วารสารเกษตรศาสตร์และเทคโนโลยี มทร.อีสาน | Agriculture & Technology RMUTI Journal
ปีที่ 6 ฉบับที่ 2 พฤษภาคม – สิงหาคม 2568 | Vol.6 No.2 May – August 2025

Received: February 13, 2024; Revised: January 22, 2025; Accepted: March 26, 2025

A review on the ethnobotany of exotic species in Thailand III: *Tamarindus indica* L. (Fabaceae)

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Abstract

This review explored the ethnobotanical uses of tamarind (Tamarindus indica L.: Fabaceae), an exotic species with a longstanding presence in Thailand. The study synthesized 199 use-reports from 42 references spanning 1995 to 2022, revealing its multifaceted roles in traditional medicine, food, and other applications across 16 ethnic groups. The plant is most commonly employed for treating digestive system disorders but also finds use in women's healthcare and combating infections. To understand its widespread use, we evaluated three hypotheses: availability, diversification, and versatility. The plant's ubiquity, due in part to its 700-year presence in Thailand, substantiates the availability hypothesis. Although the diversification hypothesis is less compelling in this context due to the existence of other species treating similar ailments, the versatility hypothesis was strongly supported by the plant's broad application across various domains. The review underscores the need for future phytochemical and ethnopharmacological studies to understand *T. indica*'s medicinal efficacy better. It also suggests leveraging ethnobotanical knowledge for community-based conservation efforts.

Keywords: Cultural practices, Ethnomedicine, Herbal therapy, Indigenous knowledge, Tamarind

Introduction

Exotic plant species, also known as non-native or introduced species, are plants that have been introduced to an area outside of their natural range through human activity (Kull et al., 2014). However, the invasion of exotic species can negatively affect forest ecosystem functions and plant diversity (Gaggini et al., 2019; Xu et al., 2022). On the other hand, exotic species play an increasingly significant role in food systems (Chamorro & Ladio, 2020) with well-adapted to local conditions, generating a greater volume of food in different time than native plant (Pilnik et al., 2023). Exploring the utilization of exotic plant species among rural and indigenous communities provides an avenue for understanding how humans have explored a variety of plant resources in their environment to promote health and wellness (Medeiros et al., 2017).

Tamarindus indica L. (Fabaceae) is a tropical fruit tree that is native to Madagascar, but has been introduced in more than 50 tropical countries, and tamarind has become naturalized or established as a wild plant (POWO, 2023). The specific epithet, "*indica*", perpetuates the misconception of its origin. In fact,

T. indica was introduced to India during ancient times, as evidenced by archaeological findings and scriptures (Neumann et al., 2003). Despite its common name being derived from the Persian word "*Tamar-I-hind*", which means "date of India", it is possible that *T. indica* was introduced by Ethiopian traders who had established contact with India and Ceylon before the arrival of Arab traders who raised the common name afterward (Shah, 2014). Indian traders are considered to carry *T. indica* to Southeast Asia in medieval period (Neumann et al., 2003).

Tamarindus indica is considered a multipurpose plant. Various parts of the tree have traditional uses, especially in India and Africa (Havinga et al., 2010; Ebifa-Othieno et al., 2017; Noorunnisa et al., 2017). *T. indica* is a keystone food resource for ring-tailed lemurs (*Lemur catta*), which are endangered species and endemic to Madagascar (Mertl-Millhollen et al., 2011).

In Thailand, *T. indica* was reported to be traded during Ayutthaya period (1687-1688 A.D.) by French priest (Komolabutra, 2005). *T. indica* has since become an important economic crop, with 19 cultivars currently grown in Thailand (Srisuvoramas et al., 2015). Additionally, tamarind has been widely used in agroforestry worldwide, including in Thailand where it has been intercropped with annual plants and other fruit trees (El-Siddig et al., 2006; Orwa et al., 2009). It is one of the most common ingredients in common northeast Thai cuisine and is rich in poly phenol contents (Tantipopipat et al., 2010). Tamarind is an ingredient in several traditional Thai medicines included in Thailand's essential medicines list - *Ya Hom Nawakot*: utilized for digestive issues; *Ya Thai Di Kluea Farang* which: acts as a natural laxative; and *Ya Prakob Samunphrai*: used in herbal compresses soothing muscle and joint inflammation.

To gain a deeper understanding of the ethnobotany of *T. indica* in Thailand, it is imperative to address the fragmentation of primary ethnobotanical data available. Despite the extensive use of tamarind in Thai culinary practices and traditional medicine, there exists a notable gap in the systematic documentation and synthesis of ethnobotanical knowledge. This study aims to bridge this gap by presenting a comprehensive collection of traditional Thai knowledge on T. indica, underscoring the significance of this exotic plant in Thai culture. By consolidating scattered ethnobotanical studies, this research provides insights into the diverse ways Thai societies utilize and interact with tamarind, highlighting its integral role in their interaction with natural resources.

Note on *Tamarindus indica* L. characteristics

Tamarindus L. is a monospecific genus, containing only a single species, in the Leguminosae family, subfamily Caesalpinioideae. The genus was established by Linnaeus in 1754. *Tamarindus indica*, the sole species in this genus, is a tree that can grow up to 20 m in height, with paripinnate leaves consisting of 10–18 leaflets. The flowers have four sepals and five petals, which are yellow or cream with red veins. Pods are cylindrical, with irregular constrictions, usually curved, and light brown, 5–15 × 4 cm. The seeds are 3–10, glossy dark brown, and embedded in a brown and sticky pulp.

As an introduced species, *T. indica* is classified as a low-level invasive species in Thailand by the Forest and Plant Conservation Research Office (FPCRO, 2013). Despite this classification in Thailand, the overexploitation of tamarind has caused a decline in the number of trees in Africa (Fandohan et al., 2010). In Madagascar, local people once regarded *T. indica* as sacred, but this traditional knowledge is fading. This cultural shift is exerting additional pressure on tamarind populations (Ranaivoson et al., 2015).

Methodology

Data Collection

Our bibliographic searches employed several sources, utilizing specific keywords relevant to the ethnobotanical study of *T. indica* in Thailand. The keywords used in this review include "*T. indica*," "*ethnobotany*," "Thai ethnobotany," "traditional Thai medicine," and "plant utilization in Thailand." The criteria for the selection of references were as follows (Panyadee, 2022):

1. The scientific name "*Tamarindus indica*" must be specified in the reference.
2. The reference must constitute original research, explicitly including information about the locality and the time of the research.

The search included both English and Thai sources from Thai university libraries, online Thai journals, and international databases (Google Scholar, Scopus, PubMed). The Thai Library Integrated System (www.tdc.thailis.or.th) was also used, covering theses and scientific reports from Thai universities. To avoid duplication, only data from these were included when overlapping with journal articles.

Data analysis

The uses of *Tamarindus indica* were classified into categories—medicine, food, food additives, materials, social uses, and fuels—based on the Economic Botany Data Collection Standard (Cook, 1995). Each use was documented as a "use-report," representing a specific application by an ethnic group from a particular reference. Medicinal uses were further subdivided following the same standard. This approach enables consistent categorization and quantitative analysis of cultural contexts.

Results

Ethnobotanical of *T. indica* in Thailand

A total of 199 use reports were obtained from 42 references spanning the period of 1995 to 2022, encompassing 16 distinct ethnic groups. These references include 2 bachelor research projects, 12 journal articles, 6 reports, and 22 theses, amounting to a total of 42 sources. Of these, 12 references are published in English, while the remaining 30 are published in Thai. Notably, the 12 journal articles were identified using online databases, with 10 found in Google Scholar and 2 retrieved from PubMed.

Among the use reports, the dominant use category was medicinal plants, comprising 43% of the total (Table 1). The remaining use reports were categorized under various other classifications, including food, food additives, materials, fuels, and social uses (Figure 1A). Fruit is the dominant plant part, accounting for more than 50% of the use reports, followed by stems (27%), which include bark and wood.

Within the category of food uses, a total of 47 use reports (24%) were documented (Table 1). It was found that the fruit pulp is commonly consumed (71%) in its raw form, both when unripe and ripe as dessert fruit. Additionally, the tender shoots and flowers were employed in culinary preparations or are incorporated into salads (Table 1). The seeds, on the other hand, were often roasted and enjoyed as snacks (Sutjaritjai, 2019).

For food additives, Tamarindus indica was commonly used as a souring agent, particularly the fruit pulps and tender shoots (Table 2). In addition to this, the bark of the plant was utilized by the Shan people in spicy minced fish salad to enhance the taste of the dish (Pongamornkul & Muangyen, 2012).

As a material, *T. indica* wood was used for construction, as reported in studies among the Karen people (Kamwong, 2009; Sutjaritjai, 2019; Georgiadis, 2022) the Tai Lue community (Muangyen, 2013), and other Thai populations (Upho, 2005; Muangyen, 2013). Furthermore, the Karen people utilized bark powder, mixed with water, for beautifying the eyes (Georgiadis, 2022). The pulp was employed as soap (Sutjaritjai, 2019; Georgiadis, 2022), while the fruit fiber was also used by the Karen people to wash dishes (Sutjaritjai, 2019).

The ripened fruit's exocarp of *T. indica* was ground and mixed with tobacco to alleviate the bitterness of smoking among the Shan (Pongamornkul & Muangyen, 2012) and Karen peoples (Trisonthi et al., 2007; Sutjaritjai, 2019; Georgiadis, 2022). Additionally, there were a few reports of the Karen people using tamarind wood as firewood (Sonsupub, 2010; Sutjaritjai, 2019).

Categories of health disorders treated with *T. indica*

A total of 86 ethnomedicinal use reports (43%) were generated for *T. indica* in Thailand (Table 3). These reports were associated with 41 ailments which were classified into 15 use categories. The category of digestive system disorders had the largest number of use reports, with 22 reports covering eight ailments. Other categories with a significant number of reports included pregnancy, birth and puerperium disorders, infections and infestations, and skin and subcutaneous cellular tissue disorders.

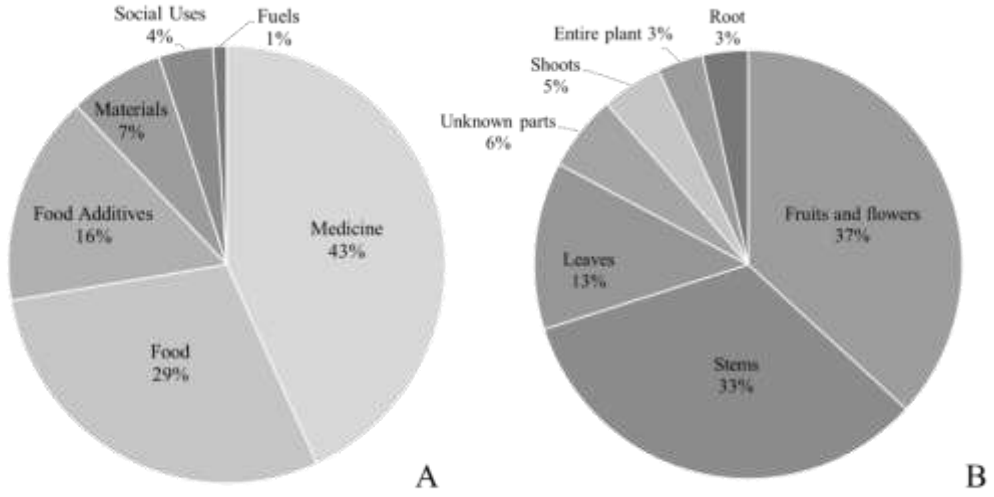

Figure 1 (A) The proportion of different use categories; (B) the proportion of different use parts within the medicinal category of *Tamarindus indica*.

Table 1 Summary of ethnobotanical use reports for *T. indica* across different secondary categories of food

Category	Usages	Ethnicity	Reference
Dessert fruits	The ripe fruit's pulp is consumed as a dessert	Akha	(Inta, 2008), (Srisanga et al., 2011)
		Hmong	(Nuammee, 2012), (Srithi, 2012)
		H'tin	(Tangtragoon, 1998)
		Karen	(Georgiadis, 2022), (Kamwong, 2009), (Khamfachuea, 2008), (Panyadee, 2017), (Pongamornkul, 2003), (Sutjaritjai, 2019)
		Khamu	(Srithi et al., 2012)
		Lahu	(Panyadee, 2017), (Yaso, 1997)
		Lawa	(Borikut, 2019), (Moonjai & Inta, 2016), (Panyadee, 2017), (Ponpim, 1996), (Srithi, 2012), (Tangtragoon, 1998)

Category	Usages	Ethnicity	Reference
		Mien	(Srithi, 2012), (Tovaranonte, 1998)
		Shan	(Panyadee, 2012), (Pongamornkul & Muangyen, 2012), (Tangtragoon et al., 2004)
		Tai Lue	(Inta, 2008)
		Thai	(Phatlamphu et al., 2021)
		Thai (Isaan)	(Numpulsuksant et al., 2021)
		Thai Yuan	(Panyadee, 2017)
		Yunnan Chinese	(Panyadee, 2017), (Ponpim, 1996)
	The young and ripe fruit is consumed as dessert	Karen	(Tovaranonte, 2003)
		Lawa	(Yaso, 2000)
Pulses	The roasted seeds are eaten	Karen	(Sutjaritjai, 2019)
Vegetables	Tender shoots added to a savory mushroom curry	Thai Yuan	(Penpanassak & Inta, 2018)
	Flowers used in curry	Karen	(Sutjaritjai, 2019)
		Shan	(Tangtragoon et al., 2004)
	Shoots are incorporated into salads	Shan	(Pongamornkul & Muangyen, 2012)
	Tender shoots are utilized in culinary preparations	Hmong	(Trisonthi et al., 2007)
		H'tin	(Klamwaewwong, 1996)
		Karen	(Kamwong, 2009), (Pongamornkul, 2003), (Tangjitman, 2017)
		Mien	(Tovaranonte, 1998)
		Shan	(Panyadee, 2012), (Tangtragoon et al., 2004)
	The young fruit is consumed as	Shan	(Pongamornkul & Muangyen, 2012)

Table 2 Summary of ethnobotanical use reports of *Tamarindus indica* across different secondary categories of food additives

Category	Usages	Part	Ethnicity	Reference
Souring agent	used as a souring agent especially in sour soup	Fruit pulp	Akha	(Srisanga et al., 2011)
			Hmong	(Nuammee, 2012)
			H'tin	(Klamwaewwong, 1996)
			Karen	(Georgiadis, 2022) (Sonsupub, 2010) (Sutjaritjai, 2019)
			Thai	(Upho, 2005)
			Thai Yuan	(Penpanassak & Inta, 2018) (Songsangchun, 2015)
		Fruit pulp, Tender shoot	Akha	(Inta, 2008)
			Hmong	(Noitana et al., 2013)
			Karen	(Winijchaiyanan, 1995)
			Lawa	(Songsangchun, 2015)
			Tai Lue	(Inta, 2008)

Category	Usages	Part	Ethnicity	Reference
		Tender shoot	Akha	(Thatsaneeyakorn, 1997)
			Karen	(Khamfachuea, 2008), (Tovaranonte, 2003)
			Lahu	(Yaso, 1997)
			Lawa	(Ponpim, 1996)
			Shan	(Pongamornkul & Muangyen, 2012)
			Tai Lue	(Muangyen, 2013)
			Thai (Isaan)	(Numpulsuksant et al., 2021)
			Thai Yuan	(Muangyen, 2013)
			Yunnan Chinese	(Ponpim, 1996)
Other additive types	used in fish larb (spicy minced fish salad)	Bark	Shan	(Pongamornkul & Muangyen, 2012)

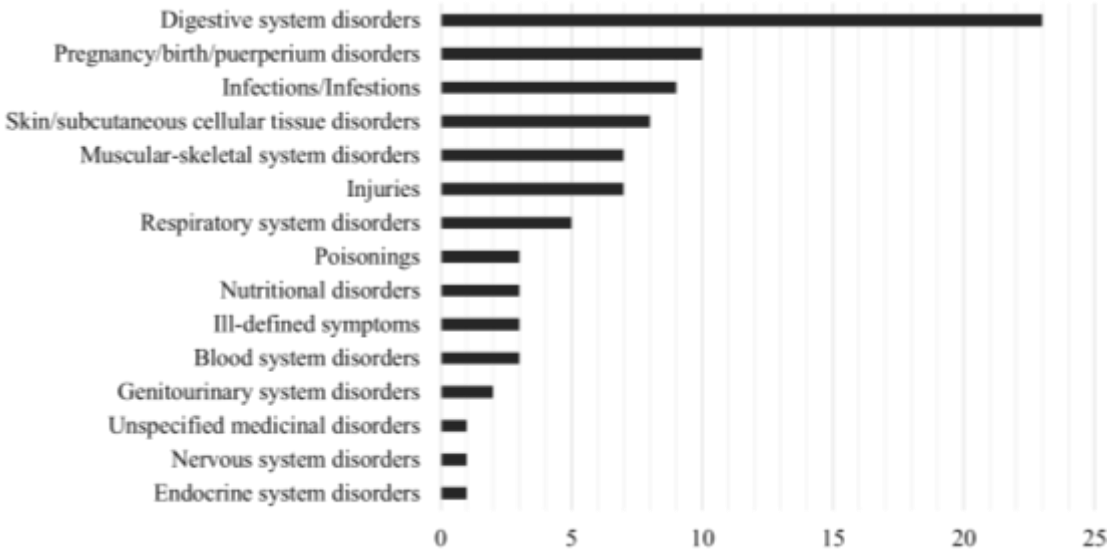

Figure 2 The number of reports used for the ethnomedical use of *T. indica* in each category (Cook, 1995).

Table 3 Ethnomedicinal uses of *Tamarindus indica* in Thailand

Category	Part	Ailments	Preparation /Application	Reference
Blood system disorders	Fruit	Blood flow improvement	Drink aqueous decoction -	(Maneenoon et al., 2015), (Pongamornkul & Muangyen, 2012)
	All parts/ whole plant	Blood flow improvement	Boiled then bath	(Pongamornkul & Muangyen, 2012)
Digestive system disorders	Bark	Diarrhea	Potion	(Sutjaritjai, 2019), (Yaso, 2000)
		Aphthous ulcer in cattle	Orally consume	(Sutjaritjai, 2019)

Category	Part	Ailments	Preparation /Application	Reference
		Colic	Drink aqueous decoction	(Tovaranonte, 2001)
	Fruit	Laxative	Orally consume -	(Sonsupub, 2010), (Sutjaritjai, 2019), (Chamratpan & Homchuen, 2005), (Neamsuvan et al., 2016), (Phatlamphu et al., 2021), (Muangyen, 2013), (Muangyen, 2013), (Pongamornkul & Muangyen, 2012), (Sumridpiem, 2017)
			Drink aqueous decoction	(Maneenoon et al., 2015)
	Fruit	Sputum Elimination	Drink aqueous decoction	(Maneenoon et al., 2015)
	Fruit pulp	Laxative	Orally consume	(Pongamornkul & Muangyen, 2013)
		Constipation	Orally consume with salt	(Tovaranonte, 2001), (Sumridpiem, 2017)
	Leaf	Gastroesophageal reflux disease	Drink aqueous Decoction	(Sumridpiem, 2017)
	Tender Shoot	Bloating	Boiled with *Lasia spinosa* then drink	(Ponpim, 1996)
	NA	Constipation	-	(Noitana et al., 2013)
		Diarrhea	Orally consume	(Sumridpiem, 2017)
Endocrine system disorders	Leaf	Diabetes	-	(Upho, 2005)
Genitourinary system disorders	Root	Urethral stones	Drink aqueous decoction	(Sutjaritjai, 2019)
		Gallstones	-	(Kamwong, 2009)
Ill-defined symptoms	Fruit	Dizziness	Bath	(Sutjaritjai, 2019)
			Orally consume	(Sutjaritjai, 2019)
Infections/Infestations	Bark	Fever	Bath	(Sutjaritjai, 2019)
			Herbal steam	(Sutjaritjai, 2019)
		typhoid fever	boiled with others	(Winijchaiyanan, 1995)
	Fruit	Bilharzia	orally consume	(Neamsuvan et al., 2016)
		Cold in children	Drink aqueous decoction	(Maneenoon et al., 2015)
	Leaf	Malarial fever	-	(Upho, 2005)
	Tender shoot	Convalescence fever	Mixed with other shoots then steamed	(Winijchaiyanan, 1995)
	NA	Deworming	-	(Noitana et al., 2013)
Injuries	Bark	Wound	-	(Pongamornkul & Muangyen, 2012)
			Poultices	(Sutjaritjai, 2019)
	Fruit shell	Wound	Boiled	(Pongamornkul & Muangyen, 2012)
	Leaf	Wound	Pounded	(Tovaranonte, 2001)
	Whole	Wound	Boiled	(Pongamornkul & Muangyen, 2012)
	NA	Wound	Boiled, mixed with water and bathed	(Phatlamphu et al., 2021)

Category	Part	Ailments	Preparation /Application	Reference
Muscular-skeletal system disorders	Bark	Back pain	Drink aqueous decoction	(Sutjaritjai, 2019)
	Fruit	Aches and pains	Herbal steam	(Sumridpiem, 2017)
	Leaf	Hands and feet soreness	Soaked	(Sumridpiem, 2017)
		Aches and pains	Compress ball	(Sumridpiem, 2017)
	Stem	Lumbago	Drink decoction	(Sutjaritjai, 2019)
Nervous system disorders	Fruit	Paralysis	-	(Chamratpan & Homchuen, 2005)
Nutritional disorders	Fruit	Tonic	-	(Sumridpiem, 2017)
			Mixed with others	(Pongamornkul & Muangyen, 2013)
	Leafy Branch	Malnutrition	Boiled with other herbs then bathed	(Bunsongthae & Chaiwong, 2010)
Poisonings	Fruit	Detoxification	Orally consume	(Sutjaritjai, 2019)
	Leaf	Detoxification	Soaked	(Sumridpiem, 2017)
Pregnancy/birth/puerperium disorders	Bark	Postpartum Recovery	Boiled or mixed with herbs	(Pongamornkul & Muangyen, 2012)
	Fruit	Postpartum recovery	-	(Pongamornkul & Muangyen, 2012)
	hardwood	Postpartum recovery	heated by fire	(Phatlamphu et al., 2021)
	Leaf	Postpartum recovery	-	(Pongamornkul & Muangyen, 2012)
	Leafy branch	Postpartum recovery	Boiled	(Bunsongthae & Chaiwong, 2010)
	Root	Postpartum abnormalities	-	(Kamwong, 2009)
	Stem	Puerperium	Drink aqueous decoction	(Sutjaritjai, 2019)
	Tender shoot	Postpartum recovery	-	(Pongamornkul & Muangyen, 2012)
Respiratory system disorders	Bark	Cough	Drink decoction	(Sutjaritjai, 2019)
		Phlegm	Boiled	(Tovaranonte, 2001)
		Sore throat	Drink decoction	(Sutjaritjai, 2019)
	Fruit	Cough	Orally consume/ drink decoction	(Sutjaritjai, 2019)
	NA	Cough	-	(Noitana et al., 2013)
Skin/subcutaneous cellular tissue disorders	Bark	Dark spots, rashes	Made into powder and used as face powder	(Tangjitman, 2017)
		Itching	Bath	(Sutjaritjai, 2019)
		Itching	Boiled then bath	(Pongamornkul & Muangyen, 2012)
		Itching	Applied	(Pongamornkul & Muangyen, 2012)
	Fruit	Dry skin	Liniment	(Sutjaritjai, 2019)
	Inner bark	Pus-filled wounds	Burnt, scraped, and mixed with water	(Sumridpiem, 2017)
	Leaf	Itchy rash	Compress ball	(Sumridpiem, 2017)

Category	Part	Ailments	Preparation /Application	Reference
Unspecified medicinal disorders	Tender shoot	Used as a herbal remedy	-	(Pongamornkul, 2006)

Discussion

Tamarindus indica is widely acknowledged as a versatile tree in Africa, Asia, and Latin America, with significant applications in medicines and foods (Lans, 2007; Ebifa-Othieno et al., 2017; Bibi et al., 2022). It has been reported as the most commonly used species among the Karen community in Thailand, due to its integral role in their culinary traditions, medicinal practices, and sustainable lifestyle (Sutjaritjai et al., 2019). It is also the species with the highest use value among an ethnic group in Indonesia (Al Yamini et al., 2023). While *T. indica* serves various medicinal purposes for treating a range of ailments within 15 used categories, it is notably employed extensively in addressing digestive system disorders as a laxative, much like its utilization in Africa (Havinga et al., 2010). This widespread use can be attributed to its high content of organic acids, dietary fiber, and phytochemicals, which stimulate bowel movements, improve digestion, and alleviate constipation. Its accessibility and effectiveness in traditional medicine systems make it a preferred remedy for digestive issues across various regions. *T. indica* has been report for postpartum recovery in Indonesia as tonic to recover the stamina (Silalahi and Khairiah, 2020), but Thailand was report only for bathing which may related with the anti-inflammatory, wound healing activities and analgesic potential (Havinga et al., 2010; Komakech et al., 2019). The limited use in Thailand could be attributed to cultural differences in postpartum care practices, where herbal remedies are often integrated into external applications rather than internal consumption. *T. indica* is suggested as a potent natural wound-healing phytochemicals including terpenoids, sterols, and fatty acids (Aly et al., 2023).

According to traditional dietary practices, *Tamarindus indica* is consumed as a food source and food additive, and it can also be prepared as a pleasantly acidic beverage (De Caluwé et al., 2010). The ripened fruits of *T. indica* are rich in essential minerals such as Zn, Fe, Ca and Mg and have a long shelf life of up to eight weeks (Nattaporn & Krittika, 2010; Okello et al., 2017). The fruit and its extract are utilized by the food industry as preservatives and for the production of ready-to-eat foods (Mansingh et al., 2021).

Although there is a preference for exotic species over native species in traditional uses, there is low redundancy observed between exotic and native species (Alencar et al., 2014). Exotic species are incorporated into pharmacopoeias to address gaps that are not fulfilled by native species (Medeiros et al., 2017). The utilization of exotic plants in traditional medicine can be attributed to the hypotheses of versatility, availability, and diversification, which aim to explain the increasing number of exotic plants being used. These hypotheses provide a potential explanation for the popularity of utilizing exotic plants (Gaoue et al., 2017).

The availability hypothesis posits that the significant incorporation of *T. indica* in Thai ethnobotany may be attributed to its greater abundance or accessibility compared to native plant species. It is noteworthy that this species has been introduced to Thailand for more than 700 years since Sukhothai period and is widely distributed across the country, thereby reinforcing its accessibility. Our study confirms this notion to a certain extent; the plant's uses spanned multiple ethnic groups and domains, suggesting widespread availability. Furthermore, its diverse utilization for non-medicinal purposes, such as food and construction material, may be indicative of its abundance in the Thai landscape. The availability of a plant species can

indeed influence its value in traditional medicine, as demonstrated by previous research (Medeiros, 2013; Panyadee, 2022).

The diversification hypothesis suggests that introduced species like *T. indica* may fill therapeutic vacancies due to their novel bioactivity. However, in the context of Thai ethnobotany, this hypothesis appears to be less compelling for explaining the plant's widespread use. While our results do show that *T. indica* has a significant role in ethnomedicine, particularly in treating digestive system disorders (Tangjitman et al., 2015; Panyadee et al. 2019), it is worth noting that Thailand has a rich repertoire of native species also employed for digestive ailments. Therefore, the plant's extensive use may not be solely attributed to filling a therapeutic gap but could also be influenced by cultural factors, traditional knowledge, or synergistic effects when used in polyherbal formulations. Future phytochemical and ethnopharmacological studies could provide more nuanced insights into this aspect.

The versatility hypothesis posits that introduced species are more likely to be incorporated as medicines due to their broader range of uses. This is vividly supported by our data, which demonstrates that *T. indica* is not only used medicinally but also in diverse non-medicinal categories like food, materials, and social uses. Furthermore, within the medicinal domain, *T. indica* is employed for a broad spectrum of ailments. Such versatile use-profiles are consistent with other ethnobotanical studies that found a high correlation between versatility and plant utilization (Bennett & Prance, 2000).

Conclusion

The ethnobotanical profile of Tamarindus indica in Thailand is a compelling tapestry woven from biological availability, cultural preferences, and medicinal versatility. This study complements global research underscoring the plant's multifaceted applications, particularly in traditional medicine. Our review provides an in-depth ethnobotanical analysis of *T. indica* in Thailand, revealing its expansive utility across various domains and ethnic groups. While the plant's applications share some commonalities with practices in other counties, unique local uses underscore the critical role of cultural context in ethnobotanical research.

Our findings contribute substantively to the existing body of knowledge, demonstrating how exotic species like *T. indica* can become deeply embedded within local pharmacopoeias and cultural norms. The utilization of nearly all parts of the plant for a range of medical conditions-including digestive system disorders, women's healthcare, and infections-is particularly noteworthy. Moreover, the plant's recognized nutritional value aligns with scientific substantiation, adding another layer to its importance.

Future investigations should focus on elucidating the phytochemical properties of *T. indica*, exploring its synergistic effects in polyherbal formulations, and assessing its role in sustainable development and biodiversity conservation. Additionally, strategies to leverage ethnobotanical knowledge for both economic and environmental benefits should be considered, as they could incentivize communities to preserve their traditional practices and knowledge.

Acknowledgement

This work was supported by the Thailand Academy of Social Sciences, Humanities and Arts (TASSHA), under the Suvarnabhumi Project, funded by the Ministry of Higher Education, Science, Research and Innovation, Thailand.

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