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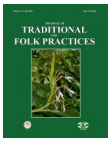

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The distribution and utilization pattern of *Musa* spp., by *Khamti* tribe in Arunachal Pradesh, India

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Abstract

The study was conducted to document the distribution and utilization pattern of *Musa* spp., by the *Khamti* tribe in Namsai district, Arunachal Pradesh. This study was conducted from January to June 2023 through a questionnaire survey and informal interviews with 60 respondents from the *Khamti* tribe. In this study, 10 *Musa* spp., were reported from the Namsai district. Of these, 7 were wild *Musa* spp., namely, *Musa balbisiana* Colla, *Musa flaviflora* N.W.Simmonds, *Musa itinerans* Cheesman, *Musa markkuana* (M.Sabu, A.Joe & Sreejith) Hareesh, A.Joe & M.Sabu, *Musa siangensis* Taid, S.S.Singh & Gajurel, *Musa velutina* H.Wendl. & Drude and one unknown *Musa* spp. M1 and 3 cultivated *Musa* sp. *Jahaji, Chinikol, Plantain.* The *Khamti* tribe utilized *Musa* spp., in eight different use categories for a variety of sociocultural purposes, including ceremonies and rituals (CNR), commercial purposes (COM), construction (CON), edible/consumption (EDB), livestock feed (FED), traditional medicinal (MED), packing (PAC) and other processes (OTH). The EDB and COM use categories had the highest utilisation (26% each), followed by CNR (15%), OTH (11%), etc. Fruits and inflorescences were used the most (21% each), followed by leaves and pseudostems (16% each). The tribe used the different plant parts of *M. balbisiana* most (7 uses) followed by *M. itinerans.* The practice of traditional knowledge in rituals, ceremonies, and ethnic dishes reflects the *Khamti* tribe's successful preservation and transmission of culture, while indicating the presence of other species were recorded other than *Musa* spp. in traditional medicine, magico-religious practices, and cuisine that may be valuable to the wider world.

Keywords: Bananas, Cultivated, Namsai, Questionnaire, Wild

1. Introduction

Banana plants belong to the genus *Musa* L., the monocot family *Musaceae* in the order Zingiberales. Two more genera are also available in the family (Kress *et al*., 2001). There are 85 species of *Musa* distributed worldwide, with the greatest diversity in tropical and subtropical regions of Southeast Asia, the Southwest Pacific and northern Australia (Liu *et al*., 2002; POWO, 2025; Kennedy, 2009). Most *Musa* spp. are concentrated in the Indo-Myanmar and South Asian regions, including Cambodia, Laos, Thailand and Vietnam (Myers *et al.,* 2000; Uma *et al*., 2005; Joe and Sabu 2016; Hastuti *et al*., 2019).

A total of 34 taxa of *Musaceae* were reported in India, of which 30 taxa occurred in the northeastern states, with 19 taxa endemic to the region, representing 81% of the total wild *Musaceae* diversity in India (Sabu *et al*., 2014). The majority of wild *Musa* in the Indian subcontinent are found in the northeastern states, located between the Indo-Burma and eastern Himalayas (Deb CR *et al*., 2023). Besides wild species in natural habitats, many cultivated varieties of *Musa* spp., are found in the traditional home gardens in the region (Molina and Kudagamage, 2002). Six new *Musa* spp. (*M. argentii* Gogoi & Borah, *M. arunachalensis* A.Joe, Sreejith &

M.Sabu, *M. markkui* Gogoi & Borah *M. markkuana* (M.Sabu, A.Joe & Sreejith) Hareesh, A.Joe & M.Sabu, *M. kamengensis* Gogoi & Häkkinen, *M. puspanjaliae* Gogoi & Häkkinen) were recorded from Arunachal Pradesh in the last 15 years (Gogoi and Borah, 2013; Gogoi and Hakkinen, 2013; Sreejith *et al*., 2013; Dey *et al.,* 2014; Gogoi and Borah, 2014; Hareesh *et al*., 2017).

With the diverse distribution of *Musa* spp., across the world, indigenous communities depend on *Musa* spp., for various sociocultural, religious and economic purposes. In addition to the widespread use of the banana fruit as a food source, various communities use different parts of the banana plant in numerous ways. The leaves of *Musa* spp. are used extensively for preparing weaving baskets, mats, table cloths, plates, cups, food wrappers for both marketing, cooking and for covering food (Kamira *et al*., 2015). The fruit, leaves, peels, pseudostem and roots of the *Musa* plant have different pharmacological effects (Palde *et al*., 2022). The male bud is cooked and consumed as a vegetable in Malaysia and India (Hassan, 2002). It is also used in several meals due to its various health benefits (Palde *et al*., 2022). The sap liquid obtained from male buds of many *Musa* species is used as a remedy for stomach problems (Mustaffa and Sathiamoothy, 2002). Ripe fruits of *M. cheesmani* N.W.Simmonds and *M. itinerans* Cheesman are consumed to cure dysentery (Dutta *et al*., 2019). Many species of *Musa* are also extensively used for magico-religious practices, *viz*., the use of *M. balbisiana* Colla, stem during preparation of the ceremonial altar in *Tallenguie* and *Sarak puja* by the Mising and Deori tribes of Assam, respectively (Pangging *et al*., 2019; Pangging *et al*., 2021).

Arunachal Pradesh, located in the Northeastern region of India, spans a large area and harbours a wide range of agro-climatic conditions, supporting rich floral and faunal diversity. The state also possess high ethnicity and cultural diversity. *Khamti* is a major tribal community inhabiting the Namsai district located in the eastern part of Arunachal. The *Khamti*, like other tribal communities, have been dependent on forest resources since time immemorial. The cultivation and use of *Musa* are integral to the traditional knowledge systems of the *Khamti* tribe. Thus, the present study was carried out to document the distribution and utilization pattern of both wild and domesticated *Musa* spp., by the *Khamti* tribe in Namsai district of Arunachal Pradesh.

2. Materials and methods

2.1. Study area and community

The *Tai-Khamti* tribe belongs to the *Tai* ethnic group, one of the major tribes inhabiting the Namsai and Changlang districts of Arunachal Pradesh. However, some populations are also found in Assam's Tinsukia, Lakhimpur and Dhemaji districts. They are followers of Theravada Buddhism, use the locally known script 'Lik Tai' and speak the *Khamti* language. Other tribes, namely *Deories, Aiton, Khamyangs* and *Phake* were also found inhabiting the Namsai district. The present study was conducted in Namsai district, located in the eastern part of Arunachal Pradesh, with coordinates 27.6692° N, 95.8644° E. Assam surrounds the district in the West and Southwest, Changlang district in the south and southeast and Lohit district in the east and north (Fig. 1).

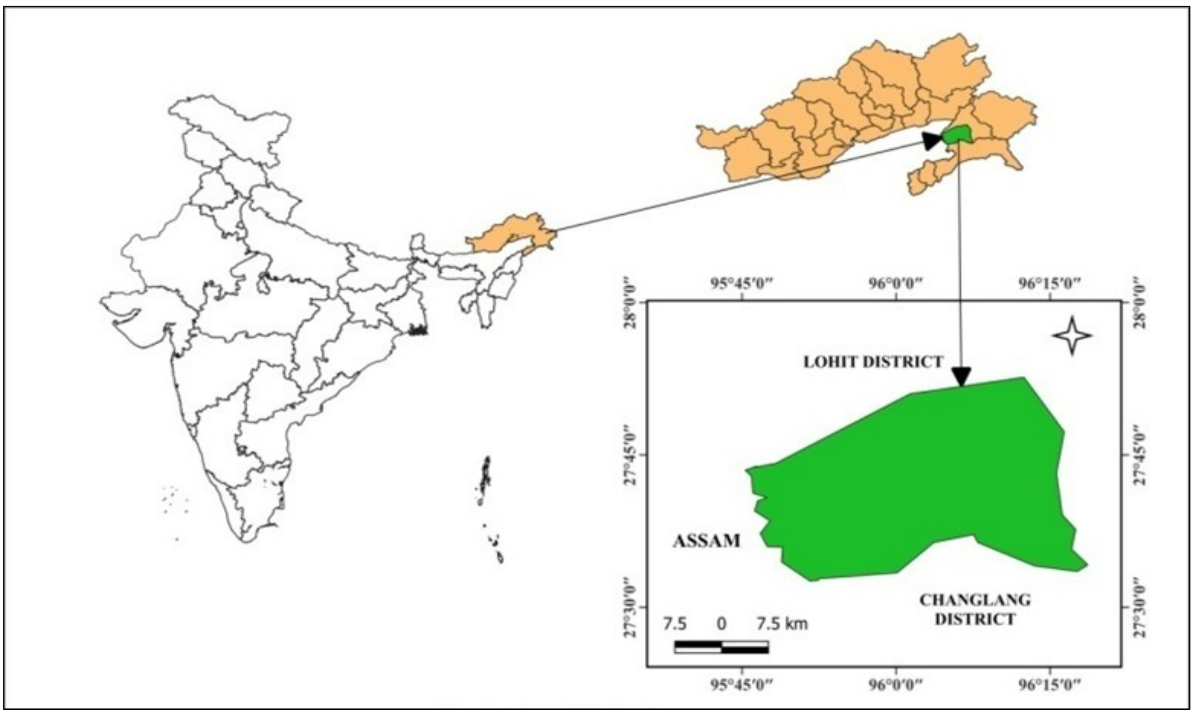


Fig. 1. Study area

2.2. Documentation of distribution and identification of *Musa* species

The documentation on the distribution of *Musa* spp. were conducted through an extensive field survey in the Namsai district. Informal interactions were conducted with locals regarding the occurrence of *Musa* species; roadside visits and forest surveys were also carried out. With the help of the Global Positioning System (GPS), the exact locations of the occurrence of *Musa* spp., were recorded. The GPS coordinates were recorded at every location where the species occurs and, as much as possible, to document its presence. These species were grouped into various categories, such as abundant –the species that is available in abundance; rare – the uncommon species, scarce, infrequently encountered or could be endemic; random – individuals that are spaced at unpredictable distances from each other; and cultivated – the species that is available and can be grown by humans to meet their needs. The distribution map of *Musa* spp. was prepared by plotting the coordinate points recorded during the field survey in QGIS 3.32 software.

The identification of *Musa* spp. was made by consulting published literature and comparing the morpho-taxonomic characterization based on description in the "descriptors of banana" (IPGRI-INIBAP/CIRAD, 1996). The name and synonyms of banana were confirmed by consulting web resources, Plants of the World Online (POWO, 2023) and Musalogue (Daniells, 2001). For unknown species, the herbarium collection was made following the standard methods of Jain and Rao (1977) and Herbarium, Queensland (2013).

2.3. Utilization pattern

The use of both wild and cultivated *Musa* spp. was assessed using a semi-structured questionnaire, an informal interview and personal observation, as per the methodology (Jain and Mudgal, 1999). In this study, 60 informants from the village level were selected by random sampling in the Namsai district, namely *Namsai, Lathao, Manfaiseng, Mengkeng, Chongkham, Kherem, Nampong, Enten, Manna, Ningloo, Mumong,* etc. The informants included village heads (GB), monks, farmers, local healers, etc., from different age groups and genders. Prior Informed Consent (PIC) was also obtained before commencing the interview. The information obtained included the local name of *Musa* spp., synonyms and meanings, if any, local knowledge and knowledge about banana. The uses of plant parts of the banana were categorized into rhizome, sucker, seed, sap, leaf, pseudostem, inflorescence and fruit. Also, the uses of bananas were grouped into nine use categories such as ceremonies and ritual (CNR- ceremony and traditional needs), commercial (COM- *Musa* parts and products sold in markets), construction (CON- used in roofing), edible (EDB- consumed by the locals, traditional cuisine etc.), feed (FED- livestock feeds), medicine (MED- traditional medicines), nutrient resource management (NRM- traditional nutrient management), packing (PAC- packing, wrapping, binding, etc.) and others (OTH- domestic uses, ornamental, miscellaneous uses, etc.).

3. Results and discussion

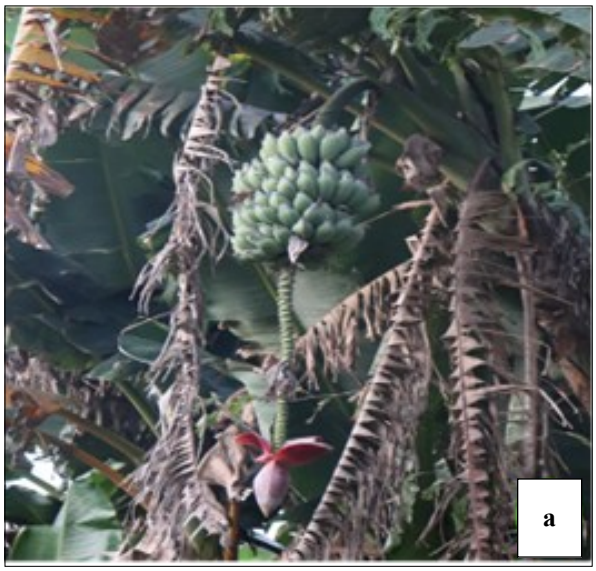
3.1. Distribution of *Musa* spp., in Namsai district of Arunachal Pradesh

The distribution of *Musa* spp., was conducted using GPS points collected with a Garmin GPS device, visiting forest areas and roadways throughout the district as much as possible. A total of seven wild *Musa* spp., namely *M. balbisiana, M. itinerans, M. velutina, M. markkuana, M. flaviflora, M. siangensis* and one unidentified spp., named *Musa M1* and three domesticated cultivars, *Jahaji, Sabji-kol* and *Chini-champa,* were recorded from different parts of Namsai district, Arunachal Pradesh. The photographs of the *Musa* species recorded in the district are shown in Plate 1 and the point distribution of wild *Musa* spp., is plotted in the distribution map (Fig. 2). The map was created using QGIS 3.32 software in the OSM standard map. The species were found distributed along roadsides, riverbanks, streams and forests. Wild species such as *M. balbisiana, M. itinerans* and *M. velutina* were found to be the most abundant with wide distribution ranges. *M. siangensis* and *M. markkuana* were the least distributed with one or two locations recorded. Other species, such as *M. flaviflora* and the unknown species *Musa M1* were randomly distributed. The domesticated *Musa* spp. were found mainly in the home gardens and agricultural fields of the tribal community. Moreover, *M. balbisiana* was also cultivated in their home gardens and compounds for various purposes.

The growth and occurrence of *M. velutina* and *M. balbisiana* were favourable in the Namsai district. However, there were also plenty of *M. flaviflora* and *M. itinerans* (Table 1). The district's elevation, recorded by the GPS device was below 200 msl, indicating that the species found there are heat tolerant. The occurrence of unknown species (M1) in the district and state suggests that Arunachal Pradesh may be a major center of *Musa* origin. The number of *Musa* spp. in the state is 21 (Taid *et al.,* 2024) and unknown species continue to occur.

3.2. Indigenous knowledge on utilization of *Musa* spp., by the *Khamti* tribe

The *Khamti* tribe utilized both wild and domesticated *Musa* spp., under 8 broad use categories (Fig. 4), such as ceremonies and rituals (CNR), commercial (COM), construction (CON), edible (EDB), feed (FED), medicine (MED), packaging/wrapping purpose (PAC) and other purposes (OTH). The indigenous knowledge system related to the utilization of *Musa* spp. by the *Khamti* tribe has been passed down from generations since time immemorial (informant). The utilization pattern of seven *Musa* spp., and three cultivars are depicted in Table 2.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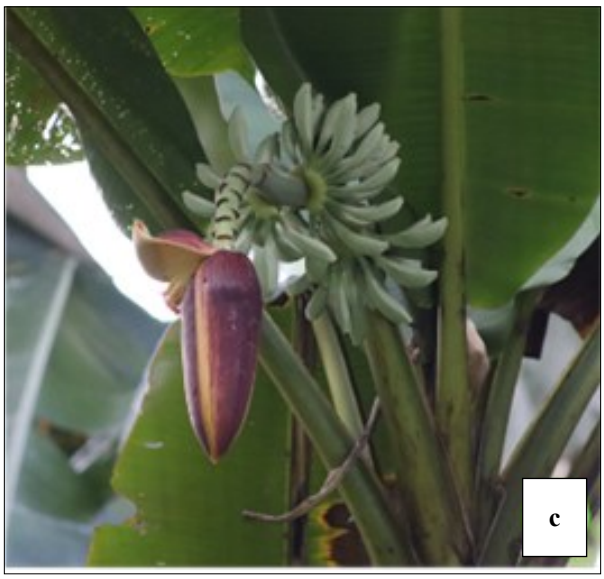
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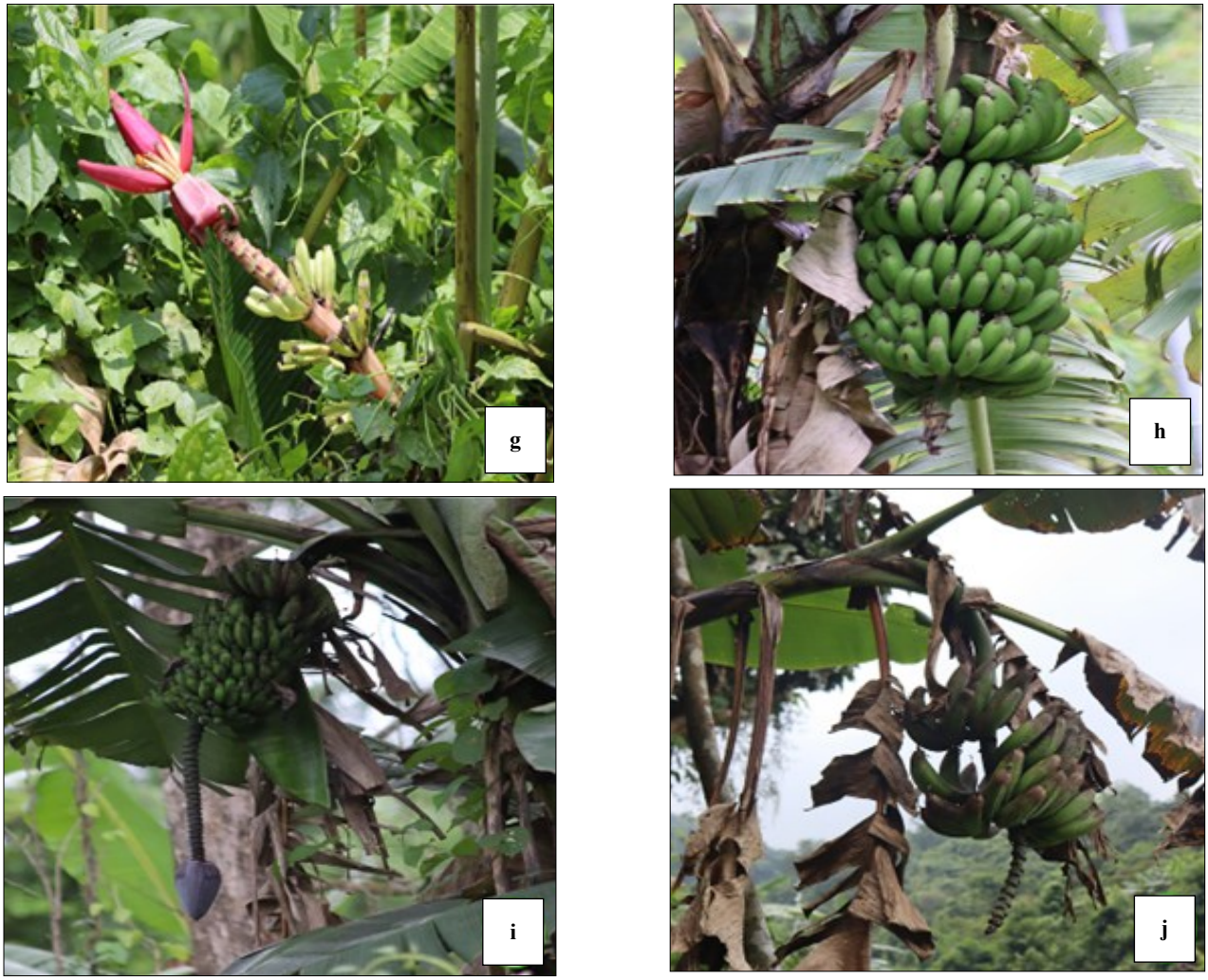

Plate 1. a. *Musa balbisiana* Colla; b. *M. flaviflora* N.W.Simmonds; c. *M. itinerans* Cheesman; d. *M. markkuana* (M. Sabu, A. Joe & Sreejith) Hareesh, A. Joe & M. Sabu; e. *M. siangensis* Taid, S.S.Singh et Gajurel; f. *M. velutina* H.Wendl. & Drude; g. Unknown *Musa M1*; h. *Musa sp.* (*Jahaji*); i. *Musa sp*. (*Chini-champa*); j. *Musa sp.* (*Plantain*)

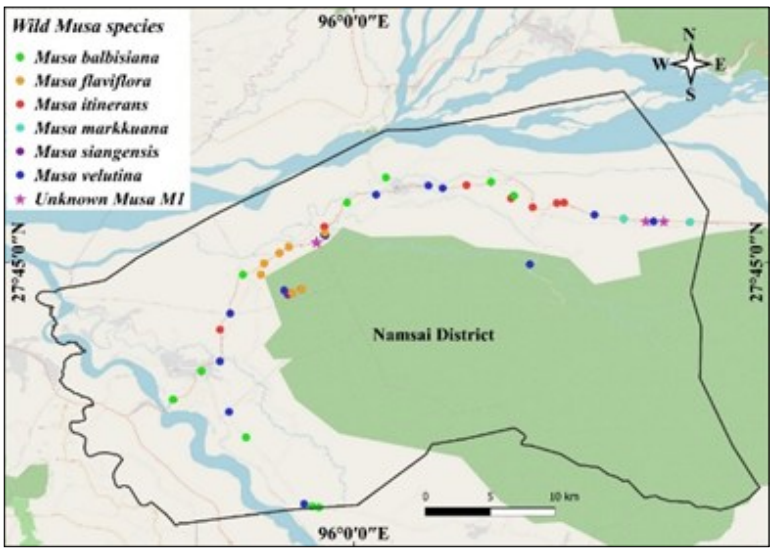

Fig. 2. Distribution map of wild *Musa* spp., found in the Namsai district *(The map was created in QGIS 3.32 using the OSM standard. Geospatial data was used to develop the study map. The point-colored dots represent the locations of Musa spp., distributed in the Namsai district. The points were recorded using a Garmin GPS device)*

Table 1. Coordinates of wild *Musa* spp., along with altitude

Sl. No.	Name of *Musa* species	Latitude	Longitude	Elevation (msl)
1	*Musa balbisiana* Colla	27^0 39’28.872”	95^0 52’34.608”	144
		27^0 48’59.364”	96^0 1’30.36”	155
		27^0 47’37.428”	96^0 7’6.924”	155
		27^0 46’40.224”	95^0 58’37.236”	154
		27^0 47’47.868”	95^0 59’41.224”	156
		27^0 48’28.872”	96^0 4’22.332”	160
		27^0 48’46.692”	96^0 6’26.856”	162
		27^0 48’50.544”	96^0 7’39.54”	162
		27^0 48’7.74”	96^0 7’31.008”	166
		27^0 48’59.4”	96^0 1’30.504”	174
		27^0 44’31.164”	95^0 55’38.712”	154
		27^0 44’24.936”	95^0 54’48.276”	157
		27^0 40’18.264”	95^0 53’30.264”	158
		27^0 39’52.992”	95^0 52’51.636”	164
		27^0 38’32.316”	95^0 51’31.392”	163
		27^0 38’8.196”	95^0 49’53.184”	166
2	*M. flaviflora* N.W.Simmonds	27^0 44’56.436”	95^0 55’47.82”	174
		27^0 43’33.24”	95^0 57’5.724”	170
		27^0 44’25.188”	95^0 55’38.712”	188
		27^0 45’25.884”	95^0 56’31.092”	192
		27^0 46’22.404”	95^0 58’38.892”	180
		27^0 45’43.488”	95^0 56’57.588”	178
		27^0 43’44.148”	95^0 57’32.832”	182
3	*M. itinerans* Cheesman	27^0 43’44.148”	95^0 57’32.832	154
		27^0 45’42.66”	95^0 56’57.12”	156
		27^0 46’40.224”	95^0 58’37.236”	152
		27^0 48’11.988”	96^0 0’14.94”	168
		27^0 48’37.44”	96^0 5’17.628”	166
		27^0 48’53.028”	96^0 6’57.456”	170
		27^0 48’0.18”	96^0 7’22.728”	165
		27^0 46’22.404”	95^0 58’38.892”	158
		27^0 43’33.672”	95^0 57’34.704”	156
4	*M. markkuana* (M. Sabu, A. Joe & Sreejith) Hareesh, A. Joe & M. Sabu	27^0 45’25.884”	95^0 56’31.092	154
		27^0 48’11.52”	96^0 0’21.204”	153
5	*M. siangensis* Taid, S.S.Singh et Gajurel	27^0 43’28.884”	95^0 56’54.384”	186
6	*M. velutina* H.Wendl. & Drude	27^0 45’53.964”	95^0 57’44.46”	154
		27^0 46’48.792”	95^0 58’57.684”	165
		27^0 47’28.5”	95^0 59’24.18”	152
		27^0 46’57”	96^0 14’4.956”	172
		27^0 48’10.584”	96^0 1’3.072”	168
		27^0 48’56.34”	96^0 6’58.608”	169
		27^0 44’27.816”	95^0 54’57.564”	174
		27^0 47’10.536”	95^0 59’9.924”	170
		27^0 48’37.08”	96^0 3’41.58”	178
		27^0 47’33.756”	96^0 3’27.18”	177
		27^0 48’45”	96^0 7’45.84”	176
		27^0 47’36.168”	96^0 10’7.212”	172
		27^0 45’27.288”	95^0 56’23.82”	154
		27^0 40’20.064”	95^0 53’43.62”	156
		27^0 38’33.072”	95^0 55’27.552”	148
		27^0 47’56.112”	96^0 7’16.608”	150
		27^0 47’37.572”	96^0 7’6.888”	158
		27^0 48’16.992”	96^0 1’17.292”	160
		27^0 43’40.908”	95^0 56’43.296”	157
		27^0 46’15.672”	95^0 58’40.332”	160
7	Unknown *Musa M1*	27^0 45’55.224”	95^0 58’15.78”	163
		27^0 43’36.984”	95^0 56’44.016”	158
		27^0 45’43.488”	95^0 56’57.588”	159
		27^0 45’55.116”	95^0 58’14.7”	162

Table 2. Utilization pattern of both wild and domesticated *Musa* spp. by the *Khamti* tribe of Namsai district

Sl. No.	Name of species	Local name	Distribution (wild/ cultivated)	Part(s) used	Uses	Use category*
1.	*Musa balbisiana* Colla	*Athiya*	Abundant (Wild)	Inflorescence	The flowers are edible and consumed in cooked form.	EDB
				Fruit	Fruits are edible and consumed after ripe.	
				Inflorescence	Sold in local markets for income.	COM
				Fruit	Sold in local markets for income.	
				Leaf	Leaves are used to store dry fish and meat for more extended periods.	PAC
					Tongtep (local *pitha*) is made and wrapped in banana leaves as a substitute for *Phrynium pubinerve* leaf.	
					The leaves are used to steam fish.	
					It is used as an offering plate during any rituals or ceremonies.	CNR
					The leaves are shaped into cones and used to offer flowers in temples during the *Sangken* festival.	
					During Measles (*aye puja*), the leaf is used as an offering plate used during the ritual.	
					The leaves are used to serve the Monk during ceremonies or festivals.	
				Pseudostem	*Nunsietapong* – pseudo-stems are used to build *Kong-mu* during the *Sangken* festival.	
				Leaf	The leaves were used by monks to write *Khamti* scripts and were stored.	OTH
					Opium is consumed by mixing with the leaves of *M. balbisiana* by aged people.	
				Pseudostem	The base of traditional fire *chulha* (*Huttak-phai*) is made with a pseudo-stem.	
				Seed	The mixture of crushed seeds and water is consumed to cure piles.	MED
					A mixture of crushed seeds and water is given to children as a vitamin during times of weakness.	
				Sap	The sap is consumed to treat dysentery and stomachache.	
				Peel	The burnt peel is mixed with water and used to cure worms in children.	
					The burnt peel is mixed with water and used to cure a cough.	
				Pseudostem	Elephants are fed to get energy during work.	
					Decayed pseudo-stem is mixed with garlic to cure tooth pain.	
				Pseudostem	Elephant feed – pseudo-stem is given as food.	FED
					It is used as pig feed.	

2.	*Musa flaviflora* N.W.Simmonds	*Koi*	Random (Wild)	Inflorescence	The flowers are edible and consumed in cooked form.	EDB
					Sold in local markets for income.	COM
3.	*Musa itinerans* Cheesman	*Koi laii*	Abundant (Wild)	Inflorescence	The flowers are edible and consumed in cooked form. It is also used in the preparation of traditional dishes such as *Pikoi-sen, Pikoi-moh, Pikoi-tam and Pikoi-tangnam*.	EDB
				Pseudostem	The pseudo-stem core is edible and consumed in cooked form.	
				Inflorescence	Inflorescences are sold in local markets for income.	COM
				Pseudostem	Pseudo-stem core is sold in local markets for income.	
					It is used to prepare traditional dishes such as *Paa-som* (fermented fish + pseudo-stem). This dish is compulsory at various ceremonies, especially weddings, newborn celebrations, etc.	CNR
					It is used during many rituals and ceremonies of the *Khamti* tribe: (i) *Khnpasa-mau* – It is a ritual done after marriage; the bride is allowed to pass between two banana plants, which are made as a gate to enter the groom's house.	
				Sucker	(ii) *Maikho-sumphai/Khamphai*– It is a ceremony where they pray to God for warm and sunny weather by burning wood after a chill winter in February. (iii) *Hongkhonkhau/hap-somna* (rice harvest) – It is a ritual done for a good harvest where two young plants are used. (iv) *Antrekang*– It is a ritual performed for the positive spirit of the house, especially done after the death of a family member, wherein four young saplings of *Musa sp.* are used.	
				Leaf	The betel leaves are wrapped in banana leaves and sold in the market.	PAC
					Used as a mat by local vegetable vendors	OTH
				Pseudostem	4-5 pseudo-stems tied together and used as a raft to cross rivers or streams.	
				Leaf	It is used as a roof for jungle camps.	CON
4.	*Musa M1*	*Koi kea*	Rare (Wild)	-	No use was reported.	-
5.	*Musa markkuana* (M.Sabu, A.Joe& Sreejith) Hareesh, A.Joe&M.Sabu	*Koi ka*	Rare (Wild)	Inflorescence	The flowers are edible and consumed in cooked form as a vegetable.	EDB
					It is sold in local markets for income.	COM
6.	*Musa siangensis Taid*, S.S.Singh & Gajurel	*Koi*	Rare (Wild)	-	No use was reported.	-
7.	*Musa velutina* H.Wendl. & Drude	*Koi kaei*	Abundant (Wild)	Inflorescence	The flowers are edible and consumed in cooked form.	EDB
					Sold in local markets for income.	COM

8.	*Musa sp.* (Musaceae)	*Jahaji*	Cultivated	Fruit	Fruits are offered in temples during any ceremony.	CNR
					Self-consumption.	EDB
					Sold in markets and to traders.	COM
				Leaf	It is used as manure for associated species.	OTH
					Used as a mat to cut meat in functions.	
				Whole plant	Serves as a nurse crop to the areca nut.	
				Pseudostem	The pseudo-stem is used as pig feed.	FED
9.	*Musa sp.* (Musaceae)	*Chinikol*	Cultivated	Fruit	Dried and preserved for extended periods and consumed.	EDB
					Consumed in ripe form.	
					Sold in local markets for income.	COM
					Fresh fruits are offered in temples during festivals and ceremonies.	CNR
10.	*Musa sp.* (Musaceae)	*Plaintain*	Cultivated	Fruit	Consumed in cooked form.	EDB
					Sold in markets for income.	COM

**CNR-Ceremonies and rituals; COM-Commercial; CON-Construction; EDB-Edible; FED-Feed; MED-Medicine; OTH-Other; PAC-Packagin*

Plate 2. Utilization pattern of *Musa spp*., by *Khamti* tribe to be added. A. Pseudostem used to build *Kong-mu*; b. *Khnpasa-mau* - Young banana plant used during marriage ceremony; c. *Hongkhon-khau*/*Hap-somna* - A ritual is conducted where two young *Musa* spp., are used and placed before the entrance of rice godown after rice harvest; d. Young banana suckers used in temples as decoration; e. Banana leaf used during sales of vegetables; f. *Khamphai/Maikho-sumphai* - *Musa* sucker used as decoration during the festival; g. Inflorescences of wild *Musa* spp., sold in the market; h. *Musa sp.* (*Jahaji*) fruits sold to trader; i. *Antrekang* - *Musa* sucker used in *Khamti* ritual; j. Domesticated *Musa* fruits sold in the local market; k. *Pii-koi tang-nam* - A traditional *Khamti* dish prepared from *Musa* inflorescence and pseudo-stem sold in the restaurant; l. *Musa sp.* (domesticated) grown as nurse crop in areca nut plantation

A comparative analysis of different use categories of *Musa* spp. (Fig. 3) showed that *M. balbisiana* was dominant with 7 use categories followed by *M. itinerans* (6 uses), *Musa* sp. (*Jahaji*) (5 uses), etc. However, *Musa M1* and *M. siangensis* had no such records among the *Khamti* tribe. It is observed that *M. balbisiana* parts were mainly used for medicinal purposes and for ceremonies and rituals. Besides, *M. itinerans* was highly used for ceremonies and rituals.

Among all *Musa* spp., *M. balbisiana* had the highest number of plant parts (7 parts) utilized for different purposes, followed by *M. itinerans* and *Jahaji,* (4 parts), etc. (Fig. 4). The least uses were seen in *M. flaviflora*, *M. markkuana*, *M. velutina* and cultivated *Musa* (Plantain) (1 part each). In *M. balbisiana*, the highest number of plant parts utilized was leaf with 9 uses, followed by pseudo-stem (6 uses) and sap with the least use (1 use), etc. (Fig. 4). Dutta *et al*. (2019) reported usages of *Musa* spp. by five different tribes of Arunachal Pradesh where *M. cheesmani* was found with maximum uses followed by *M. itinerans* and *M. acuminata* etc. in Siang and Subansiri region of Arunachal Pradesh.

The highest percentage was found in CNR use categories (23%), followed by EDB (19%), COM (18%), OTH (14%), etc. The least use was found in construction (2%), as shown in Fig. 5. However, Dutta *et al*., (2019) recorded the highest uses in food consumption (42%), followed by fodder (23%), other (15%), etc., in the Siang and Subansiri regions of Arunachal Pradesh.

Among all plant parts, fruits and inflorescences were used most (21% each), followed by leaves and pseudostems (16% each), peel (6%), etc. The least use (5% each) was recorded for the whole plant, sap, seed and sucker (Fig. 6). Dutta *et al*., (2019) reported the highest usage of fruits as food and fodder (35%) followed by leaves (24%), inflorescence (22%) and pseudo-stems (19%) in Siang and Subansiri region of Arunachal Pradesh.

3.3.Discussion

3.3.1. Occurrence of *Musa* species

A total of seven wild *Musa* species namely, *M. balbisiana, M. itinerans, M. velutina, M. markkuana, M. flaviflora, M. siangensis* and one unidentified species, i.e., *Musa M1;* and three domesticated cultivars, *Jahaji,*

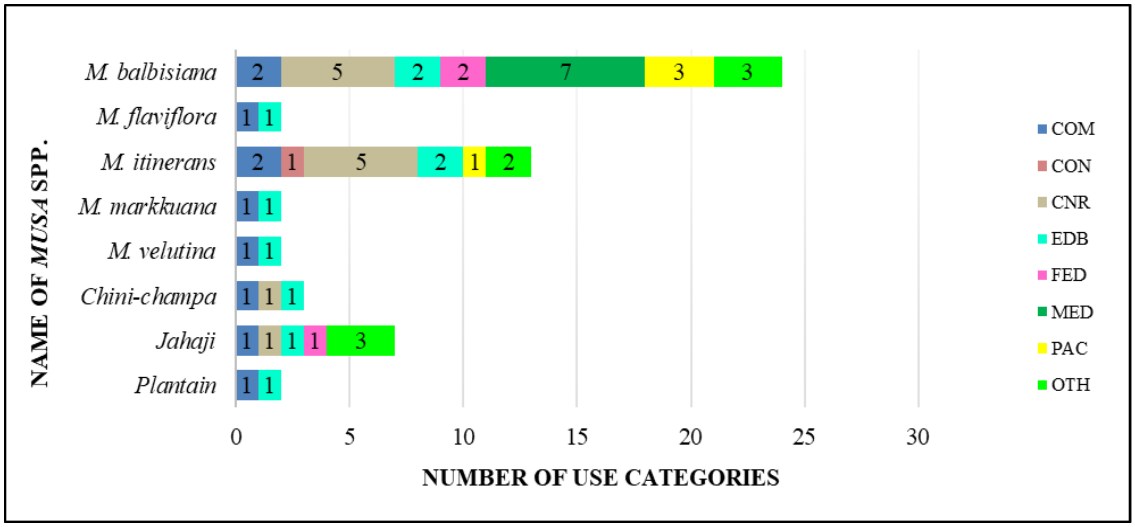

Fig. 3. Graphical representation of various use categories of both wild and domesticated *Musa* spp. (*CNR-Ceremonies and rituals; COM-Commercial; CON-Construction; EDB-Edible; FED-Feed; MED-Medicine; OTH-Other; PAC-Packaging/ Wrapping*)

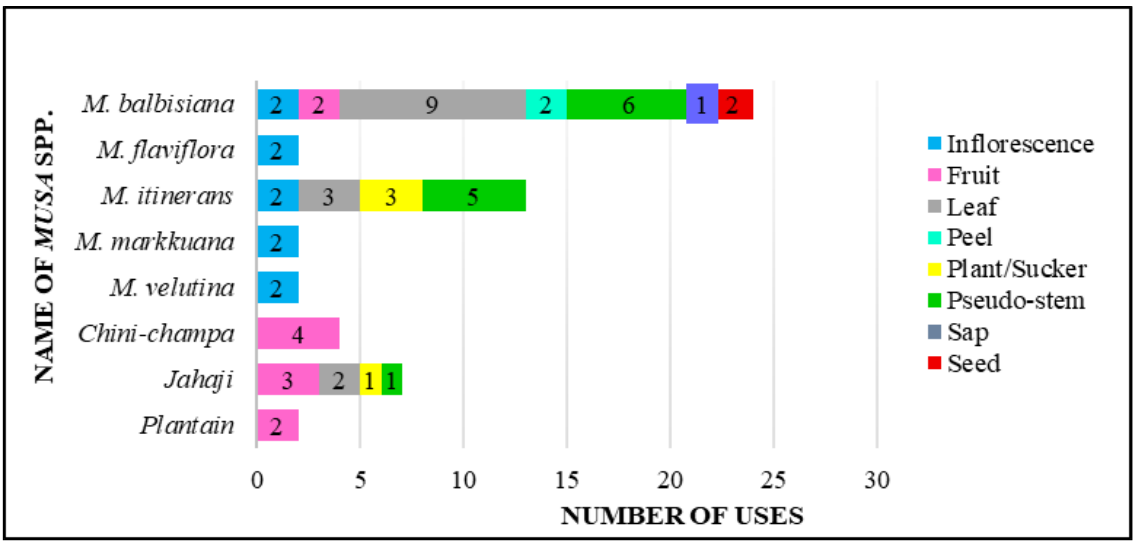

Fig. 4. Use of different parts of wild and domesticated *Musa* spp., by the *Khamti* Tribe

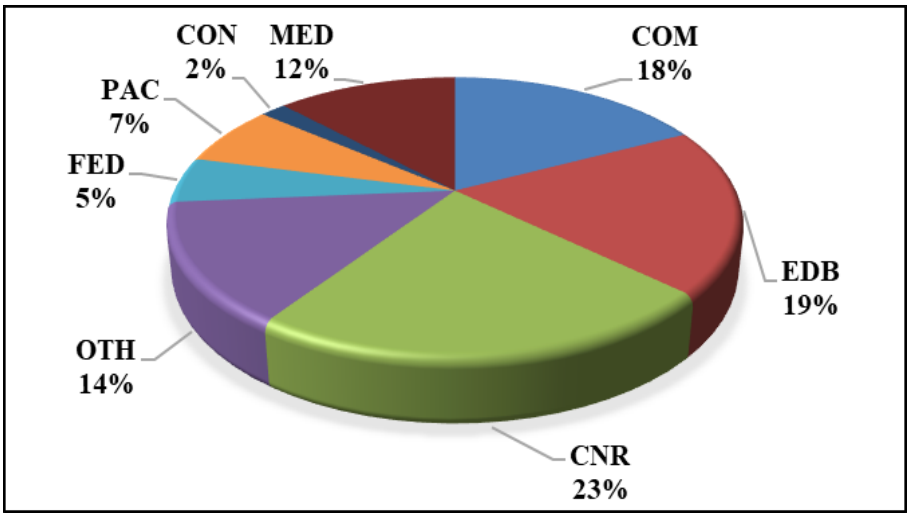

Fig. 5. Pattern of use categories of Musa species (*CNR-Ceremonies and rituals; COM-Commercial; CON-Construction; EDB -Edible; FED-Feed; MED-Medicine; OTH-Other; PAC-Packaging*)

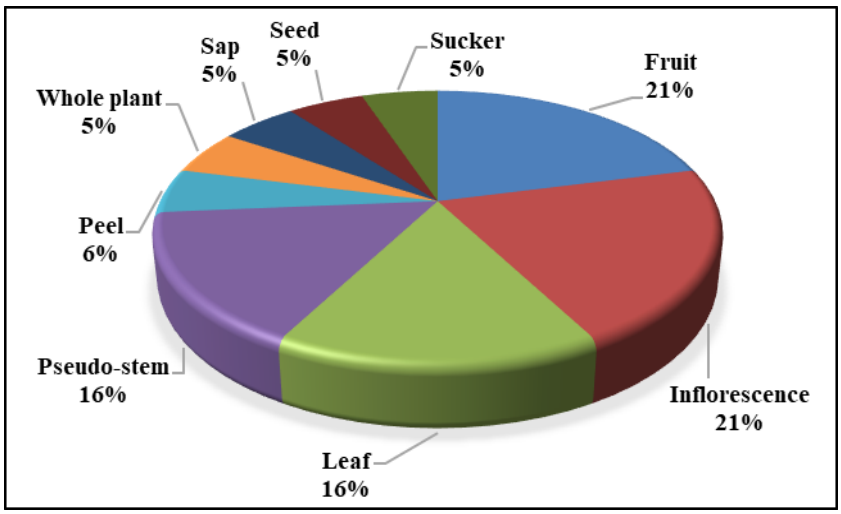

Fig. 6. The utilization pattern of different parts of *Musa* spp.

Sabji-kol and *Chini-champa* were recorded from different parts of Namsai district, Arunachal Pradesh. *M. siangensis* was recorded from the East Siang district located near agricultural lands and human with restricted its distribution and rare occurrence, making it an endangered species (Taid *et al*., 2024). On the contrary, it was also found in the forests of Namsai district, suggesting wider distribution of the species. One of the unidentified species needs taxonomic characterization and description, possibly it could be new species. *M. balbisiana* was found in abundance in the present study site, which has been reported to occur in all states in Northeastern India, particularly in Assam (Subbaraya *et al.,* 2006). Most of the species were recorded from the roadside, near agricultural fields and nearby forests. Some species, including the unknown *Musa M1*, were under tremendous threats due to the expansion of roads, agricultural fields and deforestation. This suggests an urgent need for a state-level conservation strategy to prevent the species from extinction.

3.3.2. Uses of *Musa* species in ceremonies and rituals

The highest use of the *Musa* species was observed in ceremonies and rituals. Rituals, such as *Khnpasa-mau,* in which the bride is allowed to pass between two *Musa* suckers tied with rope after marriage, are essential to the *Khamti* tribe. Likewise, the use of *Musa* species in *Antrekang* – ritual performed for positive spirit in a house after death of a household member, *Hapsomna – Musa* suckers are used in a ritual done for good fortune during rice harvest, *Maikho-sumphai* –a ritual is performed every year in February by the *Khamti* tribe where they pray to God (Buddha) for warm and sunny weather by burning woods after chill winter, here the *Musa* species is used as a substitute of bamboos to assemble the woods to burn and as decoration, *Nunsietapong* – a temporary conical structure resembling a temple (*Kong-mu*) is made with the help of banana pseudostem (bamboos are also used to construct the temple). The fruits of the *Musa-jahaji* species are offered in temples during various ceremonies and festivals in the *Khamti* tradition, i.e., *Sangken*, *Buddha Purnima* and *Poi-Pee Mau*. These practices show that the *Khamti* tribe has preserved its traditional ways of celebrating ceremonies, functions and rituals, which are also an essential part of its life. Kumar *et al*., (2012), Laishram and Thokchom (2019) and Devi *et al*., (2024) also reported the use of *Musa* spp. in different ceremonies and rituals.

3.3.3. Edible *Musa* species and traditional cuisines

The tribe prepares traditional dishes such as Pikoi-sen, Pikoi-moh, Pikoi-tam, Pikoi-tangnam and Paa-som from the inflorescences and pseudostems of *Musa* species. Here, the flowers of *M. balbisiana* and *M. itinerans* are mainly used for their good taste. However, the flowers of *M. flaviflora, M. markkuana* and *M. velutina* were also observed to be edible. Jumari (2000) reported the use of various *Musa* spp. varieties in many traditional dishes. Among the cuisines, *Paa-som* is prepared with the pseudostem core of *M. itinerans* and fermented fish and is an important dish served on several occasions, such as marriage, the naming of a newborn baby and housewarming. *M. balbisiana* leaves also play an essential role in making the local pitha called *Tongtep*, which is prepared during festivals. *Musa* inflorescences are not only consumed but also sold in local markets. Padam *et al*., (2014) reported that banana inflorescence is consumed as a vegetable. The inflorescences of wild *Musa* species such as *M. balbisiana, M. flaviflora, M. itinerans, M. markkuana* and *M. velutina* are consumed as vegetables in cooked form and sold in local markets for 20-50 rupees. The price ranges according to the size of the inflorescences.

3.3.4. Traditional medicines from *Musa* species

Tribal people have traditionally used parts of the plants, including bananas, as medicine to cure diverse health ailments (Dutta *et al*., 2019). Such traditional medicines derived from *Musa* species were also observed and are still practised by the *Khamti* tribe. These include consuming crushed *M. balbisiana* seeds after mixing with water to cure piles and using them as a vitamin

supplement for infants. The sap of *M. balbisiana* is consumed to cure dysentery and stomach-ache. A similar study was conducted by Emery *et al*. (1997) and Sampath *et al*. (2012) on the effects of banana on the treatment of stomach troubles and other stomach-related ailments. De-worming in children and cough can be cured by consuming a mixture of burnt peel of *M. balbisiana*. The tribe uses a paste/mixture of decayed pseudo-stem of *M. balbisiana* with water. The tribe uses a paste/Mixture of decayed Pseudostem of *M ballbisiana* and garlic to cure tooth pain. Also, the pseudostem of *M. balbisiana* is fed to elephants to restore energy during work, such as pulling logs and heavy objects in the forest. Recently, Mehra *et al*., (2014), Jyothirmayi and Rao (2015), Yuhlung and Battacharyya (2016) Galini (2019), Ajijolakewu *et al*. (2021), Rahman *et al*. (2022), Gaikwad *et al*. (2023) and Supiandi *et al*. (2023) reported different traditional medicines utilized from different *Musa* spp.

3.3.5. Other uses of *Musa* species

Musa plants are also utilized for packing, feed, manure and miscellaneous purposes. *Musa* leaves are used for various daily purposes such as plates in many ceremonies and festivals, steaming fish, storing dry meat and fish, roofing in forest camps, wrapping betel leaves for sale and vegetables for sale. It is also planted in an areca-nut plantation, which serves as a nurse crop. The leaves and pseudostems are also used as manure. The pseudostems are used as pig fodder. Similar reports were conducted by Aurore *et al*., (2009) found that unpeeled green bananas are used as pig feed and by Akinyele and Agbro (2007), who reported the use of *Musa* waste as animal feed. The pseudostems of *Musa* species is used to make *Huttak-phai* (traditional fire chulha) and a local raft for river crossing. *Khamti* scripts were written on the leaves of *M. balbisiana* and monks in the early days used them to write and practice in place of paper. The use of *Musa* spp. for various traditional purposes demonstrates that *Musa* species have been an essential asset of the *Khamti* tribe since time immemorial. Further, scientific investigation of wild *Musa* species may be conducted using the information obtained in this paper.

4. Conclusion

The present study reported 7 wild *Musa* spp. namely *M. balbisiana, M. flaviflora, M. itinerans, M. markkuana, M. siangensis, M. velutina* and 1 unknown *Musa sp*. (*M1*) from the Namsai district of Arunachal Pradesh. The diverse distribution of *Musa* species and the occurrence of unidentified species (*M1*) in the study area indicate that the area is suitable for *Musa*. Moreover, three domesticated (cultivars), namely *Jahaji* (Cavendish), *Chini-champa* and Sabji-kol (Plantain) were also found to be cultivated in home gardens and on agricultural land by the *Khamti* tribe. Three *Musa* species, *M. balbisiana*, *M. itinerans* and *M. velutina* were widely distributed and are found in abundance. With various uses in construction, commercial, ceremonies and rituals, edible, feed, medicine, etc. *Musa* spp. may be considered an important sociocultural plant species of the *Khamti* tribe. *Musa* spp. were also used for magico-religious purposes, including many rituals and ceremonies such as *Antrekang, Hap-somna*, *Khnpasa-mau* and *Maikho-sumphai*. Various traditional dishes, such as *Pikoi-sen, Pikoi-moh, Pikoi-tam, Pikoi-tangnam* and *Paa-som* were also prepared using different parts of the *Musa* species. The practice of traditional knowledge in rituals, ceremonies, functions and ethnic dishes demonstrates that the *Khamti* tribe has not only preserved its culture and traditions but also passed down this knowledge to the next generation. This also shows that there may be additional practices involving different species in preparing traditional medicine, magico-religious practices and ethnic dishes, rather than *Musa* species, which may be an important and beneficial resource for the outside world.

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