

Research Article



Distribution and Utilization of *Musa* spp. by Nocte Tribe in Tirap District, Arunachal Pradesh, India

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ABSTRACT

The present study emphasized the distribution and utilization of both wild and domesticated *Musa* spp. of the Nocte tribe from Tirap district, Arunachal Pradesh. An extensive field survey was conducted from July to October 2023. A total of 62 households were surveyed randomly with the help of a semi-constructed questionnaire and personal interview. About 69% of the informants were from the age group of 31-60 years. About 84% live in a nuclear family type. Maximum informants were male (74.19%) and were married (80.64%). Only 17.75% of the informants were illiterate and were farmers (46.77%). In this study, 13 wild *Musa* spp. were reported from Tirap district, and 4 *Musa* spp. were found to be cultivated by the tribe. Of these, 76.47% were wild, and the rest were domesticated. *M. itinerens* had a widespread distribution range and occurred in various habitats between 155 and 1,711 masl altitudes. The highest use percentage was found in the Edible use category with 33%, followed by Ceremonies and Rituals (19%), Commercial uses (12%), and both Other and Packing purposes (10% each). Among the plant parts, inflorescences had the highest usage with 30%, followed by leaf (24%), pseudo stem (21%), etc. Among all *Musa* spp., *M. itinerens* had the highest number of usages (14 uses), followed by *M. nagensium* (12 uses).

1. Introduction

Tribal people still have a plethora of traditional knowledge about using local plants for food and other uses (Sundriyal *et al.* 1998). Traditional knowledge of plants is the result of thousands of years of experience and learning. Many indigenous tribes throughout the world harvest these plants, which can be found in the surrounding forest, protected areas, and community woods, for clothing, food, and shelter (Wangpan *et al.* 2019). The potential of these plants is acknowledged around the world as a source of income and livelihood in rural areas (Jain 1963). Among these plants, *Musa* spp. is a major crop utilized by different communities around the world in

their day-to-day life. It is mostly used for food (either cooked or fresh), livestock feed, domestic material, shelter, ornament, medicine, ceremonial and ritual events, and many other uses (Bakelana *et al.* 2000; Hidayat *et al.* 2018). In Uganda, pseudo stems are used to weave ropes for tethering goats and sheep (Karamura 1991). The whitish inner part (stalk) of the banana and the inflorescence are commonly used as food ingredients among Asians, particularly in India, Sri Lanka, Indonesia, Malaysia, and Thailand (Wickramarachchi & Ranamukhaarachchi 2005). In India (Orissa, West Bengal, and Kerala), banana leaves are used for traditional rituals and rites and for cooking delicacies by wrapping in banana leaves (Mohapatra *et al.* 2010). The Mishing tribe of Assam uses the stem of *M. balbisiana* in a ritual (Talleng uie) to prepare a ceremonial altar (Pangging *et al.* 2021). The inflorescence and inner stem of *M. itinerens* and *M.*

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cheesmani are consumed in cooked form in Arunachal Pradesh, and the ripened fruits of *M. cheesmani* are consumed during severe dysentery as a remedy (Dutta *et al.* 2019). For some Indigenous communities, in the context of their local beliefs, bananas correspond to philosophical meaning about connecting to life processes and providing lessons about ethics (De Beer & Van Wyk 2011; Henderson *et al.* 2012; Hapsari *et al.* 2017). The use of plant-based resources is an essential part of Nocte culture, which is still practiced by many indigenous people in Arunachal Pradesh (Wangpan *et al.* 2019).

Furthermore, the genus *Musa* is largely distributed in tropical rainforests, from wet evergreen forests to deciduous forests of low rainfall zones, and is found to occur in the hilly tracts that harbor a mosaic of tropical forests in India (Dutta *et al.* 2019). A major concentration of wild species of *Musa* in India is found in the far north-eastern states and shares the international border with China in the North, Myanmar in the East, and Bangladesh to the West (Subbaraya *et al.* 2006). In India, the Musaceae family has 37 wild taxa, and they are mostly found in the Northeastern states of India (Joe *et al.* 2014). Recent studies during the last six years have reported 7 new species from the region in general and Arunachal Pradesh in particular (Ranibala *et al.* 2018). With 30 taxa, 19 of which are native to the Northeastern States, the Musaceae family has the most variety and distribution in this area (Sabu *et al.* 2014). *Musa* is still a poorly researched genus that lacks knowledge of the evolution and diversity of wild bananas (De Langhe 1996) despite its abundance. This is partially due to the significant challenges associated with preparing priceless herbarium specimens that can be utilized in subsequent taxonomic and systematic studies (Vu *et al.* 2023). Tirap district, with favorable climatic conditions for banana growth and occurrence, lies in the eastern part of Arunachal Pradesh, which is one of the Northeastern States that has the most variety and distribution of the Musaceae family with 30 taxa, 19 of which are native to the region, especially with 24 species in Arunachal Pradesh (Sabu *et al.* 2014). Still, the studies on the utilization of *Musa* spp. are meager. Many studies were conducted on the ethnobotany of *Musa* spp. in Siang, Subansiri regions and Papumpare district of Arunachal Pradesh (Dutta *et al.* 2019, Bisht *et al.* 2021). Also, studies were conducted on the Ethnomedicinal knowledge of the Galo tribe from Arunachal Pradesh (Bharali *et al.* 2016). However, no studies were found, especially on the distribution and utilization of *Musa* spp. in the Tirap district of

Arunachal Pradesh. Moreover, Tirap district in Arunachal Pradesh lies in the region bordering China and Myanmar, which is a biodiversity-rich area for Musaceae and strengthens the view that this region is one of the major centers of origin of the family Musaceae (Sabu *et al.* 2014). Thus, exploration of *Musa* spp. in this region is needed. Hence, a study was carried out to document the distribution and utilization pattern of *Musa* spp. of the Nocte tribe inhabiting in the Tirap district of Arunachal Pradesh, India.

2. Materials and Methods

2.1. Study Area

The study was conducted in the Tirap district of Arunachal Pradesh (Figure 1). The name of the district is given after the Tirap River. This district primarily consisted of mountainous areas, dangerous gorges, and ravines. It is in the southern part of the state and nestled between the latitudes of 26° 38' N and 27° 47' N and the longitudes of 96° 16' E and 95° 40' E. The district is bordered to the north by the Dibrugarh district of Assam, to the east by the Changlang district of Arunachal Pradesh district, to the west by the Longding district of Arunachal Pradesh, and to the south by Myanmar.

As per the 2011 census, the geographical area of Tirap district is 2362 km², with a forest area of 1397.21 km² and 463.78 km² of open forest, whereas scrub land constitutes 65.35 km² which is divided into two subdivisions, namely Khonsa and Deomali in the district. However, it has the highest density of population of 47 persons per km² with a total population of 55022, out of which the local/tribal people of Tirap district comprise 49,962 (90.80%), and people residing from outside the district is 5,060 (9.20%) (District Disaster Management Plan of Tirap District 2020-2021).

The district's major tribe is Nocte, while the Tutsa, Phong, Wancho, and Ollo tribes also reside in the Tirap district. These tribes have their local dialect different from each other. The Nocte speaks *Hawajap* and *Dadamjap* dialects. Traditionally, the Nocte worship nature known as 'Jauban' and 'Rangfra', while some have converted into Christians, Hindus, and Buddhists. The Nocte tribe celebrates Chalo-Loku as their major festival, while *Ronghuan*, *Kapkhut*, *Hoju*, *Chaliwan*, etc. are celebrated within the villages (Tesia 2023). The majority of the district's residents are farmers, who mostly rely on shifting cultivation to grow crops like paddy, maize, tapioca, arum vegetables, etc. In Assam's surrounding regions and river valleys, there are small

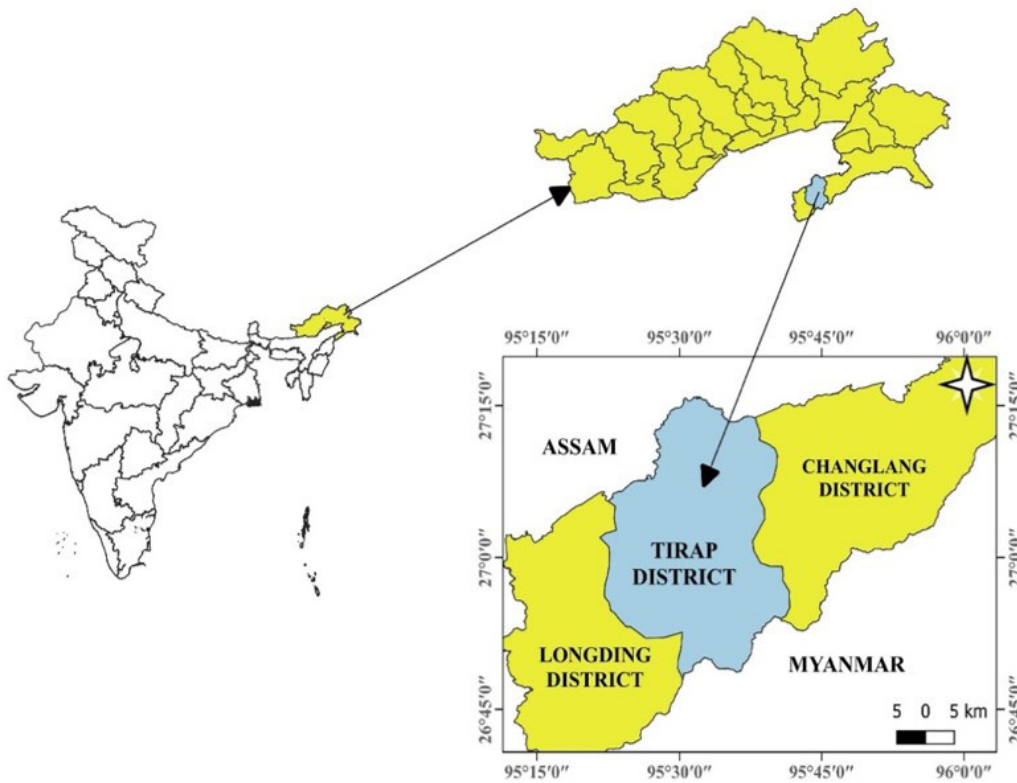


Figure 1. Study area map of Tirap district, Arunachal Pradesh, India

places where wet rice cultivation and terrace farming are practiced (District Disaster Management Plan of Tirap District 2020-2021).

The pre-monsoon season occurs from March to May and is preceded by frequent thunderstorms throughout the cold season, which lasts from the latter half of November through February. The region receives an average rainfall of 3,478.5 mm per year. Most of the vegetation consists of evergreen forests that are tropical or subtropical, interspersed with grasslands and, at higher elevations, with temperate woods (District Irrigation Plan of Tirap District 2015-2016). The important crops grown are millet, maize, and paddy, and the region has an agrarian economy. Herein, shifting agriculture or Jhum is the primary source of food, income, and livelihood. The villages are governed by the Chieftaincy and his council members (Wangpan *et al.* 2017).

The climate of the district is largely influenced by the terrain, which is marked by high hills, deep ravines, and valleys through which the streams and rivers flow. Higher elevations in the Lazu circle have a cold climate, while plain areas bordering Assam, such as Deomali and Soha circles, have a moderately hot and humid environment. From late November through February, there is a cold season that is followed by a pre-monsoon period from

March to May (District Disaster Management Plan of Tirap District 2020-2021).

2.2. Demographic Information of the Informants

In this study, 62 informants were selected through random sampling from 7 selected villages of the Tirap district, namely Soha, Subang, Kheti, New kheti, Sipini, Namsang, Pullong, and 2 towns, namely Deomali and Khonsa. The informants were villagers, village heads (GB), monks, farmers, local healers, etc., belonging to different age groups and genders. Prior informed consent (PIC) was also obtained before commencing the interview. According to Medhi 2021, the informant's profile, such as the age of the respondents, gender, marital status, family type, educational level, occupation, religion, and annual income were studied. The age groups were grouped into four groups, i.e., those below 15 years, those under 16-30 years, those who are 31-50 years, and those above 60 years. Also, the educational level of the informants was classified into illiterate, primary education, secondary education, higher secondary education, graduate, and postgraduate. The informants' occupations were grouped as farmer, business, self-employed (private sectors, SHGs, etc.), and governmental employee. Moreover, the annual income earned by the informants was grouped

as below 50,000 rupees, 51,000-5,00,000 rupees, and above 5,00,000 rupees.

2.3. Distribution and Identification of *Musa* Species

The distribution of *Musa* spp. was studied through an extensive field survey, as well as the latitude, longitude, and altitude of *Musa* spp. distributed throughout the study area was recorded with the help of the Global Positioning System (Garmin GPS). The identification of *Musa* spp. was made by consulting published literature and comparing the morpho-taxonomic characterization based on the description given in the “Descriptors of Banana” (IPGRI, INIBAP and CIRAD 1996). The botanical name and synonyms of banana were confirmed by consulting web resources such as Plants of the World Online (POWO 2023) and Musalogue (Daniells 2001). The leaves, inflorescences, and fruits were collected for preparing the herbarium following the standard methodology of Jain and Rao 1977. The distribution map of *Musa* spp. was prepared using QGIS 3.32 software. The distribution of wild species was obtained through informal interaction with the informants and by visiting the forests. These species were grouped into various categories such as abundant—the species that are available in abundance; rare—the species that is very uncommon, scarce, infrequently encountered, or could be an endemic species; random—individuals that are spaced at unpredictable distances from each other and cultivated—the species that are available and can be cultivated by humans to meet their needs (Dutta *et al.* 2019).

2.4. Utilization Pattern

The documentation of utilization patterns of both wild and cultivated *Musa* spp. was done through a semi-structured questionnaire survey, informal interview, and personal observation as per the standard methodology of Jain and Mudgal 1999. The information obtained included the inventory of the local name of the *Musa* spp., synonym, meaning if any, local knowledge, and knowledge about bananas. The uses of plant parts of banana were categorized into rhizome, sucker, seed, sap, leaf, pseudo stem, 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

3.1. Respondents Profile

A total of 62 informants were surveyed (Table 1). Out of these, 74% were male and 26% were female respondents, which indicated that most of the social interactions were attended by the males while females were not much involved in social interaction with strangers. About 81% of the respondents were married, and 19% of informants were unmarried. Most of the informants belong to the nuclear family, with 71%. About 69% of the informants belong to the age group of 31-60 years, and none of the informants belong to the age group below 15 years. About 48.39% of the informants were Christian, while 37.09% believed Indigenous faith and 14.52% were Hindus. Only 17.75% of the informants were illiterate, while 25.81% of informants were mostly graduates, followed by 20.97% with higher secondary education, with the lowest 3.22% attending postgraduate. A huge number of informants were farmers, with 46.77%, followed by self-employed and governmental employees, and the least were involved in businesses. The annual income of the informants was highest in the category between 51,000-5,00,000 with 59.67%, which means that most of them were middle-class families.

3.2. Distribution of *Musa* spp. in Tirap District of Arunachal Pradesh

A total of 17 *Musa* spp. was reported from Tirap district of Arunachal Pradesh (Figure 2). Of these, 13 spp. were wild *Musa* spp. namely, *M. itinerens*, *M. flaviflora*, *M. nagensium*, *M. balbisiana*, *M. acuminata*, *M. cheesmani*, *M. sikkimensis*, *M. sanguinea*, *M. aurantiaca*, *M. markkuana*, *M. velutina*, *M. mannii* and one unknown sp. (*Musa* M1) and 4 spp. were domesticated cultivars such as *Jahaji*, *Sabji-kol*, *Chini-champa*, and *Bharatmoni*. Among the wild *Musa*

Table 1. Demographic profile of the informants

| Particulars | Category | No. of respondents | Percentage (%) |
|---------------------------------|------------------|--------------------|----------------|
| Age (in years) | Below 15 | 00 | 00.00 |
| | 16-30 | 09 | 16.00 |
| | 31-60 | 43 | 69.00 |
| | Above 60 | 10 | 15.00 |
| | Total | 62 | 100.00 |
| Family type | Joint | 10 | 16.00 |
| | Nuclear | 52 | 84.00 |
| | Total | 62 | 100.00 |
| Marital status | Married | 50 | 80.64 |
| | Unmarried | 12 | 19.36 |
| | Other | 00 | 00.00 |
| | Total | 62 | 100.00 |
| Gender | Male | 46 | 74.19 |
| | Female | 16 | 25.81 |
| | Total | 62 | 100.00 |
| Religion | Indigenous faith | 23 | 37.09 |
| | Christian | 30 | 48.39 |
| | Hindu | 09 | 14.52 |
| | Total | 62 | 100.00 |
| Education | Illiterate | 11 | 17.75 |
| | Primary | 12 | 19.35 |
| | Secondary | 08 | 12.90 |
| | Higher Secondary | 13 | 20.97 |
| | Graduate | 16 | 25.81 |
| | Postgraduate | 02 | 3.22 |
| Occupation | Total | 62 | 100.00 |
| | Farmer | 29 | 46.77 |
| | Business | 07 | 11.29 |
| | Self-employed | 13 | 20.97 |
| | Govt. employed | 13 | 20.97 |
| | Total | 62 | 100.00 |
| Annual income of the informants | Less than 50,000 | 15 | 24.20 |
| | 51,000-5,00,000 | 37 | 59.67 |
| | Above 5,00,000 | 10 | 16.13 |
| | Total | 62 | 100.00 |

spp., 3 spp. namely, *M. flaviflora*, *M. itinerens*, and *M. nagensium* were distributed abundantly as these species were found in abundance during the survey as well as when questioned by the informants. In contrast, 2 spp. were distributed randomly, namely *M. mannii* and *M. velutina*, which were found in scattered locations. However, other species were observed to occur in a few locations which were rarely distributed. The domesticated *Musa* spp. was mainly cultivated in home gardens and boundary plantations. The utility of a particular species is directly proportional to the availability of the species. The elevation range (Table 1) was recorded with the help of a Garmin GPS device, and a distribution map (Figure 3) was prepared by using the QGIS 3.32 software by placing the point

locations of wild *Musa* spp. and recorded from the study area (Tirap district). These species were found to be distributed in altitudes that ranged from 140 to 1,723 masl (Table 2).

From the above table (Table 2), it is evident that wild species *M. itinerens* was widely found in the study area between 155 to 1,711 masl, while domesticated *Musa* sp. Jahaji was cultivated or was favorable in the high elevation range (140-1,500 masl)-two species, *M. acuminata* and *Musa* sp. *Bharatmoni* were found in one specific location. Also, *M. sikkimensis* was found to be located only at higher elevations (1,232-1,723 masl).

3.3. Indigenous Knowledge Related to the Utilization of *Musa* spp. by the Nocte Tribe

The Nocte tribe utilizes various plant parts from both wild and domesticated *Musa* spp. (Table 3) in 9 different use categories, such as ceremonies and rituals (CNR), commercial (COM), construction (CON), edible (EDB), feed (FED), medicinal (MED), nutrient resource management (NRM), packing (PAC) and other (OTH) purposes (Figure 4). The utilization of different *Musa* spp. by Nocte tribe are shown in Figure 5.

Among all *Musa* spp., *M. itinerens*, a wild species, had the highest use categories, i.e., 6 use categories, which are CNR (3 spp.), COM (2 spp.), FED (1 sp.), EDB (2 spp.), PAC (3 spp.) and OTH (3 spp.), followed by *M. nagensium* (wild) and *Jahaji* (domesticated) with 5 use categories each (Figure 4). No uses were reported from M1 and *M. markkuana*. The inflorescence of *M. itinerens* was recorded as the most preferred species for consumption and utilized under the COM use category. The pseudo stem was also consumed by both humans and livestock and sold in the local markets. The leaves are also preferred for PAC and OTH use categories.

Among all use categories, the maximum use category was reported from EDB with 33%, followed by the CNR (19%), COM (12%), OTH, and FED (10% each) (Figure 6). The least use category was reported from both NRM and CON with 2% each. Most of the inflorescences of wild *Musa* spp. were edible. The inflorescences of *M. itinerens* and *M. flaviflora* were reported to be highly consumed and were also sold in local markets due to their good taste and availability. Moreover, the pseudostem (core/pith) of *M. itinerens* was used for curry as well as for commercial purposes.

Like other tribes around the world, the use of various banana plant parts is reported in various ceremonies and rituals of the Nocte tribe, such as *Hah-khosom*, *Miksang-thang*, *Hah-som*, and *Namin*. However, some



Figure 2. *Musa* spp. found/distributed in Tirap district, Arunachal Pradesh. (A) *M. acuminata*, (B) *M. aurantiaca*, (C) *M. balbisiana*, (D) *M. cheesmani*, (E) *M. flaviflora*, (F) *M. itinerens*, (G) *M. mannii*, (H) *Musa* M1 (unknown), (I) *M. markkuana*, (J) *M. nagensium*, (K) *M. sanguinea*, (L) *M. sikkimensis*, (M) *M. velutina*, (N) *Musa* sp. (*Bharatmoni*), (O) *Musa* sp. (*Bharatmoni* fruit), (P) *Musa* sp. (*Chini-champa*), (Q) *Musa* sp. (*Jahaji*) and (R) *Musa* sp. (*Sabji-kol*)

practices such as *Nokren-set*, *Moalang-noknyak*, *Wo-boi* etc were also being discontinued where the use of *Musa* spp. is seen in the study. The use of banana pseudostem as pig feed was seen very often in the tribe.

Among all *Musa* spp., *M. itinerens* had the maximum number of uses, i.e., 14, where both leaf and pseudo stem had the highest uses (6 uses each) and inflorescence (2 uses) followed by *M. nagensium* with 12 uses, etc. (Figure 7). The leaves of *M. itinerens* and *M. nagensium* were used as a substitute for *Phrynium pubinerve* and used as plates, wrapping rice during fermentation, and used in rituals such as *Nyapkhidakiak*. The pseudo stems of *M. itinerens* were used as vegetable pig feed and sold in the local markets. It is also considered an important ingredient for preparing

traditional cuisine along with meat, especially during organizing social functions, ceremonies, and parties of the Nocte tribe. The leaf powder of *M. nagensium* is an important banana product that is utilized for both the smooth weaving of traditional cloths and tying the handle grip of traditional swords (*Dao*). The least used were reported from *M. sanguinea*, *M. sikkimensis*, and *M. velutina*, each with one use.

Domesticated *Musa* spp. was mostly planted for fruit production and is utilized for edible (EDB) and commercial (COM) purposes. Moreover, leaves were also used in the CNR use category, such as the leaves of *Bharat-moni*, *Chini-champa*, and *Jahaji* were used in rituals such as *Panta-salisong*, *Wo-boi*, *Hah-som*, and *Namin*. The fruits and pseudo stem of *Jahaji* were used

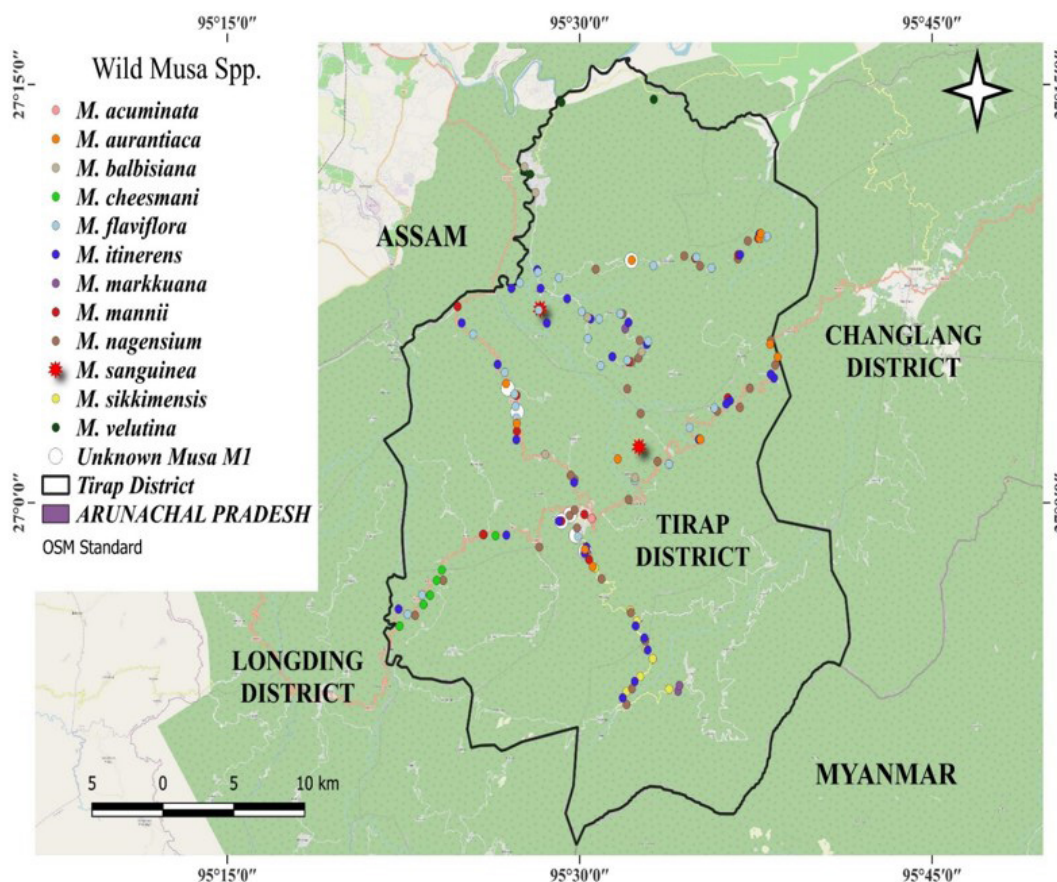


Figure 3. Distribution map of wild *Musa* spp. in Tirap district. The map shows the point distribution of different wild *Musa* spp. found in Tirap district, Arunachal Pradesh, India. The points represent the locations of the *Musa* spp., which were recorded during the field survey with the help of a Garmin GPS device. The map was prepared using the QGIS software 3.32. It was prepared in OSM standard map

Table 2. Elevation range of wild and domesticated *Musa* spp. in the Tirap district

| Name of <i>Musa</i> spp. | Elevation range (in masl) |
|--|---------------------------|
| <i>M. acuminata</i> Colla | 752 |
| <i>M. aurantiaca</i> G.Mann ex Baker | 300-1,232 |
| <i>M. balbisiana</i> Colla | 150-700 |
| <i>M. cheesmani</i> N.W.Simmonds | 300-800 |
| <i>M. flaviflora</i> N.W.Simmonds | 210-1,034 |
| <i>M. itinerens</i> Cheesman | 155-1,711 |
| <i>M. mannii</i> H. Wendl. ex-Baker | 200-1,187 |
| <i>Musa</i> M1 | 321-1,147 |
| <i>M. markkuana</i> (M.Sabu, A.Joe & Sreejith) Hareesh, A.Joe & M.Sabu | 646-1,509 |
| <i>M. nagensium</i> Prain | 450-1,715 |
| <i>M. sanguinea</i> Hook.f. | 254-700 |
| <i>M. sikkimensis</i> Kurz | 1,232-1,723 |
| <i>M. velutina</i> H.Wendl. &Drude | 144-288 |
| <i>Musa</i> sp. <i>Bharatmoni</i> | 260 |
| <i>Musa</i> sp. <i>Chini-champa</i> | 140-630 |
| <i>Musa</i> sp. <i>Jahaji</i> | 140-1,500 |
| <i>Musa</i> sp. <i>Sabji-kol</i> | 140-350 |

in ritual (*Hah-maanhon*) and compost and pig feed, respectively.

Among all plant parts, inflorescence was utilized as the dominant plant part with 30%, followed by leaf (24%), pseudo stem (21%), etc. and the least use reports were found from both leaf powder and sap (3% each) (Figure 8). The Nocte tribe used inflorescences of 11 *Musa* spp. in EDB, CNR, and MED use categories such as *M. aurantiaca*, *M. balbisiana*, *M. cheesmani*, *M. flaviflora*, *M. itinerens*, *M. mannii*, *M. nagensium*, *M. sanguinea*, *M. sikkimensis*, *M. velutina* and *M. sp.* (*Bharatmoni*). The leaves were also used by the Nocte tribe in their daily lives, such as wrapping rice for fermentation, packing foods, roofing material in camps, wrapping betel leaves for sale, performing rituals such as *Namin-hon*, *Kashia-som*, *Wo-boi*, *Panta-salisong*, etc.

Table 3. Utilization pattern of *Musa* spp. in the Nocte tribe

| Name of species | Local name (international phonetic alphabet) | Distribution (wild/ cultivated) | Part used | Uses | Category |
|---|--|------------------------------------|---------------|--|----------|
| <i>Musa acuminata</i> Colla | Kyakke (/keɪækket/) | Rare (wild) | Fruit | Consumed in the ripen stage | EDB |
| | | | Pseudo stem | Used as pig feed | FED |
| <i>Musa aurantiaca</i> G.Mann ex Baker | Nyapsa (/nja:psa/) | Rare (wild) | Leaf | Use for miscellaneous purposes such as plate | OTH |
| <i>Musa balbisiana</i> Colla | Bhim-kol | Rare (wild) | Inflorescence | Consumed in cooked form | EDB |
| | | | Inflorescence | Consumed in cooked form | EDB |
| | | | Fruit | Consumed in the ripen stage | |
| | | | Pseudo-stem | Used as pig feed | FED |
| | | | Leaf | Opium is consumed with the tender leaf of <i>Musa</i> sp. | OTH |
| <i>Musa cheesmani</i> N.W.Simmonds | Leyboh (/leɪbɒh/) | Rare (wild) | Leaf | Used as a roof in forest camps | CON |
| | | | Inflorescence | Consumed in cooked form | EDB |
| <i>Musa flaviflora</i> N.W.Simmonds | Meinyak/ Bokchom (/meɪnjæk//bɒkʃɒm/) | Abundant (wild) | Inflorescence | Consumed in cooked form | EDB |
| | | | | Sold in local markets | COM |
| | | | Leaf | Used in wrapping betel leaf for sale Used as a substitute for <i>Phrynium pubinerve</i> for packing and wrapping during some important occasions | PAC |
| <i>Musa itinerans</i> Cheesman | Nyapkhām/ Lakham (/nja:pkhəm//lɑ:kham/) | Abundant (wild) | Inflorescence | Consumed in cooked form | EDB |
| | | | Pseudostem | Consumed in cooked form | |
| | | | Inflorescence | Sold in local markets | COM |
| | | | Pseudo stem | Sold in local markets | |
| | | | Pseudo stem | Used as pig feed | FED |
| | | | Pseudo stem | Cooked as a curry along with meat during community functions, parties, funerals, rituals, and ceremonies <i>Nokren-set</i> : a ritual is done during epidemic occurrence at the village level, wherein the pseudo stem is used as a boat, and a live adult male chicken and flowers are offered to accomplish this ritual | CNR |
| | | | Leaf | <i>Namin-hon</i> : a ritual is done to give a name to a newborn baby, and banana leaves are used to select the name | |
| | | | Leaf | Used in wrapping betel leaves for sale Used as a substitute for <i>Phrynium pubinerve</i> leaf on some occasions | PAC |
| | | | | Used for wrapping and covering the cooked rice for the fermentation process | |
| | | | Leaf | Used as a cup to drink rice beer at social functions and occasions Used as a plate for taking food, especially in forest camps, agriculture fields, and picnics | OTH |
| | | | Pseudo stem | Used as an alternate source of water, especially if someone is lost in a jungle and no water source is found | |

Table 3. Continued

| Name of species | Local name (international phonetic alphabet) | Distribution (wild/ cultivated) | Part used | Uses | Category |
|---|--|------------------------------------|---------------|---|----------------|
| <i>M. mannii</i> H. Wendl. ex-Baker | Nyapchu (/nja:pʃu:/) | Random (wild) | Pseudo stem | Cooked and consumed with prawn. | EDB |
| | | | Inflorescence | Local healers used inflorescence in a ritual to treat stomach pain Inflorescence was used to drag away evil spirits from the deceased body by spiritual healers in a ritual Miksaang-thang: a ritual is done to cure a patient suffering from redness of the eye and headache by offering inflorescence of <i>M. mannii</i> to the deity of the village (village god) | CNR |
| <i>Musa</i> M1 | Nyapchu (/nja:pʃu:/) | Rare (wild) | - | - | - |
| <i>Musa markkuana</i> (M.Sabu, A.Joe& Sreejith) Hareesh, A.Joe & M.Sabu | Miksaang (/miksa:ŋ/) | Rare (wild) | - | - | - |
| <i>Musa nagensium</i> Prain | Nyapkhi/Lakhoi (/nja: pʃi:/la:khɔɪ/) | Abundant (wild) | Pseudo stem | Moalang-noknyak: a ritual done with pseudo stems from healing a sick person by local healers | CNR |
| | | | Leaf | Nyapkhi-dakliak: a ritual is done using leaves as an offering plate to bid goodbye or farewell to the Loku festival of Nocte | |
| | | | Leaf powder | The powder obtained from the leaf surface is used for the smooth weaving of local handlooms It is used in playing carom board. The leaf powder is used while tying rope on a sword (Dao) handle because it helps in smooth tying | OTH |
| | | | Fruit | Ripen fruit was used for consumption with rice in earlier days | EDB |
| | | | Leaf | Leaf was used to help smallpox or chicken-pox-infected persons lie down in earlier days | MED |
| | | | Inflorescence | Consumed in cooked form when someone suffers from stomach problems | |
| | | | Leaf | Used as temporary roofing material in forest camps, agriculture fields, etc Used as a shield against honeybee's sting while collecting honey Used for wrapping meat and rice during festivals Used for wrapping fermented rice and used during filtering rice beer in festivals and ceremonies | OTH PAC |
| <i>M. sanguinea</i> Hook.f. | Nyapchi (/nja:pʃi:/) | Rare (wild) | Inflorescence | Consumed in cooked form | EDB |
| <i>M. sikkimensis</i> Kurz | Leyra (/leɪrə/) | Random (wild) | Inflorescence | Traditionally used for treating chest pain through a ritual | CNR |

Table 3. Continued

| Name of species | Local name (international phonetic alphabet) | Distribution (wild/ cultivated) | Part used | Uses | Category |
|--|---|------------------------------------|---------------|---|------------|
| <i>Musa velutina</i> H.Wendl. &Drude | <i>Miksaang</i> (/miksa:ŋ/) | Rare (Wild) | Inflorescence | Consumed in cooked form as food | EDB |
| | | | Pseudo stem | Used for preparing stairs during a ritual called <i>Hah-khosom</i> | CNR |
| <i>Musa</i> sp. (Musaceae) | <i>Bharatmoni</i> (Kyakkelin - / kerækkeili:n/) | Cultivated | Inflorescence | Consumed in cooked form | EDB |
| | | | Fruit | Consumed in the ripen form | |
| | | | Pseudo stem | Consumed in the cooked form | |
| | | | Leaf | <i>Hahsom</i> : a ritual performed during sickness where the leaf is used as a plate for offerings of rice, flower, betel leaf, and areca-nut <i>Namin-hon</i> : a ritual performed when selecting /choosing a good name for newly born babies, where the leaf is used exclusively | CNR |
| <i>Musa</i> sp. (Musaceae) | <i>Chini-champa</i> | Cultivated | Sap | Used in treating tongue infections in babies | MED |
| | | | Fruit | Consumed in ripen form Dried fruit is used as a substitute for sugar in earlier days | EDB |
| | | | Leaf | Sold in local markets | COM |
| | | | | <i>Wo-boi</i> : a ritual performed to see the fortune of land for house construction, agriculture fields, etc., wherein the leaf is used as a plate to keep the broken egg <i>Kashia-som</i> : a ritual performed for the safety of the community/villagers where the leaf is used as a plate by offering betel leaf, areca-nut, rice, etc., done after the celebration of the Chalo-loku festival <i>Panta-salisong</i> : a ritual performed to please Panta (caretaker/deity) to cure the illness of a person where the leaf is used as a plate in ritual | CNR |
| <i>Musa</i> sp. (Musaceae) | <i>Jahaji</i> | Cultivated | Fruit | Consumed in ripen form | EDB |
| | | | | Sold in local markets | COM |
| | | | Leaf | <i>Haah-maanhon</i> : a ritual performed every year for the prosperity of the village (Soha village) where the fruit is offered to the village deity | CNR |
| | | | | <i>Panta-salisong</i> : a ritual performed to please Panta (caretaker/deity) to cure the illness of a person where the leaf is used as a plate in ritual | |
| <i>Musa</i> sp. (Musaceae) | <i>Sabji-kol</i> | Cultivated | Pseudo stem | Used as pig feed | FED |
| | | | Pseudo stem | Used as vermicompost | NRM |
| | | | Fruit | Consumed in cooked form Sold in local markets | EDB COM |

CNR-Ceremonies and Rituals, COM-Commercial, CON-Construction, EDB-Edible, FED-Feed, MED-Medicine, NRM-Nutrient Resource Management, PAC-Packing, OTH-Other

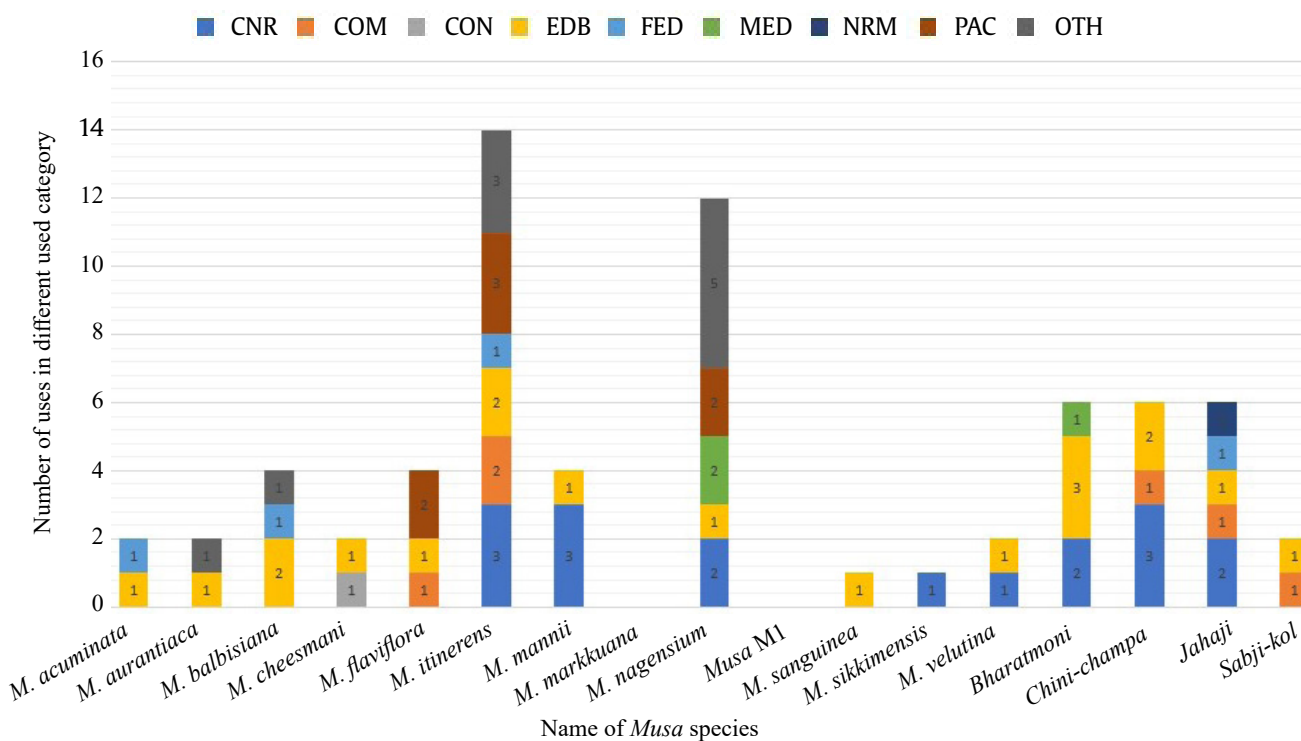


Figure 4. Different use categories of *Musa* spp. by the Nocte tribe. CNR-Ceremonies and Rituals, COM-Commercial, CON-Construction, EDB-Edible, FED-Feed, MED-Medicine, NRM-Nutrient Resource Management, PAC-Packing, OTH-Other

4. Discussion

4.1. Distribution of *Musa* spp. in Tirap District

A total of 17 *Musa* spp. was reported from the Tirap district of Arunachal Pradesh in the present study. Of these, 76.47% were wild, and the rest were domesticated. The wild *Musa* spp. consisted of *M. acuminata*, *M. aurantiaca*, *M. balbisiana*, *M. cheesmani*, *M. flaviflora*, *M. itinerens*, *M. mannii*, *Musa* M1, *M. markkuana*, *M. nagensium*, *M. sanguinea*, *M. sikkimensis*, and *M. velutina*. Meanwhile, cultivated *Musa* spp. were *Bharatmoni*, *Chini-champa*, *Jahaji*, and *Sabji-kol*, which were mostly planted in home gardens. The distribution of *M. mannii* in the Tirap district of Arunachal Pradesh was reported at elevations of 200 to 1,187 masl in the present study. A similar distribution was reported by Joe *et al.* (2014) from Changlang district, Arunachal Pradesh, which occurred at elevations of 150 to 400 masl. The distribution of *M. sanguinea* was reported for the first time from Mahuni

forests along the banks of Dihing River, Upper Assam, by Gustav Mann (1869). Later, it was also reported from Yunnan, China, by Liu *et al.* (2002) and it was reported as an extinct species in India by Sabu *et al.* (2014) and Joe & Sabu (2016). In contrast, the present study re-reported the presence of *M. sanguinea* from Tirap district, Arunachal Pradesh, NE India. In the present study, an unknown species named *Musa* sp. was also found in the study area. M1, which needs taxonomic characterization and identification. The presence of such diverse *Musa* spp. could indicate that the Indo-Burma region may be the origin of *Musa* species. Among all species, *M. mannii* was endemic to this region, and *M. sikkimensis* was reported for the first time from Tirap district at a particular location in the forests between Khonsa town and Lazu town at an altitudinal range of 1,232 to 1,732 masl, Arunachal Pradesh. Similar distribution was reported from Manipur, Sikkim, and West Bengal, as well as some parts of Mizoram (Joe *et al.* 2016). Among all wild *Musa* spp., *M. itinerens* had

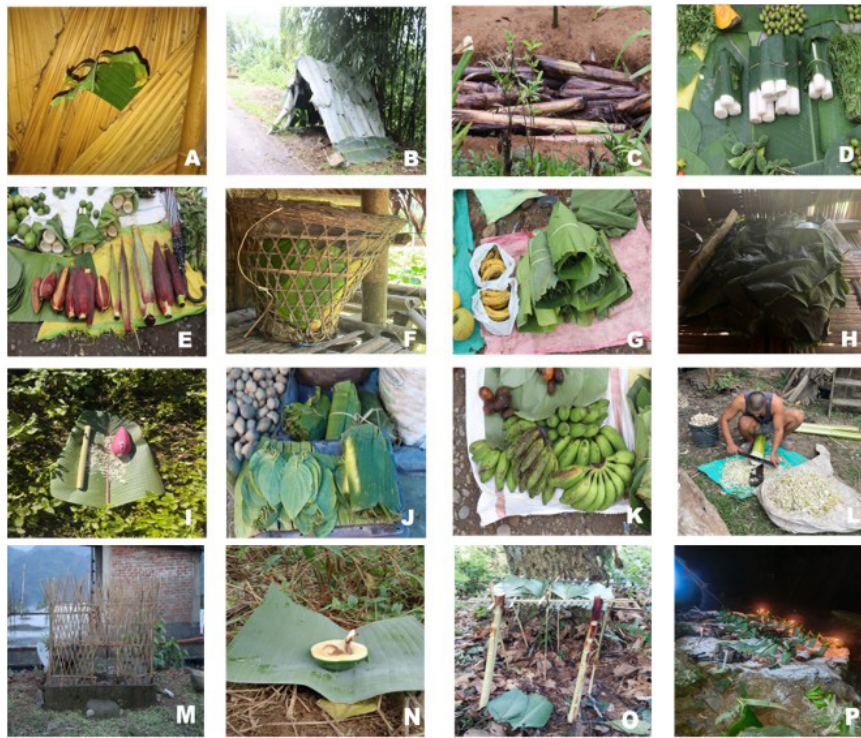


Figure 5. Utilization of *Musa* spp. by the Nocte tribe: (A) Leaf of *M. itinerens* used in Namin ritual, (B) Leaves of *M. nagensium* used as a roofing material, (C) *Musa* sp. *Jahaji* pseudo stems used in vermicompost, (D) *M. itinerens* pseudo stems sold in the market as a source of food, which are used as vegetables, (E) Inflorescences of *M. itinerens* and *M. flaviflora* sold in the market as a source of food, which are used as vegetables, (F) Leaf of *M. itinerens* used to wrap rice during fermentation, (G) Leaf of *M. itinerens* used to wrap vegetable during selling, (H) Leaves of *M. nagensium* used during fermentation of apong—a fermented local rice beer, (I) Inflorescence *M. mannii* used in a miksaang thang ritual, (J) Leaves of *M. itinerens* and *M. flaviflora* used to wrap beetle leaf, (K) Cultivated *Musa* fruit sold in the market, (L) Pseudo stem used as pig feed, (M) Leaf of *Chini-champa* used in *Kashia-som* ritual, (N) Leaf of *Bharatmoni* used as a plate in *Hah-som* ritual and (O) Pseudo stems of *M. velutina* are used as stair in *Hah-Khosom* ritual. (P) *Musa* sp. *Jahaji* fruit offered in *Hah-maanhon* ritual

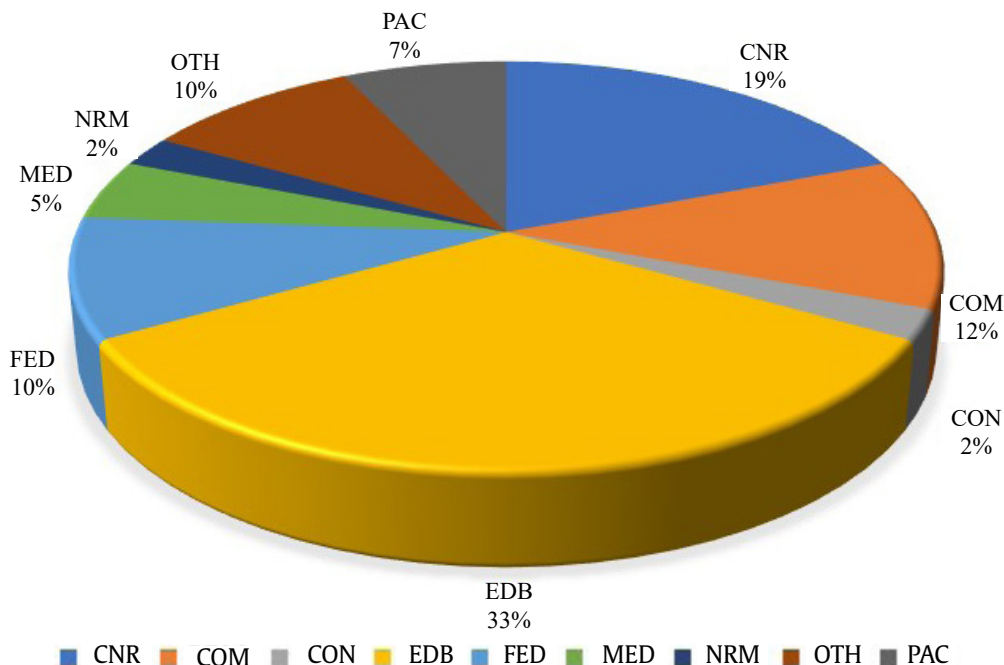


Figure 6. Utilization pattern of *Musa* spp. with respect to use categories. CNR-Ceremonies and Rituals, COM-Commercial, CON-Construction, EDB-Edible, FED-Feed, MED-Medicine, NRM-Nutrient Resource Management, PAC-Packing, OTH-Other

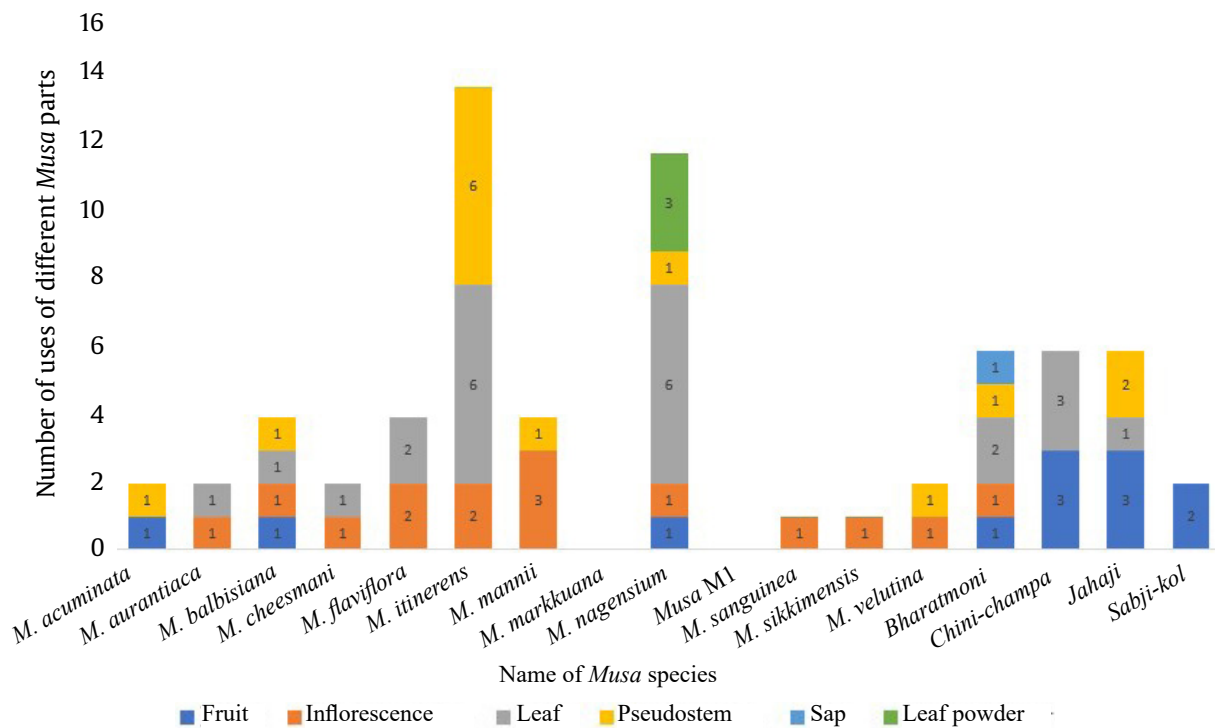


Figure 7. Various utilization of different parts of *Musa* spp.

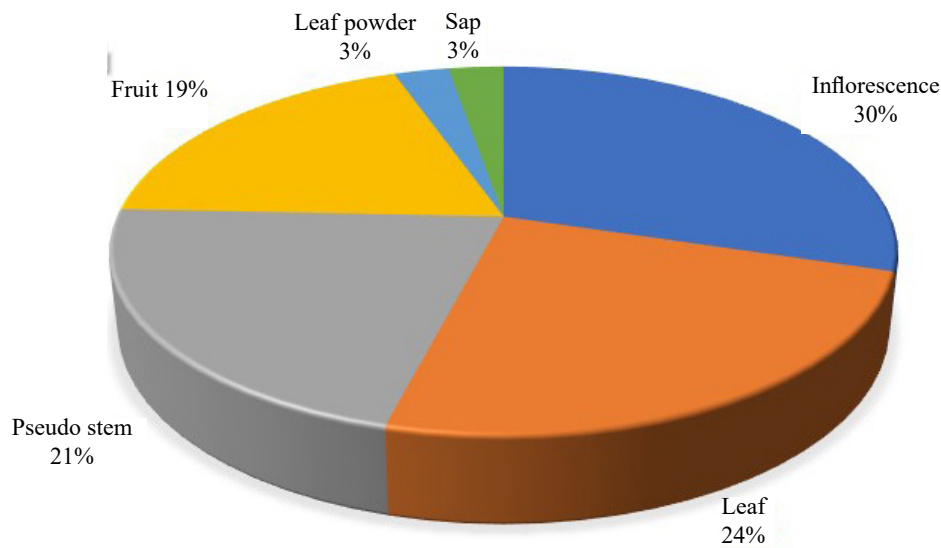


Figure 8. The utilization pattern of different parts of *Musa* spp.

the widest distribution range and occurred in various habitats with an altitudinal range of 155 to 1,711 masl. However, *M. acuminata* was only found in one location in Khonsa town. Three *Musa* spp. were distributed abundantly, such as *M. flaviflora*, *M. itinerens*, and *M. nagensium*, whereas both *M. manni* and *M. velutina* were distributed randomly, and others were distributed rarely. Similar studies on the distribution of *Musa* spp. were done by Sabu *et al.* 2014, Behrendt *et al.* 2015,

Joe & Sabu 2016, Ranibala *et al.* 2018, Hastuti *et al.* 2019, Deb *et al.* 2023 and Vu *et al.* 2023.

4.2. Bananas Utilized for Ceremonies and Rituals

In the present study, it was found that few members of the Nocte tribe still follow the magico-religious practices; however, their practices among villages may vary. In all use categories of *Musa* spp., CNR uses

category account for the second highest used category with 19% wherein fruits were used as an offering in a ritual locally known as *Haah-maanhon* in Soha village and practiced every year for good fortune and prosperity of the entire village-moreover, the leaves of *Musa* sp. *Jahaji* and *Chini-champa* were utilized during the Panta-salisong ritual in Subang village. The inflorescences of *M. mannii* were used by the village god to cure eye redness and severe headaches, whereas the leaves of *M. itinerens* and *Musa* sp. *Bharatmoni* was used to select a suitable name for newborn babies during the *Namin-hon/Namin* ritual-the leaves of *Musa* sp. *Chini-champa* was also used as an offering plate during the *Kashia-som* ritual, especially in Pullong village, which was done for the prosperity of the entire village.

Moreover, the leaf of *M. nagensium* was used as an offering plate in the *Nyapkhi-dakliak* ritual to bid farewell to the *Chalo-loku* festival in the New Kheti village of the Nocte tribe. Some of the rituals nowadays were discontinued, such as *Moalang-noknyak*, *Nokrenset*, and *Wo-boi*, due to the non-availability of local priests, urbanization, conversion of religion as well as strict rules which needed to be followed during the ritual. Authors such as Laishram & Thokchom (2019), Kumari *et al.* (2023) and Devi *et al.* (2024) also reported the similar use of *Musa* spp. in different ceremonies and rituals.

4.3. Bananas Utilized for Food and Commercial Purposes

The Nocte tribe has been using *Musa* spp. as a source of food since time immemorial. In the present study, the fruits of both domesticated and wild *Musa* spp. were used as food sources, such as *M. acuminata*, *M. balbisiana*, and *M. nagensium*. One of the most common traditional cuisine dishes prepared using the pseudo stem (inner white stalk/pith) of *M. itinerens* as a source of food (vegetable), which was cooked along with meat in any celebration of Nocte tribe such as house openings, birthday parties, village functions, etc. A similar study was done by Sarma *et al.* (2020), who reported the use of *Musa* spp. for preparing traditional cuisine. In the present study, among all the use categories, the highest uses were edible sources (food) with 33%. Kumari *et al.* (2023) reported the use of pseudo stem as a vegetable in some parts of the world, such as India, Sri Lanka, and Malaysia. The inflorescences of *M. aurantiaca*, *M. balbisiana*, *M. cheesmani*, *M. itinerens*, *M. flaviflora*, *M. nagensium*, *M. mannii*, *M. sanguinea*,

M. velutina, and *Musa* sp. *Bharatmoni* were reported to be consumed as a source of food in the present study. Similar findings were reported on the utilization of banana inflorescence as vegetables by Padam *et al.* (2014). Among all *Musa* spp., *M. itinerens* was found to be the most preferred and delicious inflorescence in the present study. Moreover, the inflorescence of *Musa flaviflora*, *M. itinerens*, and *M. nagensium* and the pseudo stem of *M. itinerens* were sold in the local markets as vegetables. A similar finding was reported by Jumari (2000), wherein some varieties of *Musa* spp. were consumed as fruit and used in preparing various traditional cuisines.

4.4. Bananas Utilized for Medicine

The *Musa* spp. were also used in traditional health care systems of the Nocte tribe, such as the use of tender leaves of *M. nagensium* as a bedcover for patients infected with smallpox, and they believed that it provides coolness to the wound and the powder on the leaves also helped in curing smallpox in the present study. Moreover, the sap of *Musa* sp. *Bharatmoni* was used to treat tongue infections in infants. In contrast, the pseudo-stem (inner core) of *M. itinerens* was used to prepare traditional cuisine that serves as a remedy for indigestion and gastritis. A similar study was done by Munishamanna *et al.* (2020), wherein they reported the use of the juice of core pseudo-stem in curing various diseases such as urinary disorders and removal of stones from the kidney, gall bladder, and prostrate; the stem juice of *Musa* spp. was used for curing various ailments, including diabetes, dysentery, diarrhea, pain from snakebite, and inflammation (Ghani (2003); stem juice also helps in dissolving pre-formed stones and prevent stones in the bladder (Kailash & Varalakshmi 1992 and Prasad *et al.* 1993). Similarly, various researchers reported the use of *Musa* spp. in the traditional healthcare system (Mehra *et al.* 2014; Yuhlung & Battacharyya 2016; Galini 2019; Ajijolakewu *et al.* 2021; Rahman *et al.* 2022; Gaikwad *et al.* 2023; Supiandi *et al.* 2023).

4.5. Other Uses of Banana

The Nocte tribe traditionally utilized *Musa* spp. as livestock feed, packing, wrapping, construction of roofs, traditional nutrient management, etc. The pseudo stems and waste derived from *M. acuminata*, *M. balbisiana*, *M. itinerens* and *Musa* sp. *Jahaji* were utilized as livestock feed in the present study. Similar studies were done by Aurore *et al.* (2009) and Akinyele

& Agbro (2007), who used unpeeled green banana and banana waste as pig feed and animal feed. In the present study, the leaves of *Musa* spp. were reported to be used for wrapping beetle leaves while selling in the local market instead of using plastic bags. Banana leaves were also used as a substitute for *Phrynium pubinerve* leaves for packing and wrapping traditional foods during festivals and ceremonies. Similar findings were reported by Padam *et al.* (2014) and Abiodun-solanke & Falade (2011) regarding the utilization of leaves as wrapping materials for traditional foods in Southeast Asia. In the present study, older people use the cigar leaf of *Musa balbisiana* to consume opium. In contrast, leaves of *M. cheesmani* and *M. nagensium* were utilized for roofing due to their durability. Moreover, the leaf powder of *M. nagensium* was used as a powder for the smooth weaving of local handlooms, preparing the tying of the handle of Dao (local sword), as a substitute for carom board powder and as a shield against bee's attack while collecting honey. A similar study was done by Abiodun-solanke & Falade (2011), who reported the use of 'Fehi' banana leaves for thatching, packing, and cigarette wrappers. Moreover, Munishamanna *et al.* (2020) reported the utilization of the pseudo stem of domesticated *Musa* sp. Jahaji as vermicompost.

Conflict of Interest

On behalf of all authors, the corresponding author states that there is no conflict of interest.

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