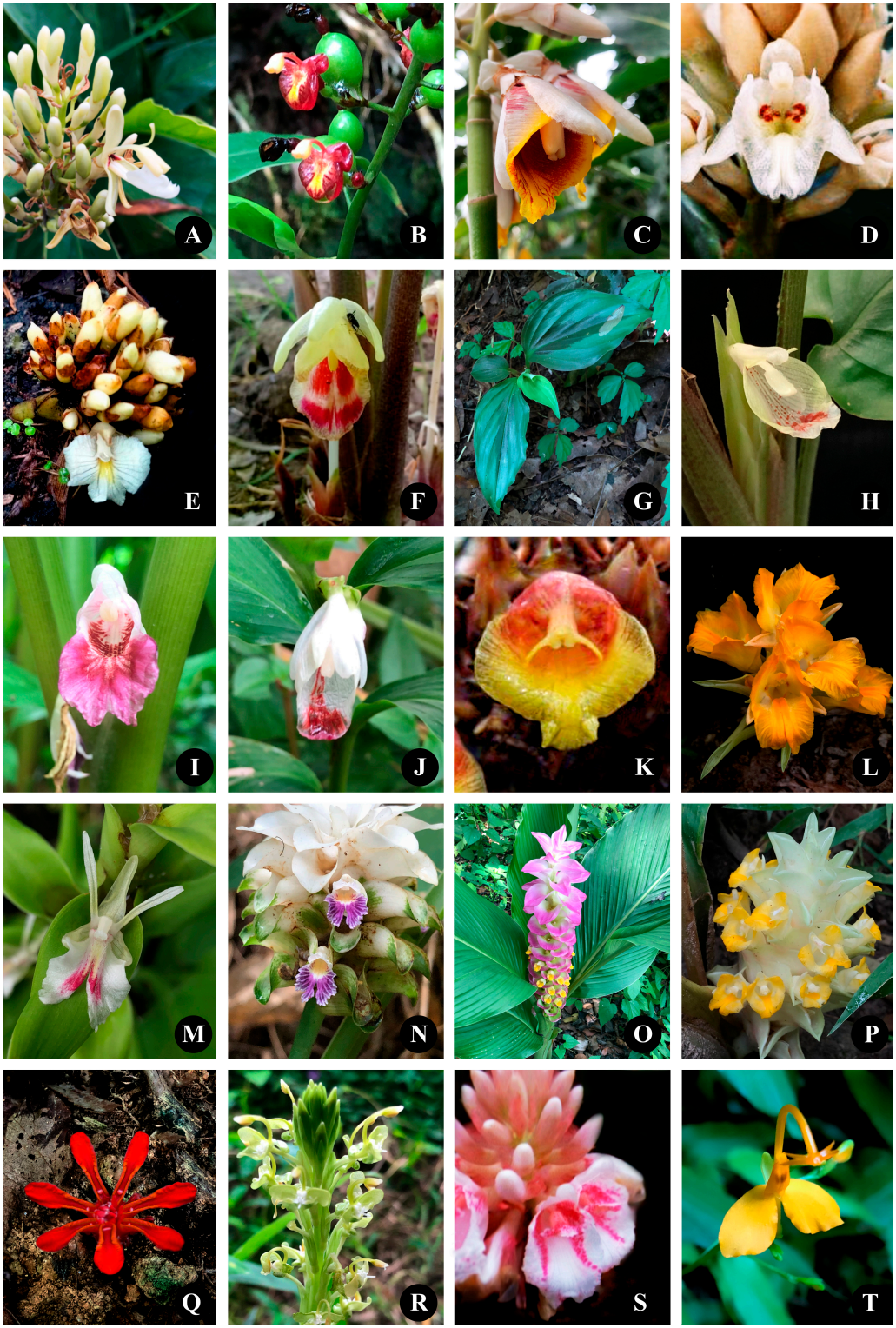

Figure 17. Wild species of Zingiberaceae found in Nakhon Nayok Province. (**A**) *Alpinia galanga*, (**B**) *A. laosensis*, (**C**) *A. macroura*, (**D**) *A. oxymitra*, (**E**) *Amomum repoeense*, (**F**) *Boesenbergia collinsii*, (**G**) *B. parvula*, (**H**) *B. petiolata*, (**I**) *B. rotunda*, (**J**) *B. thorelii*, (**K**) *Conamomum pierreanum*, (**L**) *Curcuma achrae*, (**M**) *C. harmandii*, (**N**) *C. parviflora*, (**O**) *C. petiolata*, (**P**) *C. rangsimae*, (**Q**) *Etlingera araneosa*, (**R**) *Gagnepainia harmandii*, (**S**) *Geostachys smitinandii*, and (**T**) *Globba aranyaniae*. Photographs by Thawatphong Boonma.

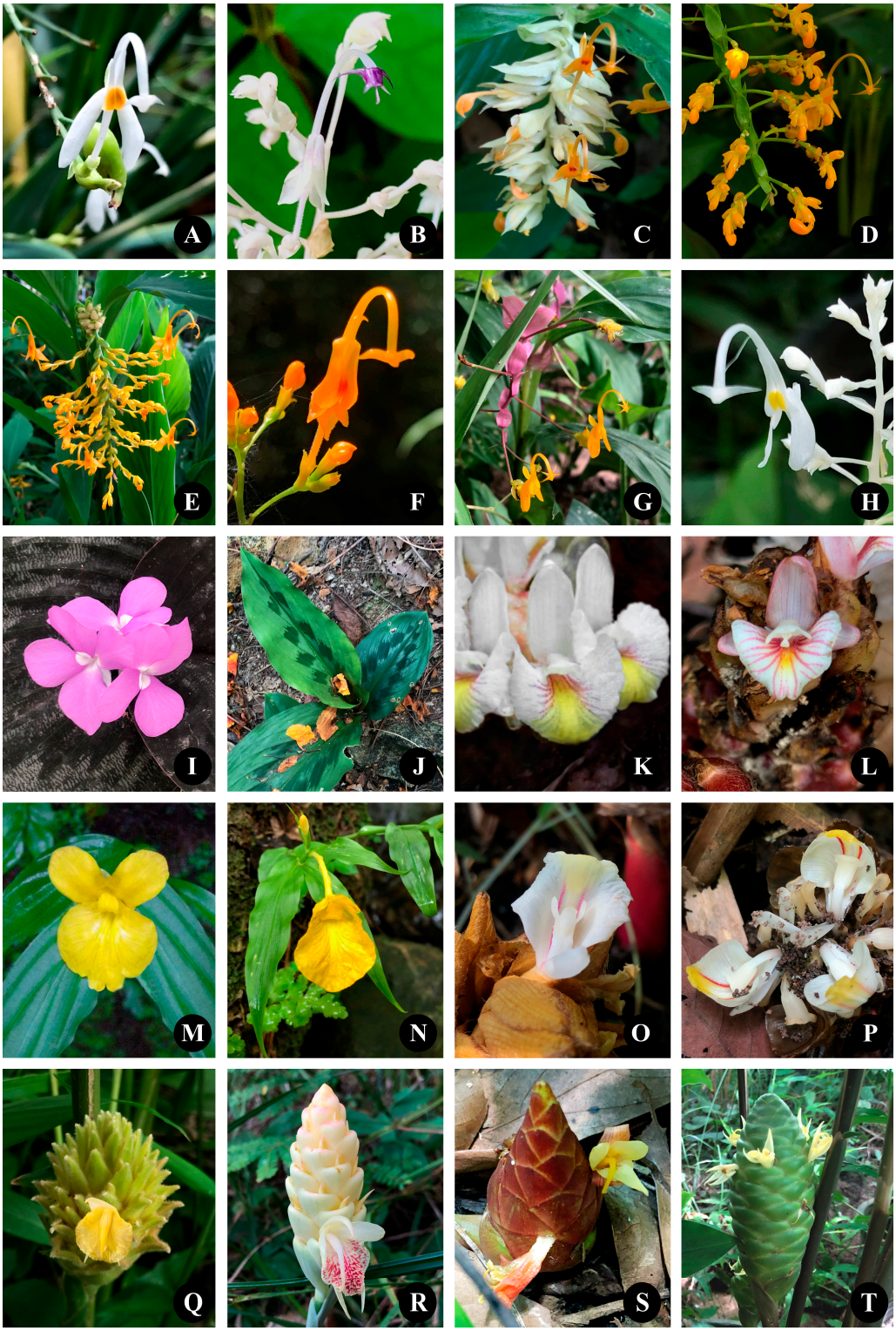

Figure 18. Wild species of Zingiberaceae found in Nakhon Nayok Province. (**A**) *Globba chrysochila*, (**B**) *G. geoffrayi*, (**C**) *G. hilaris*, (**D**) *G. obscura*, (**E**) *G. schomburgkii*, (**F**) *G. thorelii*, (**G**) *G. williamsiana*, (**H**) *G. xantholeuca*, (**I**) *Kaempferia nigrifolia*, (**J**) *K. rotunda*, (**K**) *Meistera koenigii*, (**L**) *M. tomrey*, (**M**) *Monolophus pedemontanus*, (**N**) *M. saxicola*, (**O**) *Wurfbainia testacea*, (**P**) *W. uliginosa*, (**Q**) *Zingiber gramineum*, (**R**) *Z. pyroglossum*, (**S**) *Z. thorelii*, and (**T**) *Z. zerumbet*. Photographs by Thawatphong Boonma.

Key to species of Zingiberaceae in Nakhon Nayok Province

1a. Lateral staminodes well developed, free from the labellum. 2

1b. Lateral staminodes not well developed or absent (Tribe Alpinieae)..... 134
2a. Ovary unilocular with parietal placentation (Tribe Globbeae)..... 3
2b. Ovary trilocular, rarely unilocular with central placentation (Tribe Zingibereae)..... 14
3a. Labellum 3-lobed, central lobe very short with 2 gland-like (genus *Gagnepainia*)..... 4
3b. Labellum 2-lobed to entire (genus *Globba*)..... 5
4a. Flower whitish, abaxial of lamina glabrous..... *Gagnepainia harmandii*
4b. Flower greenish, abaxial of lamina pubescent..... *Gagnepainia godefroyi*
5a. Staminodes white..... 6
5b. Staminodes yellow to orange..... 8
6a. Anther with 4 appendages, purple; labellum pure white..... *Globba geoffrayi*
6b. Anther with 2 appendages, white; labellum white with yellow patch..... 7
7a. Bracts and bracteoles ciliate; bulbils absent..... *Globba chrysochila*
7b. Bracts and bracteoles glabrous; bulbils many, fusiform and corky..... *Globba xantholeuca*
8a. Anther with 2 appendages..... 9
8b. Anther with 4 appendages..... 10
9a. Filament with cornicula..... *Globba thorelii*
9b. Filament without cornicula..... *Globba chrysantha*
10a. Inflorescence usually erect; bract caducous..... *Globba aranyaniae*
10b. Inflorescence usually hang downward; bract persistent..... 11
11a. Labellum without spot; bracts elliptic..... *Globba williamsiana*
11b. Labellum with reddish spot; bracts ovate to narrowly ovate..... 12
12a. Bract reflexed..... *Globba obscura*
12b. Bract not reflexed..... 13
13a. Calyx white; bracts white..... *Globba hilaris*
13b. Calyx yellowish orange; bracts green..... *Globba schomburgkii*
14a. Filament long exerted (genus *Hedychium*)..... 15
14b. Filament not long exerted..... 17
15a. Bracts narrow, not overlapping; filament red..... *Hedychium gardnerianum*
15b. Bracts broad, overlapping; filaments white to pale yellow..... 16
16a. Labellum white with pale lemon green patch at base..... *Hedychium coronarium*
16b. Labellum pale yellow with dark yellow patch at base..... *Hedychium flavescens*
17a. Anther crest forming a horn-like structure..... 18
17b. Anther crest not forming a horn-like structure..... 37
18a. Pseudostem very short, leaves broad, 2–3 in number (genus *Cornukaempferia*)..... 19
18b. Pseudostem more than 50 cm tall, leaves narrow, several (genus *Zingiber*)..... 23
19a. Labellum and staminodes pubescent..... 20
19b. Labellum and staminodes glabrous..... 21
20a. Leaves silver green..... *Cornukaempferia argentifolia*
20b. Leaves green without silvery..... *Cornukaempferia kamolwaniae*
21a. Leaves abaxially greenish..... *Cornukaempferia larsenii*
21b. Leaves abaxially purplish..... 22
22a. Tuberous root 2 layers; anther less than 2 cm long..... *Cornukaempferia aurantiiflora*
22b. Tuberous root 3 layers; anther more than 2 cm long..... *Cornukaempferia longipetiolata*
23a. Inflorescence terminal..... 24
23b. Inflorescence lateral..... 26
24a. Plant glabrous..... *Zingiber junceum*
24b. Plant pubescent..... 25
25a. Lamina linear..... *Zingiber gramineum*
25b. Leaf blade elliptic to oblong..... *Zingiber pellitum*
26a. Spike does not cone shaped..... *Zingiber mekongense*
26b. Spike cone shaped..... 27
27a. Peduncle procumbent..... *Zingiber thorelii*
27b. Peduncle erect..... 28
28a. Ligule bilobed..... 29

28b. Ligule entire. 34
29a. Leaf sheath and inflorescence pubescent. . . . . *Zingiber gramineum*
29b. Leaf sheath and inflorescence glabrous. 30
30a. Bracts apex reflexed. 31
30b. Bracts apex slightly curved not reflexed. 32
31a. Ligule longer than 1 cm long, lobes joined at the base. . . . . *Zingiber spectabile*
31b. Ligule less than 1 cm long, lobes free. . . . . *Zingiber niveum*
32a. Ligule pubescent. . . . . *Zingiber purpureum*
32b. Ligule glabrous. 33
33a. Spike ovoid or fusiform. . . . . *Zingiber officinale*
33b. Spike ellipsoid or cylindric. . . . . *Zingiber junceum*
34a. Corolla lobes white or creamy white. 35
34b. Corolla lobes yellow or pale pink. 36
35a. Bracts apex acute; leafy shoot compressed..... . . . . *Zingiber citriodorum*
35b. Bracts apex rounded; leafy shoot terete. . . . . *Zingiber zerumbet*
36a. Labellum pale mottled; spike ellipsoid or cylindrical. . . . . *Zingiber ottensii*
36b. Labellum dark mottled; spike fusiform. . . . . *Zingiber pyroglossum*
37a. Bracts laterally connate to each other (genus *Curcuma*). 38
37b. Bracts not laterally connate, free from each other. 96
38a. Epigynous glands absent. 39
38b. Epigynous glands present. 58
39a. Bract campanulate involucre with two slits. 40
39b. Bract laterally connate to forming pouches. 41
40a. Bract purplish brown. . . . . *Curcuma macrochlamys*
40b. Bract green or with reddish tinge. . . . . *Curcuma campanulata*
41a. Inflorescence without coma bracts. 42
41b. Inflorescence with coma bracts. 49
42a. Bracts pink with purple or green at the distal part, or reddish-brown with green margin 43
42b. Bracts pale green to dark green. 44
43a. Labellum pale to dark red with yellow. . . . . *Curcuma sparganiifolia*
43b. Labellum purple with two reddish band, without yellow. . . . . *Curcuma lithophila*
44a. Bracts puberulent. . . . . *Curcuma papilionacea*
44b. Bracts glabrous. 45
45a. Labellum with fimbriate margins. . . . . *Curcuma fimbriata*
45b. Labellum not fimbriate margins. 46
46a. Bracts lanceolate, upper half suddenly narrowed to acute apex. . . . . *Curcuma harmandii*
46b. Bracts almost orbicular or broadly ovate or broadly obovate. 47
47a. Flowers slightly exerted from bracts. . . . . *Curcuma prasina*
47b. Flowers exerted from bracts. 48
48a. Labellum with two dark yellow spots at base. . . . . *Curcuma charanii*
48b. Labellum without yellow spots as above. . . . . *Curcuma puangpeniae*
49a. Labellum with red. 50
49b. Labellum without red. 53
50a. Staminodes purple or violet tone. 51
50b. Staminodes yellow or white. 52
51a. Anther ecalcarate. . . . . *Curcuma rhabdota*
51b. Anther calcarate. . . . . *Curcuma rufostriata*
52a. Labellum white with purple, with long red lines. . . . . *Curcuma saraburiensis*
52b. Labellum yellow to orange, with short red lines. . . . . *Curcuma gracillima*
53a. Coma bracts pink. 54
53b. Coma bracts green or white... 55
54a. Staminodes white; labellum purple. . . . . *Curcuma alismatifolia*
54b. Staminodes yellow; labellum yellow. . . . . *Curcuma myanmarensis*

55a. Fertile bracts green with reddish-brown tinge. . . . . *Curcuma micrantha*
55b. Fertile bracts green without reddish-brown tinge. 56
56a. Floral tube longer than bract; coma bract green on both surface. . . . . *Curcuma purpurata*
56b. Floral tube shorter than bract; coma bract white or with green. 57
57a. Labellum deeply bilobed; coma bracts pure white. . . . . *Curcuma thorelii*
57b. Labellum with fringed edge; coma bracts white with apex green. . . *Curcuma parviflora*
58a. Inflorescences lacking coma bracts; flowers usually in open form. 59
58b. Inflorescences usually with coma bracts; flowers usually in closed form. 77
59a. Floral tube longer than bracts; petioles distinct from lamina. . . . . *Curcuma supraneeana*
59b. Floral tube shorter than bracts; lamina tapering into petiole. 60
60a. Anther spurs filamentous, or less than 2 mm long. 61
60b. Anther spurs conical, cylindrical, equal or more than 2 mm long. 65
61a. Staminodes with purple. . . . . *Curcuma pierreana*
61b. Staminodes without purple. 62
62a. Leaves puberulous on both surfaces. . . . . *Curcuma chantaranothaii*
62b. Leaves adaxially glabrous or glabrous on both surfaces. 63
63a. Midrib of leaves dark red. . . . . *Curcuma rosea*
63b. Midrib of leaves green. 64
64a. Bracts pubescent. . . . . *Curcuma suphanensis*
64b. Bracts glabrous. . . . . *Curcuma eburnea*
65a. Inflorescence terminal. 66
65b. Inflorescence lateral. 73
66a. Anther L-shape with an obtuse angle in the side view. . . . . *Curcuma siamensis*
66b. Anther almost straight shape in the side view. 67
67a. Flowers closed-form. . . . . *Curcuma cinnabarina*
67b. Flowers open-form. 68
68a. Staminode white or white with reddish purple. 69
68b. Staminode pale yellow to yellow. 71
69a. Labellum reddish purple with yellow median band. . . . . *Curcuma sabhasrii*
69b. Labellum white with yellow median band. 70
70a. Leaf base cordate to rounded, leaf midrib usually red. . . . . *Curcuma nakhonphanomensis*
70b. Leaf base cuneate to attenuate, leaf midrib green. . . . . *Curcuma peramoena*
71a. Leaves adaxially glabrous. . . . . *Curcuma rangsimae*
71b. Leaves adaxially pubescent. 72
72a. Leaf base cuneate to attenuate. . . . . *Curcuma putii*
72b. Leaf base rounded to cordate. . . . . *Curcuma stenochila*
73a. Labellum white or cream white with yellow median band. 74
73b. Labellum yellow or orange with darker median band. 75
74a. Midrib of leaves red; anther almost straight in the side view. . . . . *Curcuma candida*
74b. Midrib of leaves green; anther L-shape in the side view. . . . . *Curcuma singularis*
75a. Anther almost straight in the side view. . . . . *Curcuma achrae*
75b. Anther L-shape in the side view. 76
76a. Leaf base cuneate. . . . . *Curcuma flaviflora*
76b. Leaf base rounded to cordate. . . . . *Curcuma aruna*
77a. Branches rhizome not produced. 78
77b. Branches rhizome produced. 79
78a. Inflorescence terminal. . . . . *Curcuma plicata*
78b. Inflorescence both lateral and terminal. . . . . *Curcuma angustifolia*
79a. Inflorescence terminal. 80
79b. Inflorescence lateral. 89
80a. rhizome creeping. . . . . *Curcuma rubrobracteata*
80b. rhizome non creeping. 81
81a. Anther ecalcarate. 82
81b. Anther calcarate. 83

82a. Flowers cream white with yellow in the mid lobe of labellum. . . . . .*Curcuma roscoeana*
82b. Flowers yellow or yellowish orange. . ...*Curcuma aurantiaca*
83a. Peduncle red. . . . .*Curcuma phrayawan*
83b. Peduncle green. 84
84b. Ovary pubescent. 85
84a. Ovary glabrous. 88
85a. Leaf adaxially with reddish-purple midrib. . . ..*Curcuma wanenlueanga*
85b. Leaf adaxially with green midrib. 86
86a. Rhizome deep orange-yellow. . . . . .*Curcuma longa*
86b. Rhizome pale yellowish-white to pale yellow. 87
87a. Leaf abaxially glabrous; rhizome non-aromatic. . . . . .*Curcuma rangjued*
87b. Leaf abaxially pubescent; rhizome smell resembles to raw mango. . . . ..*Curcuma amada*
88a. Coma bracts white with violet apex; leaves pubescent. . . . .*Curcuma cordata*
88b. Coma bracts pink; leaves glabrous. . . . .*Curcuma petiolata*
89a. Leaf abaxially glabrous. 90
89b. Leaf abaxially pubescent. 93
90a. Petioles and leaf sheaths reddish brown. . ...*Curcuma rubescens*
90b. Petioles and leaf sheaths green. 91
91a. Leaf adaxially midrib red or reddish-purple. . . . .*Curcuma aeruginosa*
91b. Leaf adaxially midrib green. 92
92a. Fertile bracts pale pink. . . . .*Curcuma comosa*
92b. Fertile bracts green. . . . .*Curcuma mangga*
93a. Leaf adaxially midrib green. 94
93b. Leaf adaxially midrib reddish-purple. 95
94a. Staminodes with a patch of glandular hairs at the mid lobe. . . . . .*Curcuma zedoaria*
94b. Staminodes without glandular hairs. . . . .*Curcuma aromatica*
95a. Spike cylindrical, more than 10 cm long; coma bracts pink. . . . . .*Curcuma latifolia*
95b. Spike globular, less than 10 cm long; coma bracts brownish green...*Curcuma globulifera*
96a. Flowers form a bell-shaped, usually point downward (genus *Boesenbergia*). 97
96b. Flowers do not form a bell-shaped, usually point upward or forward. 104
97a. Inflorescence radical. 98
97a. Inflorescence arising on top of a leafy shoot. 99
98a. Flower creamy white to yellowish. . . . .*Boesenbergia collinsii*
98b. Flower white. . . . . .*Boesenbergia maxwellii*
99a. Leaves with silvery patterns. 100
99b. Leaves without silvery patterns. 101
100a. Labellum white with yellow. . . . .*Boesenbergia ochroleuca*
100b. Labellum white without yellow. . . . .*Boesenbergia parvula*
101b. Anther crest produced beyond thecae. . . . .*Boesenbergia rotunda*
101a. Anther crest not produced beyond thecae. 102
102a. Pollen sacs poricidal dehiscing; labellum not saccate. . . . .*Boesenbergia curtisii*
102b. Pollen sacs longitudinal dehiscing; labellum saccate..... 103
103a. Leaf base cordate. . . . .*Boesenbergia petiolata*
103b. Leaf base cuneate. . . . .*Boesenbergia thorelii*
104a. Staminodes yellow (genus *Monolophus*)..... 105
104b. Staminodes not yellow (genus *Kaempferia*). 106
105a. Labellum irregularly trilobed. . . . .*Monolophus pedemontanus*
105b. Labellum broadly ligulate. . . . . .*Monolophus saxicola*
106a. Produces inflorescence directly from the rhizome before the leafy shoot arises. . ..107
106b. Produces inflorescence terminal. 114
107a. Leaves horizontal near the ground. 108
107b. Leaves erect, well-develop pseudostem. . . .. .111
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4. Discussion

The diversity of Zingiberaceae in Nakhon Nayok Province reaches a total of 155 species belonging to 16 genera. Among these, the tribe Zingibereae exhibited the highest species diversity with 120 species, followed by the tribe Alpinieae and the tribe Globbeae with 23 and 12 species respectively. These species are distributed across six ecosystem types. A total of 29 species were found in the dry evergreen forest (DEF), 11 species were found in the mixed deciduous forest (MDF), 9 species were found in the evergreen forest (EGF),

4 species were found in the deciduous forest (DCF), and 1 species was found in the deciduous dipterocarp forest (DDF). Additionally, 142 species were found in cultivations.

A total of 45 species were found in the forest area of Nakhon Nayok Province. Wild species were predominantly found in the Mueang district (45 species), followed by the Pak Phli district (42 species) and Ban Na district (28 species). In the Ongkharak district, no wild species were found; only cultivated species were present, which corresponded to the local environmental conditions. The genus *Globba* had the highest number of wild species, with 10 species. It was followed by the genus *Zingiber*, which had six species, while *Curcuma* and *Boesenbergia* each had four species. The genera *Alpinia* and *Kaempferia* had three species each. The genera *Etlingera*, *Meistera*, *Monolophus*, and *Wurfbainia* each had two species, whereas *Amomum*, *Conamomum*, *Gagnepainia*, and *Geostachys* each had one species.

In Nakhon Nayok Province, there are 142 cultivated species of Zingiberaceae. The genus *Curcuma* has the highest number with 59 species, followed by 30 *Kaempferia* spp., 13 *Zingiber* spp., 10 *Alpinia* spp., eight *Boesenbergia* spp., five *Cornukaempferia* spp., five *Globba* spp., four *Amomum* spp., three *Etlingera* spp., three *Hedychium* spp., two *Gagnepainia* spp., and two *Wurfbainia* spp.

In terms of species diversity of Zingiberaceae in Nakhon Nayok Province, it corresponds to Ragsasilp et al. [20] who studied in Bueng Kan Province, and Saensouk et al. [14] who studied in Nakhon Phanom Province. The genera *Curcuma*, *Globba*, and *Zingiber* were among the genera with high diversity in these three provinces. The presence of these diverse genera in different regions of Thailand highlights their significance and wide distribution within the country. Moreover, the existence of endemic species in specific regions emphasizes the unique plant diversity found in those areas [6,8,9,11,14,15,18,20,22]. Endemic species are species that are found only in particular geographic regions and are not naturally found anywhere else. The presence of endemic species underscores the importance of conserving these specific regions to protect their endemic plants.

The phenology of the Zingiberaceae family in Nakhon Nayok Province consistently correlated with the monthly cumulative rainfall. This indicates that the timing of plant life cycle events in the Zingiberaceae family is influenced by the availability of water, as reflected in rainfall patterns. The relationship between phenology and rainfall has significant implications for agriculture, ecology, and conservation, emphasizing the critical role of water availability in ensuring the reproductive success and survival of Zingiberaceae family species in the region.

Regarding traditional uses, similar to the findings of Saensouk et al. [14], which reported that Zingiberaceae species in Nakhon Phanom Province were most frequently used for medicine, food (including spices), ornamental plants, and rituals, a similar study in Bueng Kan Province by Ragsasilp et al. [20] also reported popular uses of Zingiberaceae plants as food, spices, rituals, and ornamentals. Additionally, Inta et al. [22] reported that food and medicine were the dominant use categories of Zingiberaceae species among the ethnic groups in Mae Hong Son Province. These findings collectively demonstrate the cultural significance and diverse uses of Zingiberaceae plants across different regions in Thailand.

5. Conclusions

In conclusion, this research article explored the species diversity and traditional utilization of the Zingiberaceae family in Nakhon Nayok Province. The study identified a total of 155 species belonging to 16 genera, with the tribe Zingibereae exhibiting the highest species diversity. These species were found in various ecosystems, including dry evergreen forests, mixed deciduous forests, evergreen forests, deciduous forests, and deciduous dipterocarp forests. Furthermore, the research documented the distribution of wild species, with the Mueang district having the highest number of species.

Cultivated species were also examined, with the genus *Curcuma* having the highest number of cultivated species. The study also highlighted the traditional uses of Zingiberaceae plants in Nakhon Nayok Province. A total of 142 species from 12 genera were found

to be utilized for various purposes. Ornamental plants accounted for the majority of uses, followed by plants associated with rituals and other socio-religious practices, traditional medicines, commercial cultivation, food, spices, cut flowers, and cosmetics respectively. The study further revealed that different parts of the plants were utilized, with the whole plant and rhizome being the most used, followed by the rhizome and inflorescence.

While the research provided insights into the species diversity and traditional utilization of the Zingiberaceae family in Nakhon Nayok Province, it also identified species that lacked usage reports. These findings contribute to the existing knowledge of Zingiberaceae plants, providing essential information for future conservation efforts, providing a basic information for promoting sustainable use, and preserving traditional knowledge related to their utilization. Further research and documentation are necessary to continue expanding our understanding of this diverse plant family and its significance in local ecosystems and human cultures.

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