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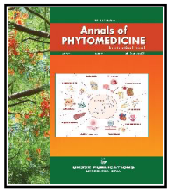

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Studies on ethnomedicinal, phytochemical and antioxidant activity of wild edible banana flowers consumed by tribals of northeast India

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Abstract

Northeast India has traditionally used the majority of its wild banana plant species for medicinal purposes. Surveys were carried out in the northeastern states of India: namely, Arunachal Pradesh, Manipur, Assam, and Tripura. Oral interviews and questionnaires were used to gather ethnomedical data from the chosen states. For phytochemical and antioxidant study, different proximate analysis methods were used. The study showed wide range in the level of phytochemicals depending on the genotypes and location. Phenol content ranged from 12 to182.2 mg/100 g, flavonoid ranged from 26.30 to134.22 mg/100 g, tannin ranged from 1.57 to 23.04 mg/100 g, carotenoid ranged from 2.07 to 7.08 mg/100 g and vitamin E ranged from 0.72 mg/100 g to 22.50 mg/100 g. Antioxidant activity also varied from 21.11% to 89.39%. Overall, the levels of phytochemicals and antioxidant activities were found to be high in wild banana blossom. The study also documented the use of banana blossom in treating arthritis, diarrhoea, anaemia, constipation, *etc*. High level of phytochemicals and antioxidant activities in banana blossom supports the traditional use of wild banana blossoms in treating many diseases. Also, the study has aided in documenting the wild banana blossom being use as medicine amongst tribals of northeast India. Therefore, in order to validate the ethnomedicinal uses of banana blossom, phytochemicals studies have been conducted in different wild *Musa* blossom.

1. Introduction

Plant components have long been used as the only means of treating illnesses and maladies in many civilizations around the world, and they are still used as traditional medicine in many nations (Ji *et al*., 2009). Finding new leads from medicinal plants is aided by traditional knowledge and historical medical literature.The World Health Organization (WHO) believes that the significant population of developing countries rely on traditional medicines for their primary healthcare needs. Even the raw materials used in modern medicines are plant-based. Therefore, there is an increased demand for medicinal plants in developing and developed countries. Several wild plants also have a twin role of food as well as medicine; hence, they represent inexpensive, locally available and versatile food resources capable of improving nutrition and health of masses (Malla *et al*., 1982, Manandhar, 1991). Many regions of the world are home to useful wild plants, and the majority of these species are used in herbal treatment, which is a significant aspect of the people's culture and traditions. Rapid urbanization has a significant impact on cultural loss, which results in a loss of knowledge about edible wild species. As a result, it is critical to gather and maintain ethnobotanical data from around the globe and to document and save traditional medical knowledge for upcoming generations. Based on species rarity and endemism, India is one of the twelve mega-diverse countries in the world, with two hotspots: the Eastern Himalayas and the Western Ghats (Myers *et al*., 2000). One of India's richest repositories of plant diversity, the northeast region is home to approximately 8 million ethnic people (Mao *et al*., 2009).

For thousands of years, the indigenous people of northeast India have coexisted peacefully with the natural world. They have developed a mutually beneficial relationship with the forest by safeguarding it, and in exchange, the forest meets their basic requirements, including clothing, food, medicine, and shelter. These ethnic groups are extremely knowledgeable about the untamed flora found in forests. Even before modern medicine was invented, they have been using traditional remedies since the beginning of time. Each tribe has its own traditional healers, referred to variously as bejes, bejinis, boidyo, kobiraj, maiba, dhonontori, Adi Miri, *etc*., who are thought to possess extensive knowledge of wild plants. However, as urbanization and the modern healthcare system have developed, people are becoming less interested in the old knowledge surrounding herbal remedies. The tribe members also think that the primary source of newly discovered illnesses is the contemporary healthcare system.

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Northeast India comprises of eight states, *viz.*, Arunachal Pradesh, Assam, Meghalaya, Manipur, Tripura, Mizoram, Nagaland and Sikkim. The total area of northeast occupies 7.7 per cent of India's total geographic area supporting 50 per cent of the biodiversity in the country, of which 31.58 per cent is endemic (Thakur *et al*., 2012). One of India's hotspots, it is renowned for having a varied geography, climate, and soil type. This area is abundant in a wide variety of fruits, vegetables, spices, medicinal plants, and flowers, especially orchids. Approximately, 300 species are present in the Eastern Himalaya alone, out of the estimated 800 species that are used as food plants in India (Singh and Arora, 1978).

Northeast India is the treasure trove that hosts a large variety of wild and cultivated Banana, and maximum genetic variability of *Musa acuminata* Colla and *Musa balbisiana* Colla occurs in northeast India. The family Musaceae is well known for its immense medicinal values and all parts of the plant including fruits, peel, pseudostem, corm, flowers, leaves, sap and roots have found their use in traditional medicine (Mathew and Negi, 2017). Banana blossom contains various nutritional values that are similar to banana fruits. Due to the presence of many different bioactive elements found in the blossom extract, this part of the banana plant had been traditionally consumed for its tremendous health benefits by the tribals. These include saponins, flavonoids, glycosides, tannins, steroids, and phenols. Besides, it also provides lots of nutrients such as potassium, protein, copper, calcium, iron, phosphorus, vitamins A, C and E, along with various antioxidant properties (Singh, 2017).The flower has been used in traditional medicine to treat bronchitis, constipation and ulcer problems (Soni and Saxena, 2021). Manipuri seat banana flower as curry or iromba (ethinic cuisine) during and after every long journey as they believe that it cures constipation and stomach problems. The use of banana in lowering vomiting and diarrhoea was also reported by Sangeeta *et al*. (2023).

Adi communities of Arunachal Pradesh and Assamese people make use of the bark of "Atia Kol" (popular banana cultivar in northeast India) for treating diarrhoea. The peel of "Atia Kol" is dried, made into powder, boiled and consumed to treat the disease. Apatani tribe of Arunachal Pradesh is well known for their unique ethnic cuisine called "Pike-Pilla", prepared from banana pseudostem. Tribes of Assam (Bodo, Garo, Karbi, Ahoms) drink the water from pseudostems to dissolve kidney stone, reduce stomach ulcers and improve bowel movement. In northeast India, banana flowers are also advised to consume during menstruation as it is believed that it reduces menstrual cramps as well as helps in increasing blood count. The present work is therefore to document and profile the ethnomedicinal, phytochemicals studies to validate the traditional use of different wild *Musa* blossom in relieving various diseases and ailments. In India, though banana fruit is extensively used due to its high nutritional value, its flower is still considered underutilized and very less scientific research has been done on banana flower bud.This study also aims to document the indigenous medicinal knowledge of wild banana blossoms for future generations.

2. Materials and Methods

2.1 Ethnomedicinal studies and sample collection

Surveys were conducted in different northeast states of India; namely, Arunachal Pradesh, Manipur, Assam and Tripura. Ethnomedicinal informations were collected as oral interviews and questionnaire were given to the oldest citizens of the state. Personal interviews and group discussions were organised to gather the information on use of banana plants, as folk medicine which was further authenticated by repeated discussions with the tribals. Out of the twelve banana species collected, eleven species were collected from wild and one genotype (Jahaji) is cultivated one. It is also known that only the wild banana flower is consumed as vegetable by the tribals while cultivated species are rarely consumed as cultivated one have more astringency even after cooking. The list of collected sample along with the passport data and local name are presented in Table 1 and Figure 1.

Figure 1: Survey, collection and interaction with local people regarding ethnomedicinal importance of wild banana species.

2.2 Description of the wild banana species and their pharmacological uses

2.2.1 *Musa acuminata* Colla

It is originated from southeast Asia and is widely distributed in the northeast India. It is a diploid having numerous hard seeds making it unfit for consumption. However, the local consumed the blossom of this plant as vegetable as it is believed to be rich in pharmacological properties. Many infectious and non-communicable diseases have historically been treated with it throughout Asia and Africa. For many years, tribal people have used it as a major source of food and medicine. Bronchitis, ulcers, and dysentery have historically been treated using banana flower. The Musa acuminata flower has strong antioxidant content and the presence of active chemicals

such as glycosides, tannins, saponins, phenols, steroids, and flavonoids, according to in vitro bioactivity and phytochemical screening. Additionally, it shows notable antibacterial activity against S*almonella* sp., *Aspergillus niger*, *Bacillus subtilis*, *Aspergillus aureus*, *Candida albicans*, and *Micrococcus* sp. These characteristics likely account for the native people's use of banana flowers to treat and cure a variety of illnesses and infections (Sumathy *et.al*., 2012). Another report by Subbaraya (2006) showed the use of *M. acuminata* flowers by Adi, Mishmi and Sherdukpens of Arunachal Pradesh in reducing joint pains and for better blood circulation.

Table 1: Collected plant sample along with the coordinates

S. No.	Samples/local name	Wild/cultivated	State	Latitude	Longitude	Altitude
1.	Sambyor	Wild	Arunachal Pradesh	27-7'56.85"N	94-43'13.4"E	353 m
2.	Lusup	Wild	Arunachal Pradesh	28-21'49.7"N	95-15'24.7"E	1046 m
3.	Lungkang (*Musa acuminata*)	Wild	Arunachal Pradesh	27-617.7"N	93-38.7.4"E	416 m
4.	Ludum	Wild	Arunachal Pradesh	28-3'20.1"N	95-57'25.7"E	321 m
5.	Kordok (*Musa velutina*)	Wild	Arunachal Pradesh	28-4'31.1"N	95-19'17.3"E	176 m
6.	Poknap Nger (*Musa aurantiaca*)	Wild	Arunachal Pradesh	27-7'56.85"N	95-44'3.18"E	353 m
7.	Aami Kar (*Musa nangensium*)	Wild	Arunachal Pradesh	27-7'56.85"N	95-44'3.18"E	353 m
8.	Changbi (*Musa balbisiana*)	Wild	Manipur	24-54'4.0'N	93-57'58.2"E	792 m
9.	Sabri (*Musa paradisiaca*)	Semi wild	Tripura	23-52'38.4"N	91-20'48.0"E	36 m
10.	Gopi (*Musa paradisiaca*)	Semi wild	Tripura	23-54'0.8"N	91-19'46.3"E	44 m
11.	Atia (*Musa balbisiana*)	Wild	Assam	27-29'29.5"N	94-55'54.0"E	113 m
12.	Jahaji (*Musa aradisiaca*)	Cultivated	Assam	27-31'7.8"N	94-43'13.4"E	120 m

2.2.2 *Musa balbisiana* Colla

It is another wild species of banana having B genome and is also commonly grown in northeastern parts of India. This species is very tall (5 to 10 m), having greenish and shiny pseudostem, fruits have numerous seeds but soft. The blossom is less astringent compared to other species. Therefore, this species is more preferred over other species of Musa. It is one of the most commonly used wild *Musa* spp. in tribal medicines. In Assam, it is commonly known as Atia kol or Bhim kol. All the ethnic people of Assam customarily used each and every part of the plants either as food or in any religious rituals. Thus, it is plant of immense importance for ethnic people of Assam. Fruit of Atia kol is used to treat infertility in women, gout, dysentery and used as health tonic and flower is used to treat jaundice. Kolakhar (banana ash) prepared from peel of banana is used as antacid, for washing cloths and preparation of Assamese dishes. Kolakhar is rich source of carbonates and potassium and act as antiseptic in cut and wounds, good for healing cough (Kalita and Kander, 2014). Moreover, Kolakhar can be salt substitute as the extract showed the presence of 46% K and 26% Na, thus making it an excellent replacement of table salt and lowering the certainty of Na associated health problems (Neog*et al*., 2013).

2.2.3 *Musa velutina* H. Wendl. & Drude

It is found only in northeast region of India. It has very attractive red coloured, erect flowers having ornamental importance. Flower is consumed as vegetable by different tribes of Arunachal Pradesh. The fresh stem juice is juice against blood dysentery (Kar and Borthakur, 2008). It can also be used to cure sore lips. Take one or two fresh leaves, warm them up gently over a fire, and dab the affected area of the sore lips three or four times a day before bed (Lokho, 2012).

2.2.4 *Musa paradisiaca* Linn.

It is locally known as Ching laphu meaning hill banana in Manipur. Blood purification and improved milk production in nursing women are achieved by the usage of pseudostem and banana flower (Singh *et al*., 2014). Manipuri's are very fond of eating raw vegetables and salad prepared from different vegetables, herbs, spices, *etc*. Ametpa, Iromba and Singju are their ethnic food prepared by smashing roasting chillies with fermented fish (Ngari) and by adding raw banana flowers, chives and other green vegetables and believed that they get direct medicinal benefits by this mode of eating. Young pseudostem and flowers are reported to improve bowel movement, cure dysentery, diarrhoea and cholera and also improves immunity (Yumnam and Tripathi, 2012).

2.2.5 *Musa nangensium* prain

According to reports, this species is exclusive to Nagaland. That has; however, lately been reported from Arunachal Pradesh's Changlang District. There has not been any phytochemical-related research done on this species yet. However, it was discovered throughout the study period that the tribal people of Arunachal Pradesh heavily consume the flower bloom as a vegetable.

2.3 Nutritional profiling

Suckers from every genotype were gathered and preserved in the Fruit Farm, College of Horticulture and Forestry, CAU, Pasighat, Arunachal Pradesh, at the time of the survey. Under the Collection ID CHF/CAU/FR/BANANA-25-36, Dr. B. N. Hazarika, Professor in the Department of Fruit Science at the College of Horticulture and Forestry, CAU, Pasighat, Arunachal Pradesh, conducted the taxonomical identification. Fresh banana blossoms were gathered during the shooting stage. Nutritional and phytochemical profiling was conducted at Basic Science and Humanities Laboratory, College of Horticulture and Forestry, CAU, Pasighat, Arunachal Pradesh. The study did not involve any trials involving animals and humans.

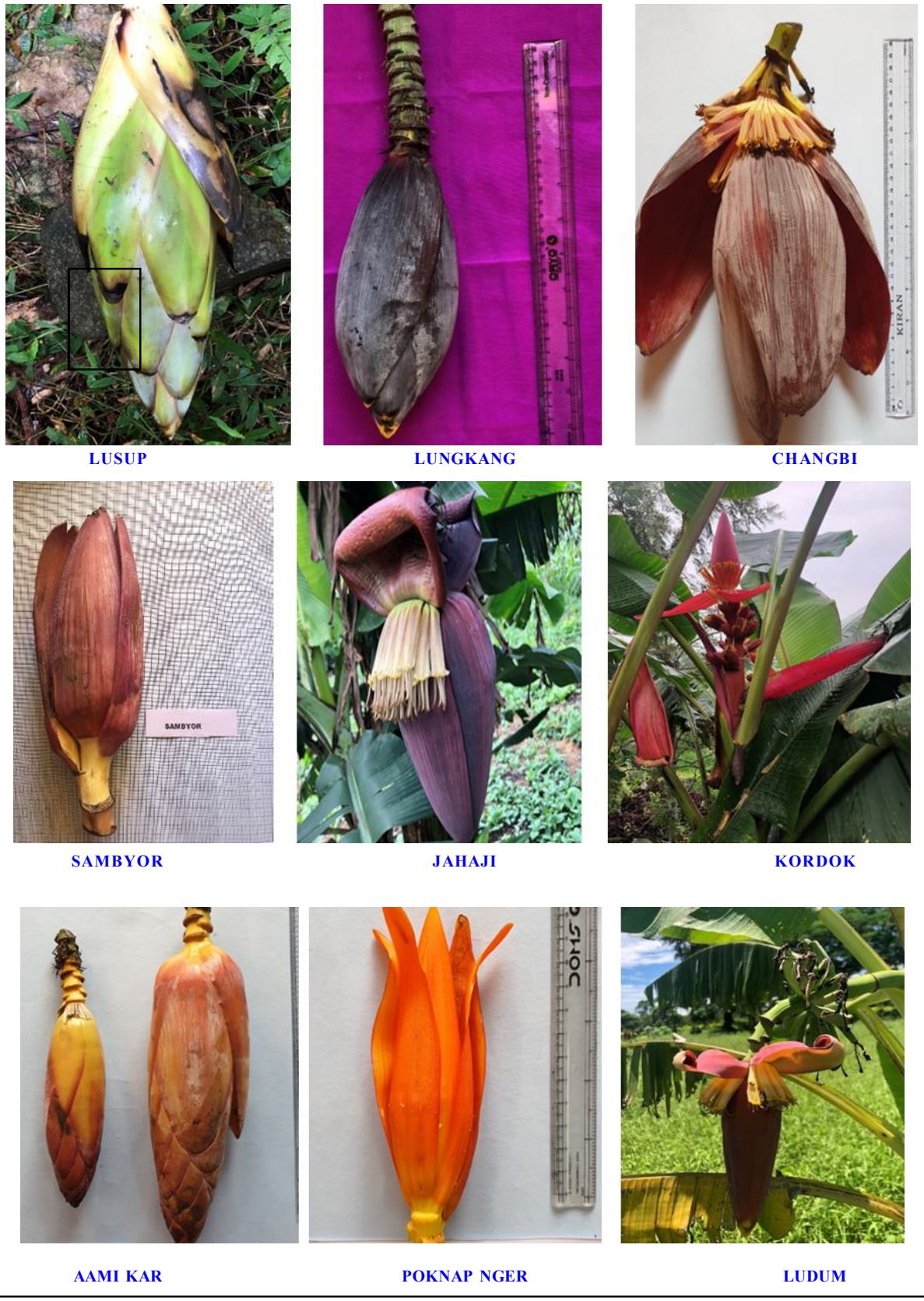

Figure 2: Different flower buds of wild banana species.

2.3.1 Anthocyanin

Anthocyanin content was performed by following the methods of Oancea *et al*. (2012) with few modifications. Extraction was done from the sample by using ethanolic HCl at a ratio of 85:15 and reading was taken at 535 nm in a UV spectrophotometer.

2.3.2 Total carotenoids

The method described by Sumanta *et al*. (2014) was followed to determine the amount of total carotenoids. The pigment was extracted by using 80% acetone and quantification of total chlorophyll was done by using UV-VIS spectrophotometer at 663 nm and 645 nm. The content of total carotenoids was quantified at 470 nm.

2.3.3 Vitamin E

Vitamin E content was checked by the procedure (Kumari and Achal, 2008) where 0.1 N sulphuric acids were used for extraction and 2, 2-dipyridyl was used as a reagent. In 0.5 g of sample, 10 ml of 0.1 N sulphuric acids was added and kept overnight. In 1.5 ml of extract, 1.5 ml of ethanol and xylene was added. Then, 1 ml of 2, 2- dipyridyl reagent was added to 1 ml of xylene, and reading at 460 nm against the blank were recorded. Later, 0.33 ml of ferric chloride was added to the solution and a second reading was observed at 520 nm exactly after 15 min.

2.4 Assessment of phytochemicals and antioxidant profiling

2.4.1 Estimation of phenol content

The method described by Malick and Singh (1980) was followed to determine the phenol content. Sample (0.5 g) was crushed using 80% ethanol and centrifuged at 10000 rpm for 20 min. Supernatant was collected and evaporated for making the sample dry then 5 ml of distilled water was added. Aliquot (0.2 ml) was taken and diluted to 3 ml with distilled water. Folin-Ciocalteau was added to the tube following addition of 2 ml of 20% sodium carbonate after 3 min and tube was placed in boiling water bath for 1 min. Ater the tube was allowed to cool down, sample was read against the blank solution sample then the phenol content was noted from the slope of phenol standard curve.

2.4.2 Estimation of tannin content

Tannin content was evaluated by the method given by Schanderi (1970). Sample weighing 0.5 g was taken in a conical flask and 75 ml of distilled water was added. The flask was boiled for 30 min and centrifuged at 2000 rpm for 20 min. Supernatant was collected and final volume was made to 100 ml using distilled water, 1 ml from this was taken out and 75 ml of distilled water was added to a 100 ml volumetric flask. Folin-Denis reagent measuring 5 ml and 10 ml of sodium carbonate was added and diluted to 100 ml with distilled water. Mixing was done properly, and reading was taken against the blank solution in a spectrophotometer at 700 nm. The concentration of tannin in the sample was calculated from the slope of tannin standard curve.

2.4.3 Estimation of flavonoid content

Flavonoid content was determined using method given by Vijay and Rajendra (2014). Sample (1g) was dissolved in 10 ml distilled water. The mixture was shaken at 25^{o}C for 180 min in a shaker. The mixture was filtered using Whatman No. 1 filter paper, 1ml of extract was taken out and 4 ml water was added to it. To this, 0.3 ml of 5% sodium nitrate was added after 5 min and 0.3 ml of 10 % aluminum chloride was mixed. Again after 5 min, 2 ml of 1 M sodium hydroxide was added and diluted to 10 ml with distilled water. The absorbance was read against the blank at 510 nm. The total flavonoid contented was expressed as mg QE/100 g of extract.

2.4.4 Antioxidant assays

The antioxidant activity of banana was determined using DPPH free radical scavenging assay according to the method given by Aoshima *et al*. (2004) with slight modifications. Sample (0.2 g) was homogenized using 5 ml ethanol and centrifuged for 5-8 min, from this 0.5ml was taken followed by addition of 3 ml ethanol and 0.3 ml DPPH. The reaction mixture was stored in complete dark for 30 min and reading was taken against a blank containing only ethanol at 517 nm.

2.5 Statistical analysis

The results of all the parameters were observed in triplicate numbers and the mean of the three analyses were presented in Tables using the procedure recommended by Gomez and Gomez (1984).

3. Results

3.1 Ethnomedicinal studies

A survey was carried out across different northeastern states to better understand the indigenous medicinal knowledge. A totalof 50 respondents including local healers between the age group 40 to 70 years participated in the survey. It was found that every part of banana plant is being utilized for either consumption or medicinal purpose since ancient times. Ethnomedicinal uses of Banana as per the survey is briefly summarized in Table 2.

Table 2: Ethnomedicinal uses of banana plant reported by the tribals

S. No.	Tribe	State	Plant part used	Method	Indigenous knowledge
1.	Adi/Assamese	Arunachal Pradesh, Assam	Peel	Drying of peel and boiling it	Cure for diarrhoea and any stomach upset
2.	Village folks	Arunachal Pradesh, Assam	Pulp and seeds	Pulp along with seeds are eaten when ripe	diarrhoea
3.	Adi, Mishmi, Sherdukpens,	Arunachal Pradesh	Flowers	Eaten with salt and oil	Relief from joint pains (Arthritis)
4.	Adi	Arunachal Pradesh	Peel	Fresh peel is used	For cleaning utensils, any metals, iron
5.	Ahoms, Garo, Karbi, Bodo	Assam, Manipur	Fruits	Seeds are removed and pulp is mashed and feed	Easily digestible for infants

6.	Apatani	Arunachal Pradesh	Pseudostem	Pseudostem are cut into small pieces, dried and made to ashes called "pilla"	Pilla is used to neutralize acidity
7.	All tribals	Assam, Arunachal, Tripura, Manipur	Leaves/ pseudostem	Leaves/pseudostem are placed in burn and blistered skin	As coolant, anti-inflammatory
8.	All folks	Manipur	Flower	Eaten raw or cooked as "Iromba", "Sinju"	Relief from menstrual cramp, recover from excessive blood loss during periods
9.	All folks	Manipura	Pseudostem/flower	Eaten as raw or cooked	Constipation, lactation
10.	All folks	Assam, Arunachal, Tripura, Manipur	Flower/tender pseudostems	Eaten as vegetable	Anaemia, arthritis

*Adi, Ahoms, Apatani, Bodo, Garo, Mishimi and sherdukpens are the tribal communities of Northeast India

3.2 Nutritional profiling

The results revealed that nutritional content in banana blossom (anthocyanin, carotenoids and vitamin E) were recorded to be very high. Lusup exhibited the highest level of carotenoids, vitamin E and anthocyanin of all the species that were investigated. Carotenoid content in all the species was found to be very high, ranging from 2.09 to 7.08 mg/ 100 g. Nutritional content of all the wild species of banana blossom is presented in Table 3.

Table 3: Nutritional, phytochemical and antioxidant composition in the blossom of different wild species of banana

Species	Phenols (mg/100 g)	Flavonoids (mg/100 g)	Tannins (mg/g)	Carotenoids (mg/100 g)	Vitamin E (mg/100 g)	Antioxidant (%)	Anthocyanin (mg/100 g)
Sambyor	135.3	64.22	1.57	4.62	2.16	77.94	4.620
Lusup	36.6	87.33	7.29	7.08	22.50	74.44	7.077
Lungkang (*Musa acuminata*)	27.8	80.44	1.71	2.74	0.72	89.39	3.817
Ludum	182.2	60.89	17.29	3.82	3.29	21.11	2.742
Kordok (*Musa velutina*)	51.7	43.78	7.14	2.09	0.96	56.99	2.085
Poknap Nger (*Musa aurantiaca*)	61.6	64.15	14.90	2.51	1.58	61.40	2.506
Aami Kar (*Musa nangensium*)	77.4	50.96	10.86	3.74	5.73	59.13	3/741
Changbi (*Musa balbisiana*)	30.6	26.30	7.86	2.88	1.95	52.35	2.883
Sabri (*Musa paradisiaca*)	12.0	78.89	11.86	2.08	3.39	68.82	2.075
Gopi (*Musa paradisiaca*)	14.6	134.22	13.57	7.05	2.99	80.10	7.053
Atia (*Musa balbisiana*)	31.9	52.22	8.76	2.07	2.17	54.46	2.074
Jahaji (*Musa paradisiaca*)	92.2	128.89	23.05	3.78	2.06	70.70	3.783

3.3 Phytochemical and antioxidant assessment

Phenol content in the tested germplasm ranged from 12-182 mg/100 g. Highest phenol content was recorded in Ludum (182 mg/100 g), followed by Sambyor (135 mg/100 g). Flavonoid content in the tested germplasm varied from 26.30-134.22 mg/100 g. Highest flavonoid content was recorded in Gopi (134.22 mg/100 g), followed by Jahaji (128.89 mg/100 g). Tannin content ranged from 1.57 to 23.04 mg/100 g. Sambyor has the least tannin content of 1.57 mg/ 100 g, whereas Jahaji has the maximum tannin content of 23.04 mg/ 100 g. Among the twelve-sample screened, highest antioxidant activity was recorded in Lungkang (89.39%), followed by Gopi (80.10%) and lowest was registered in Poknap Nger (32.84%) which is depicted in Table 3.

4. Discussion

Phenolics are plant secondary metabolites and they are the most common water soluble antioxidant compounds. High level of phenols implies higher antioxidant activities and higher antimicrobial activities (Thaweesang, 2019; Mokbel, 2005; Sumathya *et al,* 2011; Windholz,1983) due to which banana flower plays a beneficial role as a health food supplements for lactating mothers (Govindara, 2022). The present experiment shows maximum phenol content for Ludum which was as high as 182 mg/100 g, followed by Sambyor with 135 mg/100 g. Similar findings were reported by Thaweesang (2019) where they found total phenol of 74.1mg/100 g to 123.5 mg/100 g in fresh and blanching banana blossom. Soni and Saxena (2021) also reported phenol content of 96.155mg GAE/100 g in banana flower. Additionally, according to Akhtar (2024), plants antibacterial qualities are due to the presence of secondary metabolites such glycosides, alkaloids, flavonoids, tannins, and terpenoids. Another finding by Kumari *et al*. (2020) indicated that high phenol content in banana peels aids in the treatment of acne, indicating antibacterial qualities of bananas.

Flavonoid is also one of the essential secondary metabolites, exhibiting various biological properties, such as antioxidant, anti-inflammatory, antithrombotic, antifungal, anticarcinogenic, antiallergenic, and hepatoprotective property (Sumathy *et al.,* 2011). There are reports from tribals of Assam, Arunachal and Manipur that banana blossoms are used in treating various gastrointestinal disorders. This may be due to antiulcer and anti-inflammatory activities of flavonoids and tannins (Sampath *et al,* 2012; Goel, 1986). Studies have also showed that the presence of vitamin E and flavonoids in banana flower has hepatoprotective, hypocholesterolaemia and hypoglycaemic effect (Liyanage *et al*., 2016). Flavonoid is also effective in reducing the risk of cardiovascular diseases by lowering the oxidation of LDL as well as preventing other degenerative diseases (Pierini *et al*., 2008). Flavonoid content of the current samples ranged from 26 to 134 mg/ 100 g. This is similar to the findings of Soni and Saxena (2021) where they reported flavonoid content of 137.585 mg QUE/100 g. During the survey, it was discovered that banana flowers were used traditionally to treat a variety of digestive issues. The phytochemical research reveals that banana blossoms have high flavonoid content, which may help treat stomach-related problems. According to Siddiqui *et al*. (2023), flavonoids have the ability to scavenge reactive oxygen species, which helps alleviate dysentery, constipation, and diarrhoea.

Tannin has shown diverse medicinal importance. At lower dose, it can retard the bacteria growth; while at a higher dose, it is known to display antifungal properties (Sumathy *et al*., 2011). Tannin also have additional properties such as anti-inflammatory, antioxidant, anticarcinogenic, cardioprotective, and radical scavenging properties (Redondo *et al*., 2014).Tannins have also been reported to exert other physiological effects, such as to accelerate blood clotting, reduce blood pressure, decrease the serum lipid level and modulate immune responses and also act as antidiarrheal (Siji and Nandini, 2016). On the other hand, they have been reported to be responsible for decrease in palatability as it is responsible for the astringency taste in fruits and vegetables. From the results, it can be seen that Jahaji and Lungkang have the highest tannins. While, Ludum and Sambyor have the minimum tannin content.

Carotenoids provide health benefits due to their unique physiological functions, such as pro-vitamins and their role as antioxidants, especially in scavenging singlet oxygen. They have active role in decreasing the risk of diseases, particularly certain cancers and eye diseases. Consumption of foods rich in carotenoids improves immunity and reduces the risk of diseases, such as cancer, diabetes and heart problems (Krinsky and Johnson, 2005). Since β-carotene is the precursor for vitamin A, its higher concentration in wild banana blossoms indicates its nutritional significance. Provitamin A carotenoids are easily absorbed and converted into vitamin A in the human body, thus helping alleviate vitamin A deficiency (Van de Berg *et al*., 2000). Dana and Thaha (2014) also reported that wild banana blossoms possess more than six times β-carotene content than that of cauliflower (0.03 mg/100 g).

To ascertain the antidiabetic potential of wild banana flowers, numerous investigations have been conducted in the last year. Kitdamrongsont *et al*. (2008) have reported the presence of anthocyanins in wild banana flowers, specifically delphinidin-3-rutinoside, cyanidin-3-rutinoside, petunidin-3-rutinoside, pelargonidin-3-rutinoside, peonidin-3-rutinoside, and malvidin-3-rutinoside. According to Matsui *et al*. (2008), potent inhibitors of α-glucosidase have been found for these compounds. Additionally, anthocyanins contribute to how insulin sensitivity is improved and blood glucose is lowered.

A class of micronutrients known as vitamins is important and needed in different amounts for physiological processes and the maintenance of health. Since our bodies are unable to synthesize vitamins, it is essential to obtain vitamins from diet, either by taking supplements or eating foods high in functional components. Pharmacological activities concerned with vit-E are cancer, cardiovascular diseases, cataract, neurological disorders and age-related disorders (Miranda-Vilela *et al.*, 2014). From the total sample screened, Lusup has the highest vitamin E content (22.50 mg/100 g). The value found in wild banana flower in present study was higher than those reported by others researchers.

DPPH tests are frequently used to assess the potency of primary antioxidants in plants. These assays involve the primary antioxidants reacting to scavenge the free radical from the DPPH solution, suppressing the formation of the free radical's initiation chain and destroying its propagation chain by donating an electron or hydrogen atom, thereby converting the free radical into a more stable form of product (Nurliyana *et al*., 2010; Yan *et al*., 2006). Bananas have been classified as one of the prominent antioxidant foods by Kanazawa and Sakakibara (2000). Among the 12 samples screened, highest antioxidant activity was recorded in Lungkang (89.39%), followed by Gopi (80.10%). High antioxidant potential in Lungkang and Gopi can be correlated with high phenols and flavonoids in both the sample as phenolic compounds are considered to be the most important antioxidants of plant materials. DPPH is a stable free radical that is reduced to colourless DPPH upon exposure to antioxidants (Mishra *et al.,* 2012). Bananas have been categorized as one of the prominent antioxidant foods by Kanazawa and Sakakibara (2000).The antioxidant qualities of quercetin to scavenge free radicals and lessen oxidative stress in the body were also reported by Ramadevi *et al*. (2024). Furthermore, by rupturing microbial cell membranes, preventing microbial enzyme activity, and otherwise demonstrating antibacterial qualities against a variety of pathogens, including bacteria and fungus.

5. Conclusion

Because wild banana flowers have significant concentrations of phenols, anthocyanins, flavonoids, tannins, carotenoids, and antioxidant properties, the study demonstrates and supports the use of these flowers by tribal people in northeastern India for the treatment and prevention of a variety of ailments. However, more ethnopharmacological validation is needed, and a detail investigation on the nutritional profiling and pharmacological activity of wild banana species like *Musa nangensium* and *Musa velutiana* should be carried out in future. It is noted that the majority of study on bananas focuses exclusively on the fruits; yet, there is a belief that the flowers, peels, and pseudostems of bananas are similarly rich in nutrients, despite the fact that very little scientific research has been done on this topic. As a result, the relevant work needs to be completed. Nonetheless, the study has shed light on how nutritious bananas and their blossoms are used in northeastern India.

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Conflict of interest

The authors declare no conflicts of interest relevant to this article.

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