Kavita Arora
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The Solidarity Approach in Geography

Cases from the Indian Subcontinent

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Socio-Economic Development through Ecological and Social Solidarity: A Case of NABARD Springshed-Based Participatory Watershed Development Program in the North East Region

A. K. Mishra and Atosü Hibo

Introduction

The various dimensions of the sustainable development model for the socio-economic group of masses rest on poverty alleviation and the conservation of nature. In an interdependent and multi-plural economic, political, economic, and administrative environment, it is still being determined to build a consensus on key factors influencing global issues like climate change, food security, water security, human health, conservation of biodiversity, etc. Mother Earth, which is home to mankind and other living beings, provides food, shelter, water, and a platform for healthy living from generation to generation. The socio-economic issues that need attention are centred on health and hygiene, poverty alleviation, conservation of nature, rational use of natural resources, and more and more use of renewable energy.

Objectives of the Study

To determine the role of NABARD in fostering Social and Solidarity Economy (SSE) in the Northeast.

To examine the NABARDs Springshed program in the North East Region (NER) and its impact on community empowerment, equitable development, and sustainable economic practices.

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NAGALAND ETHNOBIOLOGY

TRADITIONAL PRACTICES AND CONTEMPORARY RESEARCH

EDITED BY
KENSIBO PAMAI
THEJANUO RHETSO

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CONTENTS

CHAPTER-1

TRADITIONAL ENTOMOPHAGY AMONG THE SANGTAM PEOPLE OF TUENSANG DISTRICT, NAGALAND, NE-INDIA

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ABSTRACT

This study explores the practice of entomophagy (insect consumption) among the Sangtam tribe in Tuensang District, Nagaland, Northeast India. The research highlights the diversity of edible insects consumed, their nutritional benefits, and their role in traditional medicine and cultural practices. A field survey conducted in four villages identified 12 edible insect species across seven orders, with Hemiptera being the most represented. Insects such as *Arhopalus* sp., Cicada and *Bombyx* sp. are consumed in various life stages (larvae, pupae, and adults) and prepared through roasting, frying, or boiling. The study emphasizes the high nutritional value of these insects, which are rich in protein, fats, and essential minerals, offering a sustainable alternative to conventional livestock. Also, certain insects are used therapeutically, such as *Darthula* sp. for treating cough, asthma, and jaundice; *Tessaratoma* sp. secretions are applied to warts. Despite their nutritional and cultural significance, entomophagy faces challenges due to changing dietary habits and modernization. The study stresses the need for further research on the ecological, economic, and conservation aspects of edible insects, as well as the potential for insect farming to support sustainable food systems and livelihoods in the region.

Keywords: Entomophagy, Sangtam tribe, edible insects, Tuensang District, Nagaland

Introduction

Situated in Nagaland's easternmost region along an international border, Tuensang District is flanked by Mon and Longleng to the north, Mokokchung and Zunheboto to the west, Kiphire to the south, and Shamator and Noklak to the east. The area exhibits a mix of subtropical

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PREFACE

Nestled in Northeast India, Nagaland's rich biodiversity and vibrant indigenous practices form the backdrop for this book, '*Nagaland Ethnobiology: Traditional Practices and Contemporary Research'* which presents a comprehensive account of traditional knowledge and contemporary scientific research.

The chapters provide insights into the intrinsic link between its people and nature and emphasize the deep understanding these communities have developed over generations in managing their local ecosystems. The book covers topics ranging from zootherapeutic and ethnomedicinal practices to the consumption of insects and wild edible plants, as well as the diversity of rice, cabbage pest and aquatic insect studies. The book also includes evaluation of fruit quality and DNA barcoding of the Naga Tree Tomato (*Solanum betaceum*) and its invitro regeneration and genetic fidelity, and phytochemical and antimicrobial analysis of *Parkia roxburghii.*

We hope that the book will acts as a bridge between tradition and science, seeking to motivate conservation and empower local communities to protect their ecological heritage. By paying tribute to the work of researchers and indigenous knowledge holders, it promotes the blending of tradition and innovation in the conservation of Nagaland's biodiversity. This book is a call to celebrate and conserve the delicate harmony between humans and nature- a harmony that supports both heritage and ecological resilience.

-K. Pamai & T. Rhetso

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CONTENTS

CHAPTER-3

ETHNOMEDICINAL PLANTS OF KIKRUMA VILLAGE, PHEK DISTRICT, NAGALAND

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ABSTRACT

Ethnobotanical studies play a crucial role in understanding the indigenous community's traditional knowledge and application of medicinal plants. It is essential to recognize the indigenous knowledge systems and promote their integration with modern healthcare systems for the overall well-being of communities. This study aims to document and categorize the therapeutic plants available in Kikruma village through semi structured questionnaire, interview and field survey among the traditional healers and informed individuals. A total of 46 plant species belonging to 29 families were documented. The most predominantly utilized plant parts were leaves (39%), followed by whole plant (19%) and fruits (13%). The study revealed that these medicinal plants were used to treat various ailments, including gastrointestinal disorders, respiratory problems, skin diseases, and musculoskeletal disorders. The most commonly available plants were *Ageratina adenophora*, *Ageratum conyzoides, Bidens pilosa* whereas *Entada rheedei and Abelmoschus moschatus* were less commonly available. This study provides valuable insights into the therapeutic medicinal plant diversity and traditional knowledge of Kikruma village. This study concludes that there is a need for conservation activities and education campaigns on sustainable methods for collecting the plants to avoid overuse and habitat destruction to ensure the long-term availability of these unique plant resources.

Keywords: Kikruma village, Ethnomedicinal plant, Traditional therapy

Introduction

Ethnobotany is the study of how people classify, use, and manage plants, it is essential given the growing significance of creating new crops, products such as medicines from traditional plants and preservation of

biodiversity (Martin, 2010). The study of ethnobotany has grown recently to include a variety of academic fields, such as pharmacology, anthropology, ecology and conservation biology, reflecting the diverse perspective needed to understand the complex relationship between plants, people and environment (Balick & Cox, 1996). If folklore and tradition surrounding plants had been taken more seriously, many well-known vegetable drugs would have entered widespread use decades ago. The current interest in accessible, affordable health care, new medications and supplemental nutritive foods has prompted ethnobotanical studies in a number of underdeveloped societies around the world (Jain, 1986).

Kikruma village is located in Phek district of Nagaland. The village is rich in natural vegetation with numerous medicinal plants which is used by the villagers for the treatment of various diseases like diarrhoea, dysentery, wound healing, bleeding, gastritis etc. The villagers have a rich knowledge of traditional medicine which has been passed down from generation to generation. This study was undertaken to identify and document the medicinal plant diversity to preserve the traditional knowledge.

Materials and Methods

Study area: the study was carried out in Kikruma village under Phek district, Nagaland, India located at latitude 25.5807° N and longitude 94.2199° E and altitude of 1270 meters above sea level. The average rainfall ranges around 200-250 cm.

Data collection: the survey was carried out in Kikruma village. The survey included interview using semi-structured questionnaire and interaction with the local healers and tribal informants for obtaining data on their vernacular name and their uses and collection of plants for herbarium preparation.

Herbarium preparation and Identification: herbarium were prepared using Jain & Rao (1997) technique. The scientific names of the plants were identified by studying the morphologies and further verified from

Department of Botany, Patkai Christian College (Autonomous), Chümoukedima-Seithekema, Nagaland.

Results and Discussion

A total of 46 medicinal plant species belonging to 46 genera and 29 families (Figure 1 & 2) were documented in our study used by the people of Kikruma Village to treat various diseases and ailments. The medicinal plants revealed that herbs constitute the highest proportion represented by 22 species, followed by shrub with 13 species, trees represented by 6 species, climbers represented by 3 species and one species of liana and grass. Asteraceae was found to be the dominant family with 9 species followed by solanaceae with 4 species and Fabaceae and Rosaceae with 3 species. The parts used has been categorized into leaves, fruits bark, whole plant, root, bulb, seed flower, stem etc.

Leaves

The crushed leaf paste of *Ageratina Adenophora*, *Ageratum conyzoides*, *Artemisia indica*, *Crassocephalum crepidiodes*, *Nicotiana tabacum* and *Oxalis corniculate* are applied to cuts and wounds as haemostatic, *A. indica* leaf is also used as an insect repellent. *Alnus nepalensis* leaf paste is applied to cure sore foot. The leaf paste of *Bidens Pilosa* is applied on skin diseases. The leaves of *Brugmansiasu aveolens* and *Ricinus communis* are warmed on fire and applied to body ache to relieve muscle pain and sprain. The decoction of *Cajanus cajan* leaf is consumed to cure jaundice and gall bladder problems. The leaves of *Gynura bicolour* are boiled and taken orally for gastritis, stomach-ache and constipation. The leaves of *Justicia adhatoda* are boiled, the water extract is used to massage the body to relieve muscle-ache. The leaves of *Laggera crispata* are made into a paste and applied to skin infection it is also used to treat piles. The white tomentum is scraped from the leaves of *Leucosceptrum canum* and applied as a haemostatic. The leaves of *Melia azedarach* are boiled in water and are used for bathing to treat skin diseases. The leaf paste of *Mimosa pudica* are applied on skin infections, the leaf decoction is used to treat urinary problem. The leaves of *N. tabacum* are crushed and mixed with water and used as pesticides. The juice extract from leaves of *Oxalis corniculate* is used to wash latex and sap stains from

hands. The leaf juice of *Paederia foetida* is consumed to treat diarrhoea, dysentery and the leaf extract to ease ear pain. The leaves of *Passiflora edulis* are boiled and consumed to reduce high blood pressure and treat diabetes. The leaf paste of *Prunus persica* is used to treat ring worms. The leaves of *Psidium guajava* are consumed raw or consumed as decoction for treating diarrhoea and dysentery. The leaf decoction of *Punica granatum* is taken for the treatment of high fever and typhoid. The fresh leaves of *Urtica ardens* are crushed and the paste is applied to treat mumps. The soup of *Zanthoxylum armatum* leaf is prepared with garlic and chilly and consumed to reduce fever.

Fruits

The fruit of *Debregeasia longifolia* aids in digestion. *Litsea cubeba* fruit is also taken as a spice and also used as stimulant. The fruits of *Phyllanthus emblica* are consumed to treat cough, fever, high blood pressure, stimulate appetite and as blood purifier; the juice extract from raw fruit is used to treat eye infection. The fruit of *Psidium guajava* is used for controlling diarrhoea. The raw and ripe fruit of *Pyrus pashia* is used to treat diabetes. Raw or boiled fruit of *Solanum indicum* are consumed to control high blood pressure and fever. The fruit of *Solanum myriacanthum* are roasted and the steam is put below the teeth for the treatment of toothache. The soup of *Zanthoxylum armatum* fruit is cooked with garlic and chilly and consumed to reduce fever, fruit is also used to reduce tooth-ache.

Whole plant

Bidens Pilosa plant is boiled in water and the decoction is taken orally to treat fever and stomach-ache. The whole plant of *Centella asiatica* is boiled in water or consumed raw for gastric problem and as blood purifier. The *Drymaria cordata* plant is used in the treatment of nasal blockade and nose bleed. The decoction of *Equisetum ramosissimum* is taken orally to treat kidney problem and urinary tract infection. The whole plant of *Houttuynia cordata* is consumed raw or cooked to treat diarrhoea and blood pressure. The whole plant of *Persicaria capitata* is warmed over fire and applied to treat dislocation of bones. The whole plant of *Plantago erosa* is boiled in water and consumed to treat stomach

ache, dysentery and kidney problem. The whole plant of *Ranunculus diffusus* is crushed and applied to wounds. The decoction of the plant *Rubia sikkimensis* is taken for urinary problem.

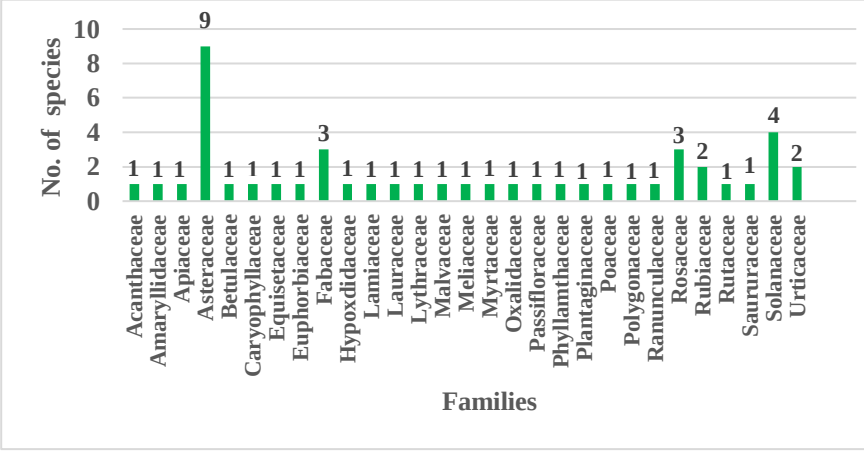

Figure 2: Graph showing the number of medicinal plants families collected in the study area

Bark

The crushed bark of *Abelmoschus moschatus* and *Debregeasia longifolia* are used as shampoo, *A. moschatus* also provide relieve from dandruff. The bark of *Alnus nepalensis* is soaked overnight and the infusion is taken for treating diabetes. The decoction of *Rubus ellipticus* bark is used for stomach-ache.

Roots

The root extract of *Curculigo capitulata* is used in treating ear and eye infection. The root decoction of *Mimosa pudica* is used to treat urinary problem. The decoction of *Rubus ellipticus* root is used for treating stomach-ache.

Others

The bulb of *Allium chinense* is used in culinary as a flavouring agent and to lower the blood pressure. The cotyledon of the *Entada rheedei* is used as soap. The stem of *Gynura bicolour* is boiled and taken orally for gastritis, stomach-ache and constipation. The flowers of *Laggera crispata* are made into a paste and applied to skin infection. The

inflorescence of *Leucosceptrum canum* is soaked in water and used as a tonic. The juice from the culm of *Saccharum officinarum* is used to treat jaundice and gall bladder problem. The aerial part of *Sonchus wightianus* is boiled with water and consumed for treating of kidney and high blood pressure. The inflorescence of *Spilanthes paniculata* is crushed and applied to control toothache. The following table (Table 1) shows the utilization pattern of different plant parts.

Conclusion

Ethnobotanical studies of medicinal plants was conducted in Kikruma village, Phek, Nagaland, these findings have shed important light on the community's indigenous knowledge and application of various plants as a source of medicine. This study aimed to record indigenous peoples' knowledge of therapeutic plants, preserve traditional plant resources and promote their sustainable use.

Field surveys revealed a broad diversity of medicinal plants in the area with numerous applications for a range of illnesses and health issues. The natives have a great understanding of the curative properties and traditional uses of these plants, which had been passed down orally through the generations.

Several plant species were identified as having significant value. Species such as *Ageratina adenophora, Ageratum conyzoides, Artemisia indica, Crassocephalum crepidiode, Leucosceptrum canum, Nicotiana tabacum, Oxalis corniculata* were commonly used for treating cuts and wounds as a haemostatic, other plants like *Alnusnepalensis, Passiflora edulis, Pyrus pashia,* is used for the treatment of diabetes, *Paederia foetida, Plantago erosa, Psidium guajava*is used in the treatment of diarrhoea and dysentery. Several other medicinal plants were utilized for their immunomodulatory properties, gastritis, hypertension, hypotension, urinary tract problem.

The findings of these ethnobotanical studies emphasise the importance of traditional knowledge in medical practises and the potential for medicinal plants to provide easily accessible and reasonably priced healthcare, particularly in rural and remote areas. The documentation of

such knowledge promotes the preservation of cultural heritage and acts as a springboard for future scientific investigation and the development of novel drugs.

Nevertheless, it is essential to recognise the necessity for promoting community-based conservation initiatives, educating people about sustainable harvesting methods and explore the potential for the cultivation and propagation of medicinal plants. Overexploitation and habitat destruction may pose major threats to both the continued existence of these plant species and the associated traditional knowledge.

In conclusion the documentation of local traditional knowledge, aids in the preservation of cultural heritage which also paves the way for sustainable use of these unique plant resources for efficient and economical healthcare solutions and for future research.

Acknowledgement

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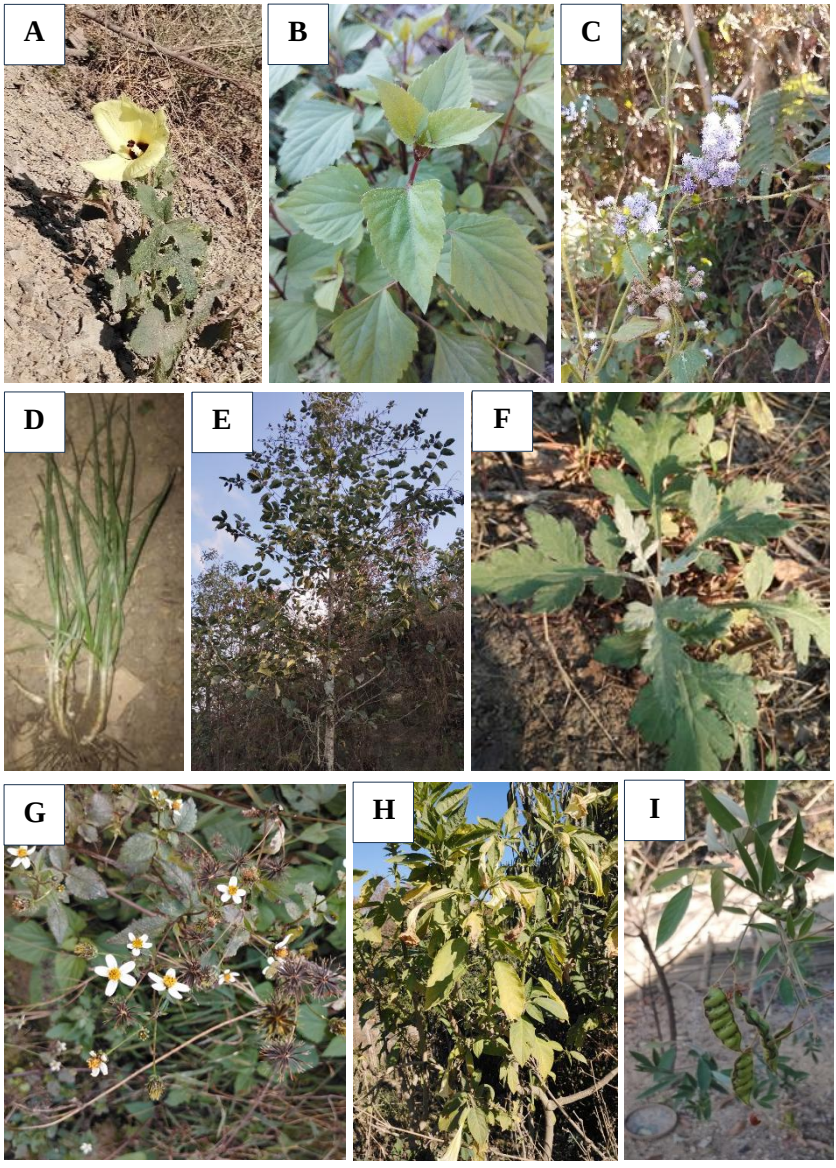
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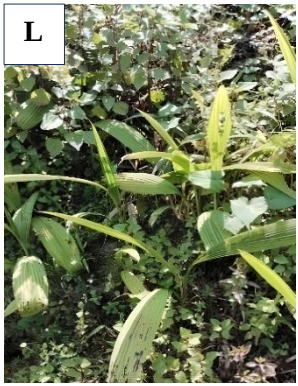
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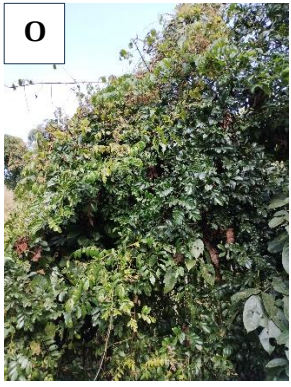
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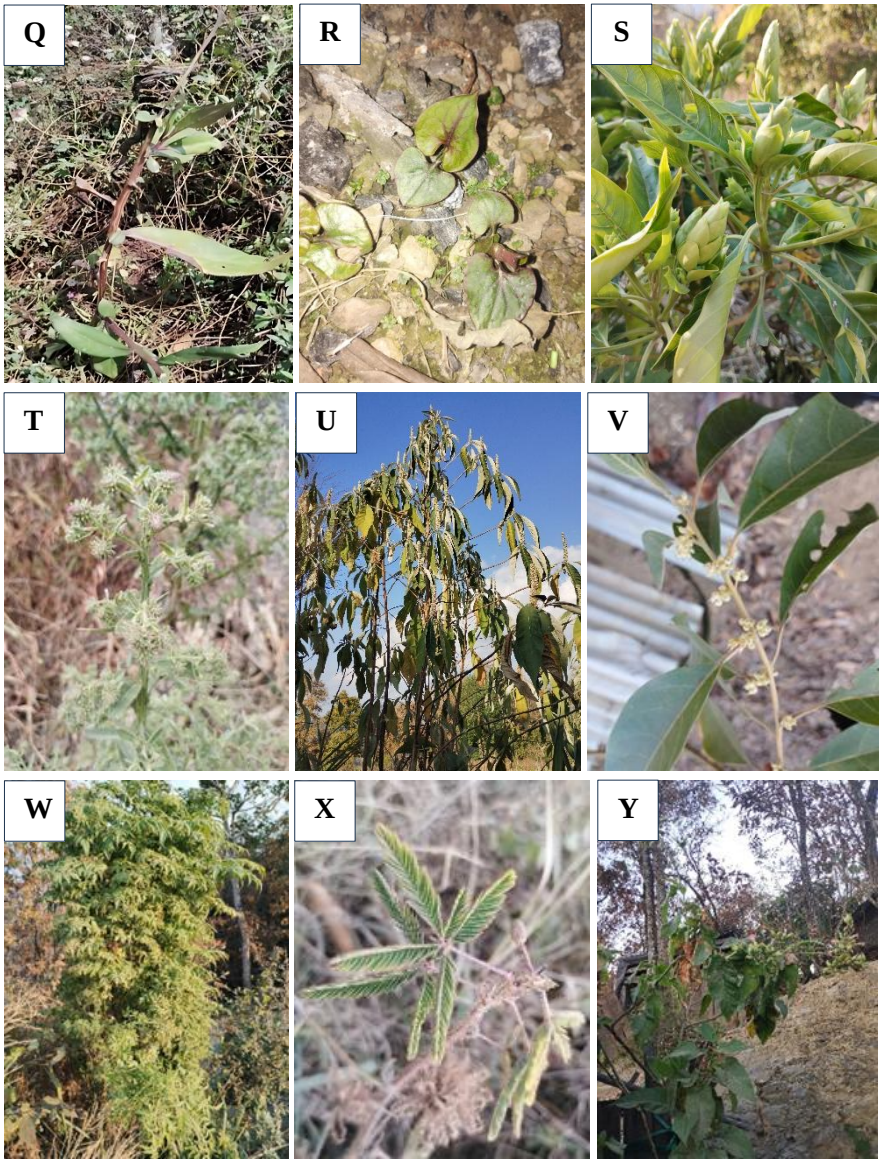
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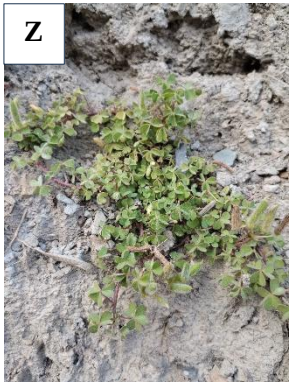
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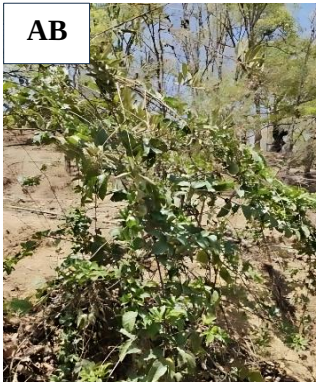
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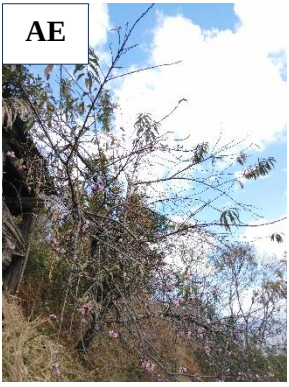
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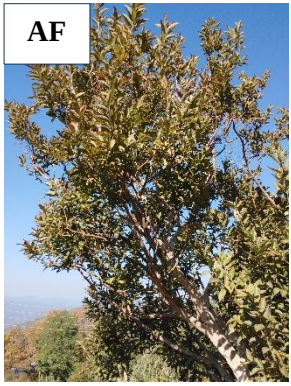
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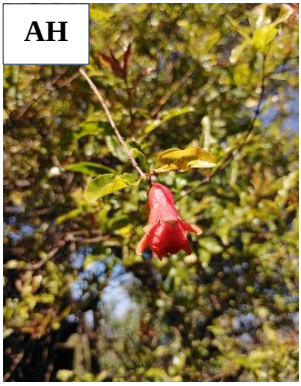
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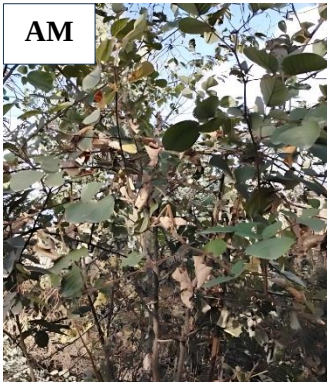
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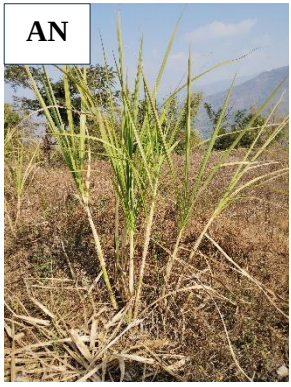
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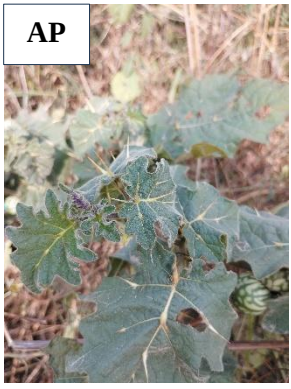
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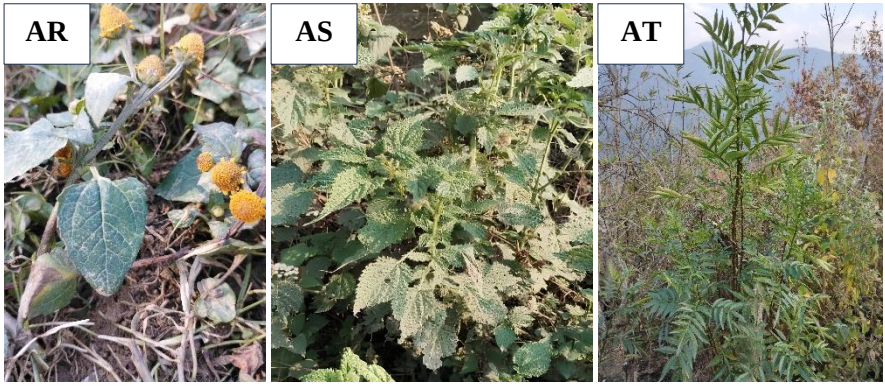

Figure 1: Ethnomedicinal Plants of Kikruma Village (A) ***Abelmoschus moschatus*** **Medik; (B)** ***Ageratina Adenophora*** **(spreng.) R.M. King & H. Rob.; (C)** ***Ageratum conyzoides*** **L.; (D)** ***Allium chinense*** **G. Don; (E)** ***Alnus nepalensis*** **D. Don; (F)** ***Artemisia indica*** **Wild.; (G)** ***Bidens Pilosa*** **L.; (H)** ***Brugmansia suaveolens*** **(Willd.); (I)** ***Cajanus cajan*** **L. Millsp.; (J)** ***Centella asiatica;*** **(L.) Urb. (K)** ***Crassocephalum crepidiodes*** **(Benth.) S, Moore; (L)** ***Curculigo capitulata*** **(Lour.); (M)** ***Debregeasia longifolia*** **Wedd.; (N)** ***Drymaria cordata*** **(L.) Willd. Ex Roem. & Schult; (O)** ***Entada rheedei*** **Spreng.; (P)** ***Equisetum ramosissimum*** **Desf.; (Q)** ***Gynura bicolour*** **(Roxb. Ex. Willd); (R)** ***Houttuynia cordata*** **Thumb.; (S)** ***Justicia adhatoda*** **L.; (T)** ***Laggera crispata*** **(Vahl) Hepper & J.R.I Wood; (U)** ***Leucosceptrum canum*** **Sm.; (V)** ***Litsea cubeba*** **(Lour.); (W)** ***Melia azedarach*** **L.; (X)** ***Mimosa pudica*** **L.; (Y)** ***Nicotina tabacum*** **L.; (Z)** ***Oxalis corniculate*** **L.; (AA)** ***Paederia foetida*** **L.; (AB)** ***Passiflora edulis*** **Sims; (AC)** ***Persicaria capitata*** **(Busch.-Ham. Ex D. Don); (AD)** ***Phyllanthus emblica*** **L.; (AE)** ***Plantago erosa*** **Wall.; (AF)** ***Prunus persica*** **L.; (AG)** ***Psidium guajava*** **L.; (AH)** ***Punica granatum*** **L.; (AI)** ***Pyrus pashia*** **L.; (AJ)** ***Ranunculus diffusus*** **DC.; (AK)** ***Ricinus communis*** **L.; (AL)** ***Rubia sikkimensis*** **Kurz; (AM)** ***Rubus ellipticus*** **Sm.; (AN)** ***Saccharum officinarum*** **L.; (AO)** ***Solanum indicum*** **L.; (AP)** ***Solanum myriacanthum*** **Dunal; (AQ)** ***Sonchus wightianus*** **DC.; (AR)** ***Spilanthes paniculata*** **Wall. Ex. DC.; (AS)** ***Urtica ardens*** **Link; (AT)** ***Zanthoxylum armatum*** **DC.**

Table 1: Utilization pattern of different plants used by the people of Kikruma Village

S. No.	Scientific Name	Common Name	Local Name	Habit	Utilization Pattern
1	*Abelmoschus moschatus* Medik. (Malvaceae)	Musk mallow	Mujo pinni	Shrub	**Bark:** The bark is crushed and used for washing hair to relieve from dandruff
2	*Ageratina adenophora* (spreng.) R. M. King & H. Rob (Asteraceae)	Mexican devil	Japan nha	Herb	**Leaves:** The leaf is crushed and the paste is applied to cuts and wounds as haemostatic
3	*Ageratum conyzoides* L. (Asteraceae)	Billygoat weed	Nhanalu	Herb	**Leaves:** The leaf paste is crushed and the paste is applied to cuts and wounds as haemostatic
4	*Allium chinense* G.Don (Amaryllidaceae)	Chinese onion	Khuva	Herb	**Bulb:** It is used in culinary as a flavouring agent and to lower the blood pressure
5	*Alnus nepalensis* D. Don (Betulaceae)	Nepalese alder	Rupubo	Tree	**Bark and leaves:** The bark is soaked overnight and the infusion is consumed for diabetes and the leaf paste is applied on sore foot
6	*Artemisia indica* Willd. (Asteraceae)	Indian wormwood	Pinna	Herb	**Leaves:** Leaf paste is applied to cuts and wounds as haemostatic and the fresh plant is also used as an insect repellent
7	*Bidens Pilosa* L. (Asteraceae)	Black-jack	Tsurho	Herb	**Whole plant:** Plant is boiled in water and the decoction is taken orally for fever and

					stomach-ache and the leaf paste is applied on skin disease
8	*Brugmansia suaveolens* (Humb. & Bonpl. Ex Willd.) (Solanaceae)	Angel's tears	Mutretusu	Shrub	**Leaves:** The leaf is warmed in fire and applied to body ache, muscle pain and sprain
9	*Cajanus cajan* (L.) Millsp. (Fabaceae)	Pigeon pea	Susujo se	Shrub	**Leaves:** The decoction of the leaf is consumed for jaundice and for gall bladder
10	*Centella asiatica* (L.) Urb. (Apiaceae)	Asiatic pennywort	Gapri	Herb	**Whole plant:** The whole plant is boiled in water or taken raw for gastric problem and is consumed as a blood purifier
11	*Crassocephalum crepidiodes* (Benth.) S. Moore (Asteraceae)	Fireweed	Tuphrenh a	Herb	**Leaves:** The Leaf paste is applied to cut and wounds as a haemostatic
12	*Curculigo capitulata* (Lour.) Kuntze (Hypoxdidaceae)	Palm grass	Tsu	Herb	**Root:** The root extract is used to cure ear and eye infection
13	*Debregeasia longifolia* (Burm. f.) Wedd. (Urticaceae)	Orange wild rhea	Mulubo	Shrub	**Bark and fruit:** The bark is crushed and used as shampoo and the fruit aids in digestion
14	*Drymaria cordata* (L.) Willd. ex Roem. & Schult (Caryophyllaceae)	Chickweed	Pupu nha	Herb	**Whole plant:** The plant is used in the treatment of nasal blockade and nose bleed
15	*Entada rheedei* Spreng. (Fabaceae)	African dream herb	Sulu	Liana	**Seed:** The cotyledon of the seed is used as soap

16	*Equisetum ramosissimum* Desf. (Equisetaceae)	Branched horsetail	Suuhe	Herb	**Whole plant:** The decoction of the plant is taken orally to treat kidney problem and urinary tract infection
17	*Gynura bicolour* (Roxb. ex Willd.) DC. (Asteraceae)	Okinawan gynura	Chivenyo ga	Herb	**Leaves and stem:** The leaf and the stem are boiled and taken orally for gastritis, stomach-ache and constipation
18	*Houttuynia cordata* Thunb. (Saururaceae)	Chameleon plant	Gatha	Herb	**Whole plant:** The whole plant is consumed raw or cooked to treat diarrhoea and blood pressure
19	*Justicia adhatoda* L. (Acanthaceae)	Malabar nut	Kuku nipu	Herb	**Leaves:** The leaves are boiled in water and the water is used to massage the body to relieve muscle-ache
20	*Laggera crispata* (Vahl) Hepper & J.R.I Wood (Asteraceae)	Curly Blumea.	Naru	Herb	**Leaves and flower:** The flowers and leaves are made into a paste and applied to skin infection and the leaves are also used to treat piles
21	*Leucosceptrum canum* Sm. (Lamiaceae)	Hairy hand-wand	Chitutuga	Shrub	**Leaves and inflorescence**: The white tomentum is scraped from the leaves and applied as a haemostatic and the inflorescence is soaked in water and taken as a tonic
22	*Litsea cubeba* (Lour.) Pers. (Lauraceae)	Mountain Pepper	Cho se	Shrub	**Fruit:** It is used as a stimulant. Fruit is also taken as a spice
23	*Melia azedarach* L. (Meliaceae)	Chinaberry	Khutshe se	Tree	**Leaves:** The leaves are boiled in water and is used for bathing for skin disease

24	*Mimosa pudica* L. (Fabaceae)	Touch-me-not	Kusa nha	Shrub	**Root and leaves:** Leaf and root decoction is used to treat urinary problem. Leaf paste is applied on skin infections
25	*Nicotiana tabacum* L. (Solanaceae)	Tobacco	Muta	Herb	**Leaves:** The leaf paste is used as a haemostatic. The leaves are crushed and mixed with water and used as pesticides
26	*Oxalis corniculata* L. (Oxalidaceae)	Creeping wood sorrel	Zotutu	Herb	**Leaves:** The leaf juice is also used to treat cut wounds. Juice extract from raw leaves is used to wash latex and sap stains from hands
27	*Paederia foetida* L. (Rubiaceae)	Stink vine	Thubu ro	Climber	**Leaves:** The leaf juice is taken for diarrhoea, dysentery and the leaf extract is used to ease ear pain
28	*Passiflora edulis* Sims (Passifloraceae)	Passion fruit	Bell se	Climber	**Leaves:** Leaves are boiled and taken for high blood pressure and treat diabetes
29	*Persicaria capitata* (Buch. -Ham. ex D. Don) H. Gross (Polygonaceae)	Pink knotweed	Kutsugazhi	Herb	**Whole plant:** The whole plant is warmed over fire and applied to treat dislocation of bones
30	*Phyllanthus emblica* L. (Phyllanthaceae)	Indian gooseberry	Tsoho se	Tree	**Fruit:** Fruits are consumed to treat cough, fever and high blood pressure, stimulate appetite, blood purifier. Juice extract from raw fruit is used to treat eye infection
31	*Plantago erosa* Wall. (Plantaginaceae)	Chinese plantain	Gapa	Herb	**Whole plant:** The plant is boiled in water and taken for stomach-ache, dysentery and kidney problem.

32	*Prunus persica* (L.) Batsch. (Rosaceae)	Peach	Mutro o	Tree	**Leaves:** The leaf paste is applied to ring worms
33	*Psidium guajava* L. (Myrtaceae)	Gauva	Muduram	Tree	**Leaves and fruit:** The leaves are consumed raw or as decoction for treating diarrhoea and dysentery. Fruit is also used for controlling diarrhoea
34	*Punica granatum* L. (Lythraceae)	Pomegranate	Turalu se	Shrub	**Leaves:** The leaf decoction is consumed for the treatment of high fever and typhoid
35	*Pyrus pashia* Buch.-Ham. ex. D. Don (Rosaceae)	Wild Himalayan pear	Tsotso se	Tree	**Fruit:** The raw and ripe fruit is consumed for the treatment of diabetes
36	*Ranunculus diffusus* DC. (Ranunculaceae)	Spreading buttercup	Bethimithise	Herb	**Whole plant:** The plant is crushed and applied to wounds
37	*Ricinus communis* L. (Euphorbiaceae)	Castor oil plant	Chotrani	Shrub	**Leaves:** The leaves are warmed over fire and used to massage muscle pain, sprain and body-ache
38	*Rubia sikkimensis* Kurz (Rubiaceae)	Manjitotsod	Sohe	Climber	**Whole plant:** The decoction of the plant is taken for urinary problem
39	*Rubus ellipticus* Sm. (Rosaceae)	Yellow Himalayan raspberry	Tsamhi se	Shrub	**Bark of shoot and root:** The decoction of root and bark is used for stomach-ache
40	*Saccharum officinarum* L. (Poaceae)	Sugar cane	Mutropri	Grass	**Culm:** The juice of the plant is used to treat jaundice and gall bladder problem
41	*Solanum indicum* L. (Solanaceae)	Black nightshade	Tsukhu se	Shrub	**Fruit:** The fruit is taken raw or boiled for the treatment of high blood pressure and fever

42	*Solanum myriacanthum* Dunal (Solanaceae)	Himalayan nightshade	Vuzuni se	Shrub	**Fruit:** The fruit is roasted and the steam is put below the teeth for the treatment of toothache
43	*Sonchus wightianus* DC. (Asteraceae)	Wight's sow-thistle	Gazu	Herb	**Aerial part:** The aerial part is boiled with water and taken for treatment of kidney and high blood pressure
44	*Spilanthes paniculata* Wall. Ex. DC. (Asteraceae)	Toothache plant	Huthinha	Herb	**Inflorescence:** The inflorescence is crushed and applied to control toothache
45	*Urtica ardens* Link (Urticaceae)	Himalayan nettle	Sazuu	Herb	**Leaves:** The fresh leaves are crushed and the paste is applied to treat mumps
46	*Zanthoxylum armatum* DC. (Rutaceae)	Winged prickly ash	Ganyo se	Shrub	**Leaves and fruit:** Soup of leaf/fruit is taken with garlic and chilly to reduce fever, fruit is also used to reduce tooth-ache

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NAGALAND ETHNOBIOLOGY

TRADITIONAL PRACTICES AND CONTEMPORARY RESEARCH

EDITED BY
KENSIBO PAMAI
THEJANUO RHETSO

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PREFACE

Nestled in Northeast India, Nagaland's rich biodiversity and vibrant indigenous practices form the backdrop for this book, '*Nagaland Ethnobiology: Traditional Practices and Contemporary Research'* which presents a comprehensive account of traditional knowledge and contemporary scientific research.

The chapters provide insights into the intrinsic link between its people and nature and emphasize the deep understanding these communities have developed over generations in managing their local ecosystems. The book covers topics ranging from zootherapeutic and ethnomedicinal practices to the consumption of insects and wild edible plants, as well as the diversity of rice, cabbage pest and aquatic insect studies. The book also includes evaluation of fruit quality and DNA barcoding of the Naga Tree Tomato (*Solanum betaceum*) and its invitro regeneration and genetic fidelity, and phytochemical and antimicrobial analysis of *Parkia roxburghii.*

We hope that the book will acts as a bridge between tradition and science, seeking to motivate conservation and empower local communities to protect their ecological heritage. By paying tribute to the work of researchers and indigenous knowledge holders, it promotes the blending of tradition and innovation in the conservation of Nagaland's biodiversity. This book is a call to celebrate and conserve the delicate harmony between humans and nature- a harmony that supports both heritage and ecological resilience.

-K. Pamai & T. Rhetso

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CONTENTS

DIVERSITY OF WILD EDIBLE PLANTS USED BY KONYAK TRIBE IN CHI VILLAGE, MON, NAGALAND

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ABSTRACT

Wild edible plants play a crucial role in providing essential nutrients and other life-sustaining resources in supporting both humans and other organisms. Since time immemorial the people of Chi village rely on nature for their daily necessities and for generations, they have engaged in the collection of wild plants for food and medicine. The aim of this study was to document the indigenous knowledge concerning the uses of wild edible plant, identify native wild species and their uses through semi structured questionnaire, interviews, personal observation and interactions with local informants. A total of 28 wild edible plants were identified belonging to 25 genera and 23 families. The locals relied greatly on the WEPs for their daily needs, fruits (44%) were the most commonly consumed plant part, followed by leaves (29%), seeds (11%), shoots (4%), flower (4%), bark (5%), stem (4%) and whole parts of the plant (4%). Plants like *Entada phaseoloides, Hodgsonia macrocarpa, Caryota urens* were consumed during famine and food shortages. Additionally, *H. macrocarpas, E. phaseoloides* and *Myrica esculenta* were found to have a better prospect in the local market since the seasonal fruit last for a short period of time. These WEPs are of significant value to the tribal community, providing nutrition and a source of income.

Keywords: Chi village, Wild edible plants, Indigenous knowledge

Introduction

Plants that can grow in natural habitats and survive without human intervention are referred to as wild plants. WEPs (wild edible plants) are defined as to those plants that can be consumed as food when harvested at the appropriate developmental stage and processed properly. For centuries, humans have foraged for wild plants to sustain themselves,

with knowledge passed down through generations on which plants are safe to consume, when they are in season, and how to prepare them for maximum benefit. These plants play a crucial role in providing essential nutrients and other life-sustaining resources, supporting both humans and other organisms (Sawian, 2007).

People have been using WEPs for thousands of years but yet many remain unexplored (Bhatia *et al.,* 2018). Wild edible plants have played a significant role in human society particularly for medicine and food due to their higher nutritional content, as a source of vitamin and mineral supplement (Patil, 2017). In addition to their nutritional value, WEPs can generate income through the sale of fruits, leaves, barks, roots etc. offering employment opportunities, especially in rural areas. Despite their importance, many rural populations remain unaware of the value of these plants which are often used as food supplements for survival during times of famine and drought (Duguma, 2020). While the nutritional, ecological and socioeconomic benefits of WEPs have gained recognition in recent decades, they remain underappreciated and underutilized in many regions due to ongoing modernization and globalization.

Today, when food crops are limited, WEPs continue to be crucial for ensuring food security. Wild plants grow abundantly in forests, fields and even urban spaces, offering a variety of flavors and nutrients. Additionally, WEPs can play a key role in empowering local vendors and reducing dependency on global value chains by reducing the gap between producers and consumers. Despite the capacity of the global food system to meet nutritional needs, many people remain hungry due to unaffordable price and lack of access to nourishing diets, while heavily processed foods pose health risks (Motti, 2020). Furthermore, challenges such as poor crop yields, rising rates of healthy foods, malnutrition, food insecurity and a lack of food supplies highlights the need for alternative food sources. In this context, WEPs have substantial potential to support global food security, meet nutritional requirements needs and alleviate the economic burdens of impoverished communities, particularly in rural areas (Pinela et al., 2017).

Nagaland which comes under the Indo-Burma Biodiversity hotspot, has a rich biodiversity with 52% forest cover (Ministry of Environment, forest & climate change, 2021). Chi village is a town under Mon district of Nagaland. It is inhabited by the Konyak tribe, the village is situated in a hill area surrounded by lush green forest that serve as a natural habitat for variety of wild plants. Many of the locals depend on the forest for their household income generation and daily day-to-day life, WEPs plays a major role to meet the needs for the individuals living in low income. The knowledge on the different uses of these wild edible plants has been passed down from generation after generation.

The aim of this study was to identify and document the traditional knowledge of the local people, offering insights into cultural perceptions and their uses as food and medicine in Chi village.

Materials and Methods

Study Area

The study was carried out at Chi village of Mon district. The village is located at Mon Sadar Circle of Mon district, situated 8 km away from the district headquarter Mon at an elevation range of 290 to 1800 metres above sea level. The climate conditions in Mon district vary substantially from place to place due to wide differences in altitudes. The average annual rainfall ranges from 2000 mm to 3000 mm, mostly occurring between May and October. Winter is very cold with minimum temperature up to 4ºC. Summer is moderately warm with temperature ranges from 21 to 40ºC. The average temperature is 24.4ºC and the relative humidity is 76%.

Field survey and data collection

A field survey was conducted from January to April 2023 in the forest area of Chi village to document wild edible plants. The wild edible plants were identified and collected with the help of locals from their habitat. Further the local name, knowledge on plant usage and the value of different plant parts etc. were obtained from the locals, village elders, vendors etc. through interview and questionnaire. In addition, a visit was made to two local market New Site and Bazar line. The collected plants

were further verified from the Department of Botany, Patkai Christian College (Autonomous), Chümoukedima-Seithekema, Nagaland.

Results and Discussion

The wild edible plants used by the people of Chi village are diverse. In the present study a total of 28 species (Figure 1) belonging to 25 genera and 23 families were documented. Ethnobotanical information of the wild edible plants, scientific name, family, common name, local name, habitat, edible part and the utilization patterns are listed in Table 1.

The WEPs in Chi village comprises of 5 groups, trees (12 species), shrubs (4 species), climbers (2 species), herbs (9 species) and mushroom (1species), the WEPs were dominantly from Moraceae, Arecaceae, Apiaceae, and Rutaceae families (Figure 2). The tribals gather (Figure 4) and consume the WEPs in many different traditional ways, the most common parts consumed were the fruits and leaves. The tribals predominantly consume the WEPs raw followed by cooking, soaking, after fermentation and drying (Figure 3) as vegetables, fruits, as a flavoring agent in culinary for nutrition and treating various ailments. The locals had extensive knowledge on the processing of the plants before consumption to eliminate toxicity, bitterness, or unsuitable parts, making the food more palatable, many of these dietary practices preserve traditional knowledge on the uses of WEPs.

Fruits

A total of 12 different types of fruits belonging to Moraceae (3 species) and 1 species each from Anacardiaceae, Phyllanthaceae, Arecaceae, Combretaceae, Rosaceae, Burseraceae, Cucurbitaceae, Myricaceae and Melastomataceae were recorded. All the fruits were consumed raw except for *R. semialata* where the fruits were sundried and crushed for consumption, decoctions are used to cure stomachache. *Phyllanthus emblica* fruits are often consumed raw or boiled and then processed to make pickle, it is also used in treating insomnia, boost immunity, improves eyesight etc. *Ficus auriculata* are used in preparing jam and *R. idaeus* for juice. Ripe fruits of *M. malabathricum* are directly consumed and also used for treating diarrhea, dysentery and stomachache. The

ripped fruits of *Canarium strictum* are directly consumed and also used as anti-diabetic.

Leafy vegetables

A total of 9 plants with leaf as the edible parts were recorded. The tender fronds of *D. esculentum* are blanched or boiled or stirred fried and consumed. The leaves of *B. roxburghii* are favored for their acidic taste and are also used in curry to substitute fermented bamboo shoots; it also used for treating dysentery, jaundice, skin infection and gastric ulcer. The tender shoots of *B. vulgaris* are sliced into thin strips and boiled to remove the toxin and bitter components; after boiling the water is drained off and the tender shoots are used to prepare curries. The fresh leaves of *E. foetidum* and *H. cordata* are used as seasoning in culinary which also prevents stomachache. The leaves of *C. asiatica* are consumed raw or cooked, it is also used to reduce high blood pressure. The fresh leaves of *Z. rhetsa* are used in culinary as a flavoring agent, the leaves are also dried and preserved for garnishing. The fresh leaves of *P. major* are cooked and consumed also used to treat kidney problems. The *C. colebrookianum* are blanched and cooked for consumption.

Seeds

The seed of *Z. armatum* are sundried and use as spice in culinary, it was also found to be most commonly used in the household due to its medicinal purposes, its decoctions are used to treat stomach ailments, sore throat and cough with other spices. The seeds of *H. macrocarpa* are roasted or baked and fermented to be used as a flavoring agent in curries. The matured seeds of *E. phaseoloides* are roasted, the extracted kernels are soaked in water overnight to remove toxins, it is then consumed as salads; the crushed seeds are used as shampoo and in treating allergies. The seeds of *A. dealbatum* are consumed as mouth freshener and as flavoring agent in curries.

Others

The tender parts of *M. acuminata* flowers are consumed after cooking. The bark of *C. cassia* is sundried and use as spice in culinary and used as anti-diabetic. The trunk of *C.* urens outer bark is removed, then the inner part is cut into pieces and sun dried, it is then pounded into flour

which is then used in making bread. The locals also reported that *E. phaseoloides, H. macrocarpa and C. urens* were consumed during famine and food shortages. *Auricularia auricula-judae* a wood ear mushroom the whole body is cooked and consumed.

Beside their vital role in daily livelihood, wild fruits like *H. macrocarpas, E. phaseoloides,* and *M. esculenta* were in demand in the local market since the seasonal fruit last for a short period of time. Wild edible plants, *P. emblica, Z. rhetsa, E. phaseoloides, H. macrocarpa, M. esculenta, C. asiatica, H. cordata,* and *C. urens* have good prospects in the local market and also contribute greatly in uplifting the economy of the region (Figure 5).

Conclusion

The study conducted an ethnobotanical survey of WEPs in Chi village of Mon district, recording 28 species belonging to 25 genera and 23 families and their traditional way of utilizing the WEPs for their daily purposes. The local community had a wide knowledge on the uses and palatability of 28 species as well as their habitat, distribution and harvesting seasons.

Although jhum cultivation is their primary occupation, it has been found that the local populace was reliant on the plants that naturally occurred in their surroundings. The market value of these plant species provides families in need with excellent means of revenue production and job prospects. Additionally, these three plants *H. macrocarpas, E. phaseoloides,* and *M. esculenta* were found to have a better prospect in the local market since the seasonal fruit last for a short period of time (Figure 5). In addition to being essential for the survival of sociocultural traditions and the food system, wild plants have also been an essential component of their diet.

However, over usage of wild plants can harm the local diversity and make it less likely that these species would persist in their natural habitats. According to the indigenous people, the main causes contributing to the high threat level for wild edible plants includes human activity such as firewood collection and agricultural expansion, as well as relatively ineffective conservation efforts to safeguard wild plants. As

a result, action must be taken to conserve and utilize plant species in a sustainable way.

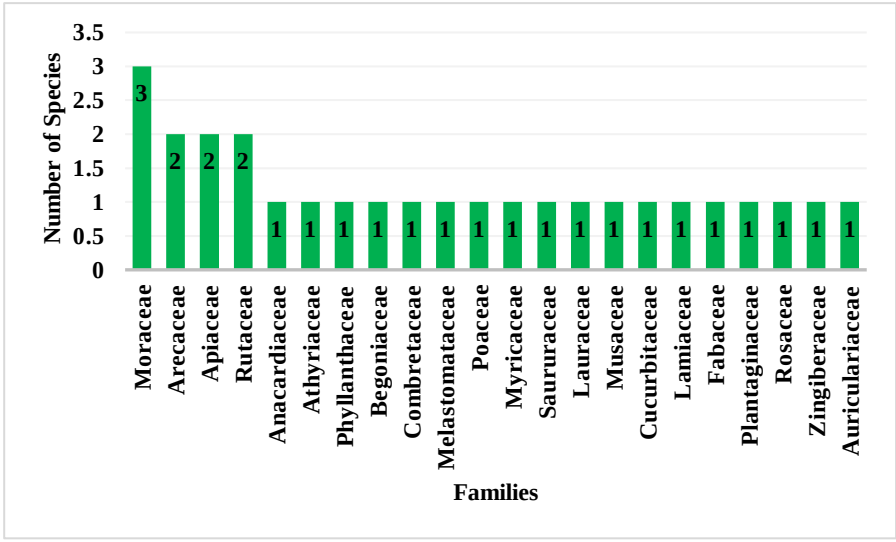

Figure 2: Family wise number of ethnobotanical wild edible plants

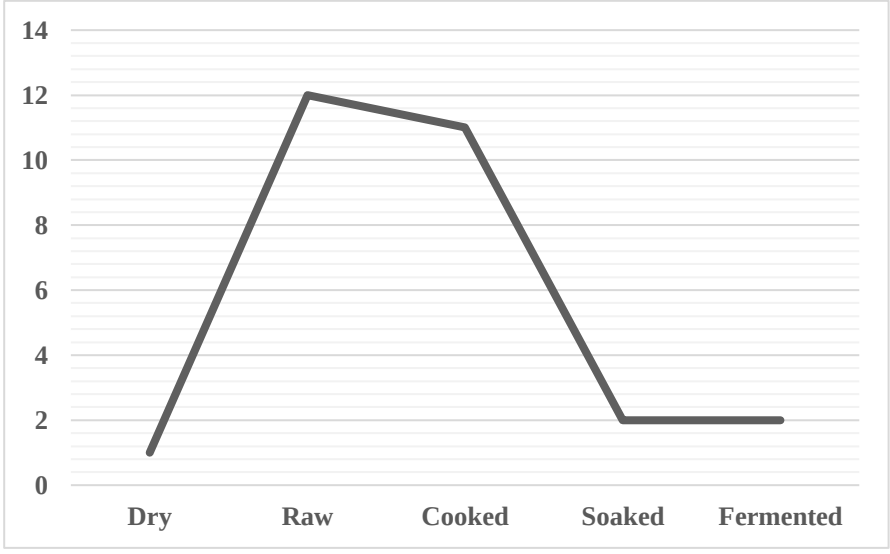

Figure 3: Mode of consumption

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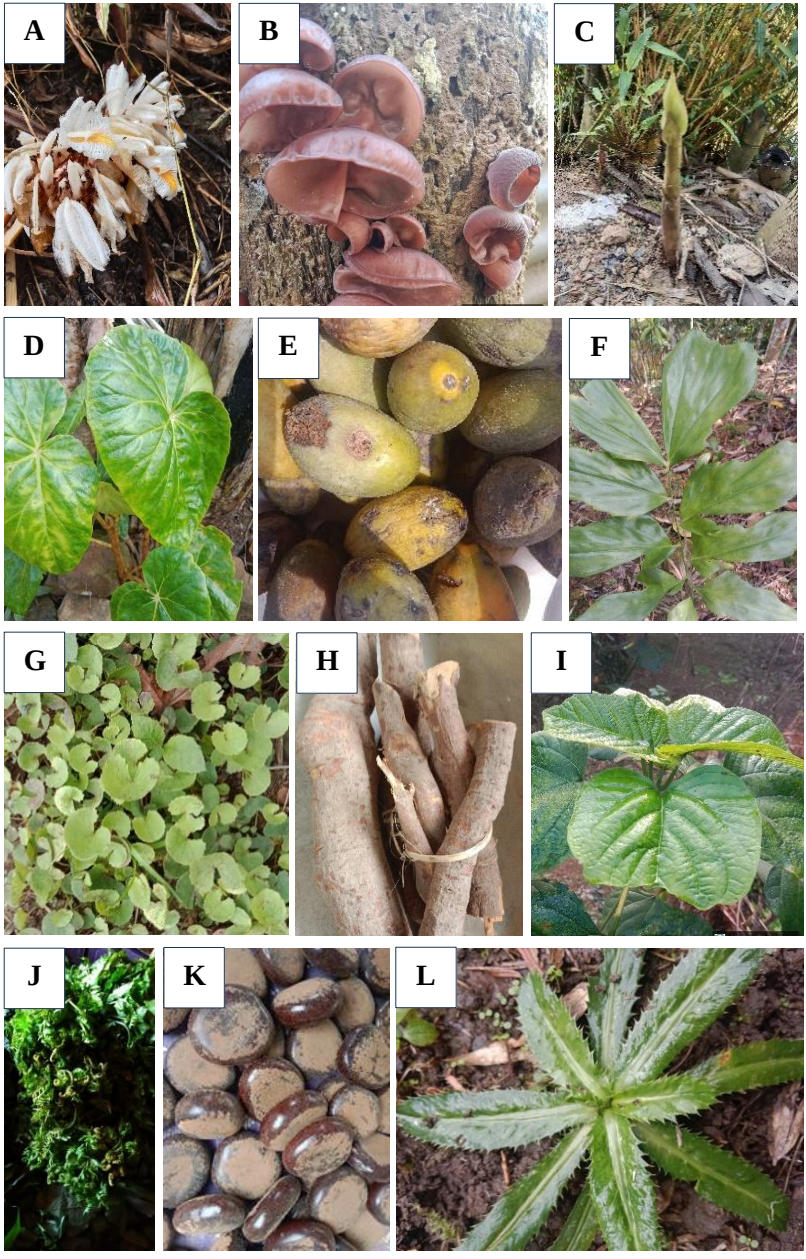
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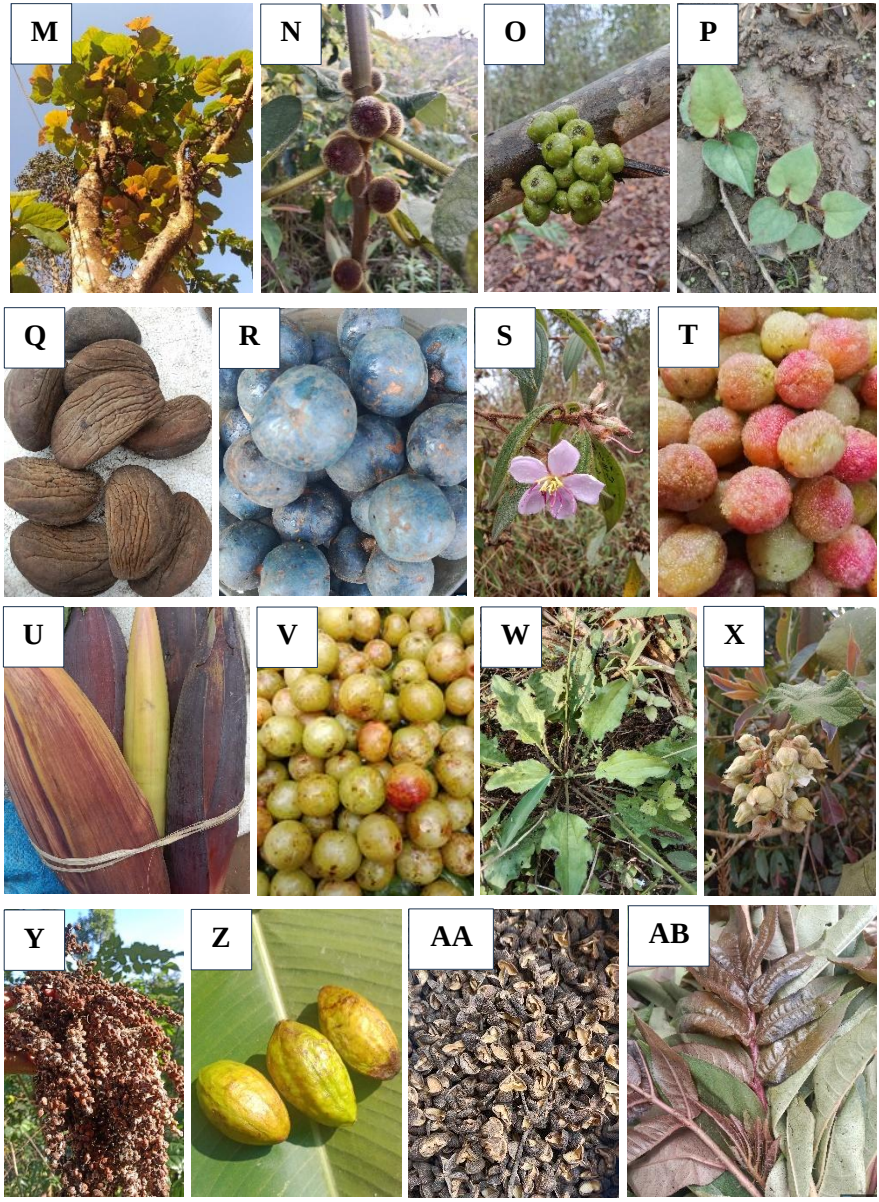

Figure 1: Wild Edible Plants of Chi village (A) *Amomum dealbatum* Roxb.; (B) *Auricularia auricula-judae*; (C) *Bambusa vulgaris*; (D) *Begonia roxburghii A. DC.*; (E) *Canarium strictum* Roxb.; (F) *Caryota urens* L.; (G) *Centella asiatica* (L.) Urban; (H) *Cinnamomum cassia* (L.) J. Presl.; (I) *Clerodendrum colebrookianum* Walp.; (J) *Diplazium esculentum* (Retz.) Sw.; (K) Entada *phaseoloides* (L.) Merr.; (L) *Eryngium foetidum* L.; (M) *Ficus auriculata* Lour.;

(N) *Ficus hirta* Vahl.; (O) *Ficus nota* (Blanco) Mer.; (P) *Houttuynia cordata* Thunb.; (Q) *Hodgsonia macrocarpa* (Bl.) Cogn.; (R) *Livistona jenkinsiana* Griff.; (S) *Melastoma malabathricum* L.; (T) *Myrica esculenta* Buch.-Ham. ex D. Don; (U) *Musa acuminata Colla*; (V) *Phyllanthus emblica* Linn.; (W) *Plantago major* L.; (X) *Rubus ideaus* L.; (Y) *Rhus semialata* Murr.; (Z) *Terminalia chebula* Retz.; (AA) *Zanthoxylum armatum* DC.; (AB) *Zanthoxylum rhetsa* (Roxb.) DC.

Figure 4: Tribals collecting wild edible plants

Figure 5: Tribals selling wild plants along with cultivated plants

Table 1: Enumeration of ethnobotanical plants and their utilization pattern

S. No.	Scientific name and family	Common name	Local name	Habitat	Edible part and utilization pattern
1	*Amomum dealbatum* Roxb. (Zingiberaceae)	East-Himalayan Cardamom	Nakali elaichi	Herb	**Seed:** Ripped seeds are harvested and consumed as mouth freshener and as a flavoring agent in curries
2	*Auricularia auricula-judae* (Bull.) (Auriculariaceae)	Wood ear	Pintu	Mushroom	**Whole plant body:** The whole plant is directly cooked and consumed
3	*Bambusa vulgaris* (Poaceae)	Bamboo shoot	Maay	Grass	**Shoots:** Tender shoots are consumed after cooking
4	*Begonia roxburghii* A. DC. (Begoniacea)	East Himalayan begonia	Rhoithu	Herb	**Leaves:** The leaves are used in curry as a substitute for fermented bamboo shoots due to its acidic flavors. It is also used for treating dysentery, jaundice, skin infection and gastric ulcer
5	*Canarium strictum* Roxb. (Burseraceae)	Raal	Kong	Tree	**Fruit:** Ripped fruits are directly consumed and also used as anti-diabetic
6	*Caryota urens* L. (Arecaceae)	Fish tail palm	Lok	Tree	**Trunk:** Outer bark is removed, then the inner part is cut into pieces and sun dried, it is then pounded into flour which is then used in making bread

7	*Centella asiatica* (L.) Urban. (Apiaceae)	Indian pennywort	Hingshaak	Herb	**Leaves:** Consumed as a vegetable and to reduce high blood pressure
8	*Cinnamomum cassia* (L.) Urban (Lauraceae)	Chinese cinnamon	Longkhok	Tree	**Bark:** Barks are used in culinary purposes and also as anti-diabetic
9	*Clerodendrum colebrookianum* Lindl. (Lamiaceae)	East Indian glory bower	Bangmik	Shrub	**Leaves:** Fresh leaves are blanched and consumed
10	*Diplazium esculentum* (Retz.) Sw. (Athyriaceae)		Taak	Herb	**Young tender fronds:** Tender fronds are blanched, boiled or stir-fried for consumption
11	*Entada phaseoloides* (L) Merr. (Fabaceae)	St. Thomas Bean	Gihoak	Climber	**Seeds:** Mature seeds are roasted and the outer hard coverings are removed, it is then soaked overnight to remove bitterness and other toxins. It is consumed as salads; crushed seeds were used as shampoo and in treating allergies
12	*Eryngium Foetidum* L. (Apiaceae)	Burmese cilantro	Rhoinyae	Herb	**Leaves:** Fresh leaves are used as seasoning in culinary to prevent stomachache
13	*Ficus auriculata* Lour. (Moraceae)	Broad leaf fig	Bhookju	Tree	**Fruit:** Ripped fruit are consumed with skin and seed intact and are also cooked to prepare jam
14	*Ficus hirta* Vahl. (Moraceae)	Hairy fig	Bhookrha	Tree	**Fruit:** Ripped fruit are consumed with skin and seed intact
15	*Ficus nota* (Blanco) Merr.	Tibig	Bhookrha	Tree	**Fruit:** Ripped fruit are consumed with skin and seed intact

	(Moraceae)				
16	*Hodgsonia macrocarpa* (BI.) Cogn. (Cucrbitaceae)	Chinese Lard Seed	Pai	Climber	**Fruit:** After removing the cover, the inner part is roasted, further second layer is removed. After which the whitish innermost part is boiled and fermented in bamboo tube. It is used as a flavoring agent in curries
17	*Houttuynia cordata* Thunb. (Saururaceae)	Chameleon plant	Yantu	Herb	**Leaves:** Fresh leaves are directly use in culinary as fresh herbal garnish
18	*Livistona jenkinsiana* Griff. (Arecaceae)	Taraw palm	Loahliak	Tree	**Fruit:** The fruits are consumed after soaking in warm water with salt till it's outer cover softens
19	*Melastoma malabathricum* L. (Melastomataceae)	Blue tongue	Kaikhee	Shrub	**Fruit:** Ripe fruits are directly consumed and also used for treating diarrhea, dysentery and stomachache
20	*Musa acuminata* Colla (Musaceae)	Wild banana	Ngoshoi	Herb	**Banana blossom:** After removing the hard covers the soft, tender parts are consumed after cooking
21	*Myrica esculenta* Buch.-Ham ex D. Don ***(***Myricaceae***)***	Bayberry	Iin	Tree	**Fruit:** The berries are directly consumed. It also helps to treat indigestion
22	*Phyllanthus emblica* Linn. (Phyllanthaceae)	Indian Gooseberry	Phaang	Tree	**Fruit:** The fruit is often eaten raw or boiled and then processed to make pickled. It is used in treating insomnia, boost immunity, improves eyesight etc.

23	*Plantago major* L. ***(***Plantaginaceae***)***	Broad leaf plaintain	Hingshaak	Herb	**Leaves:** Fresh leaves are directly used in culinary and also use to treat kidney problems
24	*Rhus semialata* Murr. (Anacardiaceae)	Sumac	Abah	Tree	**Fruit:** The fruit are consumed after drying in sunlight, then crushed or pounded. The decoction of it is therapeutically valued for treating stomachache
25	*Rubus idaeus* L. Rosaceae)	Raspberry	Huhhoi	Shrub	**Fruit:** Fresh fruits are consumed raw and also used in preparing juice
26	*Terminalia chebula* Retz. (Combretaceae)	Black or Chebulic myrobalan	Lingkhah	Tree	**Fruit:** The fruits is directly eaten raw, especially for treating stomachache
27	*Zanthoxylum armatum* DC. (Rutaceae)	Rattan pepper	Maakat	Tree	**Seeds:** Ripe fruits are dried and used as spice in culinary
28	*Zanthoxylum rhetsa* (Roxb.) DC. (Rutaceae)	Indian prickly ash	Rharrhoi	Shrub	**Leaves:** Fresh leaves are cooked and consumed; it can also be used after drying in the sun

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CHAPTER-5

QUALITATIVE ANALYSIS OF AQUATIC INSECT COMMUNITIES IN KHONOMA AND ADJACENT HABITATS

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ABSTRACT

This study conducted from October 2017 to March 2018 in Khonoma, and its surrounding areas. A total of 21 genera from 18 families and 7 orders (Ephemeroptera, Odonata, Plecoptera, Hemiptera, Trichoptera, Coleoptera, Diptera) were recorded. Streams/rivers exhibited higher diversity with 14 genera, dominated by Coleoptera (21.0%), while ponds were dominated by Hemiptera (64.0%). Key taxa such as *Ischnura* sp. (Odonata) and caddisflies (Trichoptera) were consistently present across all months. Orders like Ephemeroptera, Plecoptera and Trichoptera were exclusive to streams, reflecting their sensitivity to pollution and preference for oxygen-rich habitats. Hemiptera, the most abundant order (33.3% overall), thrived in ponds due to their adaptability to stagnant conditions. Seasonal variations revealed peak diversity during post-monsoon and winter months, aligning with nutrient availability and stable water conditions. The study highlights the role of aquatic insects as bioindicators, with taxa like *Acroneuria* sp. (Plecoptera) and flathead mayflies signalling good water quality in streams. Conversely, the dominance of pollution-tolerant genera like *Baetis* sp. in certain habitats shows ecosystem stressors. Findings align with global patterns of Hemiptera prevalence in lentic systems and stress the ecological significance of aquatic insects in food webs and organic matter cycling. This research reinforces the need for conservation of Khonoma's freshwater ecosystems, emphasizing continuous monitoring to mitigate threats from anthropogenic activities and climate change.

Keywords: Aquatic insects, Khonoma, Bioindicators, Hemiptera dominance, Stream ecosystems

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PREFACE

Nestled in Northeast India, Nagaland's rich biodiversity and vibrant indigenous practices form the backdrop for this book, '*Nagaland Ethnobiology: Traditional Practices and Contemporary Research'* which presents a comprehensive account of traditional knowledge and contemporary scientific research.

The chapters provide insights into the intrinsic link between its people and nature and emphasize the deep understanding these communities have developed over generations in managing their local ecosystems. The book covers topics ranging from zootherapeutic and ethnomedicinal practices to the consumption of insects and wild edible plants, as well as the diversity of rice, cabbage pest and aquatic insect studies. The book also includes evaluation of fruit quality and DNA barcoding of the Naga Tree Tomato (*Solanum betaceum*) and its invitro regeneration and genetic fidelity, and phytochemical and antimicrobial analysis of *Parkia roxburghii.*

We hope that the book will acts as a bridge between tradition and science, seeking to motivate conservation and empower local communities to protect their ecological heritage. By paying tribute to the work of researchers and indigenous knowledge holders, it promotes the blending of tradition and innovation in the conservation of Nagaland's biodiversity. This book is a call to celebrate and conserve the delicate harmony between humans and nature- a harmony that supports both heritage and ecological resilience.

-K. Pamai & T. Rhetso

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CONTENTS

CHAPTER-6

DIVERSITY OF RICE, ITS CULTIVATION AND USAGE PATTERN IN JALUKIE 'B' VILLAGE, PEREN DISTRICT, NAGALAND

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ABSTRACT

Jalukie 'B' village is a part of the Jalukie valley which is also known as the "Rice Bowl of Nagaland" is inhabited by the Zeliang tribe, rice is the primary source of food; the local people practice both jhum and wet paddy cultivation. The study conducted an extensive survey by identifying, documenting and interviewing locals using questionnaire on the lifecycle, yield, post-harvest management and usage pattern. The study found that the wet paddy cultivation was preferred over jhum cultivation due to its high productivity and good water sources from Mongleu and Keleireu rivers. The rice plantation starts by May and harvesting period starts by early November till December. Keimdai rei keha and Keimdai rei ketik had the shortest lifecycle while rice varieties and cultivar like Kemne, Kemne mei tik and Mei tik, had the longest lifecycle. The highest yielding cultivars were Mei tak and Ranjit Kedui, with a yield of 120 tin per acre. The tallest paddy was Mei gei (169 cm), and the shortest was Gotkha rei (116 cm). Local farmers store rice in Hebauki (rice granary) for 3-5 years and use neem leaves, ashes, and warm water to prevent bacterial, fungal and insect infestations. The locals predominantly preferred glutinous rice for their aroma, flavour, unique taste and its use in important events and festivals. Our study suggests that, in addition to adopting high yielding varieties, the people of Jalukie 'B' village must focus on preserving traditional landraces to prevent the genetic erosion.

Keywords: Jalukie 'B', Rice diversity, Cultivation, Utilization pattern

Introduction

Oryza sativa L. commonly known as rice is a semi-aquatic, annual grass plant belonging to the class Liliopsida of angiosperm, order Poales,

family Poaceae, and genus *Oryza*. The genus *Oryza* is best known for its two cultivated species, *O. sativa* L. or Asian rice, and *O. glaberrima* Steud. or African rice. The *O. sativa L*. is cultivated worldwide in various agro-ecosystems, while *O. glaberrima Steud*. is predominantly found in South Africa (Mohapatra & Sahu, 2022).

Rice is an important cereal crop and the staple food for more than half of the world's population (Umadevi et al., 2012). Rice is an essential dietary component for over 3.5 billion people worldwide, making the most important agricultural crop used by humanity (Bates, 2022). Rice is a very significant food crop in India, and it covers the world's largest land area of 44.3 million hectares (Yeptho et al., 2023).

Agriculture, particularly rice cultivation is the main source of food to the Nagas occupying approximately 86 % of the state's arable, shifting cultivation covers about 56.50% of the area and accounts for 49.26 % of the total rice yield; the total rice cultivation area in Nagaland spans 1,81,400 hectares, yielding 318 thousand tonnes (Yeptho et al., 2023). Though the Naga farming system are very primitive and old yet it is still deeply engraved in the life of local farmers. Traditional practices, like terrace and jhum cultivation, are prevalent and rely heavily on monsoon rains.

Jalukie 'B' is a village in Jalukie Valley, Peren District, Nagaland, India, and is renowned as the "Rice Bowl of Nagaland" (https://www.peren-district.nic.in) known for its fertile soil, abundant water sources, good landscape and favourable climatic condition. The Zeliang tribe are the inhabitants and they practice indigenous method of jhum and wet paddy method of rice cultivation. The locals cultivate cultivars (improved variety) as well as landraces (variety). Each rice cultivars and variety grown have its own unique taste, texture, and nutritional profile, contributing to the dietary needs of the villagers and offering a palette of flavours.

This study ventures on to explore the diverse rice varieties and cultivars; their morphological and agronomic traits, as well as their ecological and cultural niches. Studying the diversity of rice, methods of cultivation,

harvesting and post-harvest management can help us understand this vital food crop better, and its role in food security and culture.

Materials and Methods

Study Area

The study was conducted at Jalukie 'B' village, Peren, Nagaland, India located at latitude of 25°37'42.077"N and longitude is 93°41'0.419"E and altitude of 362 m (about 1187.66 ft) above sea level. The average annual rainfall ranges around 200-250 cm. The average temperature ranges from 25°C-33.65°C during summer season and 6°C–23°C during winter season.

Data collection

An extensive survey was conducted in Jalukie 'B' village through field visits, during the month of August 2023-April 2024. The local informants were interviewed using a semi-structured questionnaire to collect the data on the lifecycle, yield, usage patterns and post-harvest management. All the data and information recorded was authentically obtained from the local farmers.

Handling of specimens and Herbarium preparation

Healthy rice plants were collected by manual hand-picked method from the rice fields. Herbariums were prepared using Jain & Rao (1997) technique.

Identification

The collected plants were first identified in the field through the vernacular names from the local informants. Further their morphologies were studied by referring scientific journals to determine their variety and cultivar names which were then verified through a taxonomist from ICAR-KVK Peren and Department of Botany, Patkai Christian College (Autonomous), Chümoukedima-Seithekema, Nagaland.

Results and Discussion

Rice Diversity

In the present study, a total of 11 rice cultivars and 2 varieties (Figure 1) were identified belonging to the family of Poaceae. The local people practice wet paddy cultivation due to higher yield and abundant water

sources from Mongleu and Keleireu river. Jhum cultivation is also practiced in some areas but less preferred due to its intense labor work and low yield. The cultivars and variety could be differentiated from their husk, aroma, size etc. Colored rice husk are produced by cultivars and varieties like Mei gei, Mei tik, Hegwang mei, Keimdai rei keha, Keimdai rei ketik and Kemne mei tik these colors are due to the presence of anthocyanin pigments on the husk of the rice grains (Priya et al., 2019). The characteristic features of each rice husk are in Table 1.

Table 1: Characteristic feature of rice husk in cultivars and varieties

	Variety/ cultivar name	**Vernacular name**	**Husk**
Varieties	Gom dhan	Kemne	Brownish black husk
	Kala gom dhan	Kemne mei tik	Husk and inner grain both are black
	Lal dhan	Mei gei	Brownish red husk
	Raja dhan	Hegwang mei	Brownish yellow husk
	Kala dhan	Mei tik	Black husk
	Boga dhan	Nki rei	Light golden yellow husk
Cultivars	Kala joha	Keimdai rei ketik	Brownish black husk
	Boga joha	Keimdai rei keha	Brownish yellow husk
	Gotkha dhan	Gotkha rei	Golden yellow husk
	Ranjit	Ranjit kete	Golden yellow husk
	Ranjit	Ranjit kedui	Yellowish brown husk
	Bahadur	Mei tak	Golden white husk
	Ponkosh	Arai rei	Golden yellow husk

The rice varieties and cultivars were further categorized into glutinous, non-glutinous and special rice. The glutinous rice is sticky in nature due to the presence of Amylopectin (Wang et al., 2023). The locals preferred this variety due to its aroma, flavour and unique taste; it is used in important events and festivals holding cultural significance. Non-glutinous rice is simply the regular rice and is the most common type of rice cultivars grown in the area. The cultivars are Mei tak, Gotkha rei,

Ranjit kete and Kedui and Arai rei are favoured by the farmers due to its high yielding traits and high demand. It is fluffy when cook and consumed on daily basis. Special rice is a broad term that consist of several cultivars, some of special rice cultivars are Keimdai rei keha and Keimdai rei ketik, they are preferred for their distinctive fragrances and high demand. These cultivars of rice are usually consumed on the special occasion, events and during festivity. They are commonly cultivated and preferred by all the local farmers due to their vibrant colors, good taste and soft traits. Mei tik and Hegwang mei are often cooked on special events or occasion to honour the guests.

Indigenous practice of paddy cultivation, yield and post-harvest management

The local farmers soak the rice seed on the first week of May for 1-3 days for germination, during this period the farmers prepare the nursery seed beds on well-drained land. The soaked seeds are sown on the nursery beds, after 20-25 days the seedlings are uprooted and transplanted to the wet paddy and jhum fields. The seed development starts in the month of September, and seed ripening by October to last week of November. The harvest starts by first week of November to last week of December depending on the cultivars and varieties.

Out of all the rice cultivars cultivated in the area Keimdai rei keha and Keimdai rei ketik has the shortest lifecycle, cultivated in the month of May and harvested in the first week of November. They are preferred by the farmers due to its high price and short life cycle (Figure 1). Singh et al. (2024) reported early harvest in November in Assam which is in par with Jalukie. The varieties and cultivars with longest lifecycles were Kemne, Kemne mei tik, and Mei tik harvested in the last week of November to first week of December. Besides their long lifecycle they are favoured by the farmers due to their high price and good taste.

The highest yielding cultivars were Mei tak and Ranjit Kedui, which has a staggering yield outcome of 120 tin per acre. These cultivars were developed by the Indian Council of Agriculture Research and International Rice Research Institute by crossing Ranjit and Swarna Sub1 cultivars, they are also flood, pest and insect resistant which is preferred

by the farmers over the other cultivars (Chetia et al.,2018, Gautam et al., 2018). The lowest yield variety and cultivar were Kemne mei tik and Keimdia rei ketik. The tallest paddy was Mei gei measuring a height of 169 cm or 5.54 ft, the shortest paddy was Gotkha rei standing at 116 cm or 3.80 ft. The majority of the paddy plant heights were around 4-5.5 ft.

The local farmers use metal container called Tinibung and Ntui (locally made bamboo basket) for measuring the yield of the rice, they usually have a capacity of around 12 kg (Figure 2). The locals store their rice in Hebauki (traditional rice granary_Figure 3), made from bamboo and straw, the shed provides aeration and prevents moisture accumulation, the rice paddy are usually stored for 3-5 years. The locals use several measures to prevent post-harvest infestation. Neem leaves are hanged to prevent bacterial and fungal growth in the granary, ashes are spread around the granary to prevent insect infestation, warm water is poured on the post of granaries to prevent termite infestation. Metal mesh and mosquito nets are placed on the ventilations to prevent bird's from eating the rice grains.

Utilization pattern

Rice is the main source of food in Jalukie 'B' as their day start with rice in the morning and end with rice at night. Rice is used to prepare different delicacies like cake, porridge, beer, sticky steam rice, rice flour, etc. Kemne mei tik, Mei gei, Mei tik and Hegwang mei are the rice varieties and cultivars used in the events, festivals and community gatherings and also the most popular rice cultivars in the area (Figure 4).

Sticky tortilla made from sticky rice variety like Kemne is one of the famous delicacies in the local community. Puff fried rice and puff rice are consume as a snack which are both made from Mei gei rice cultivar. Sticky steam rice is made from rice varieties like Kemne and Kemne mei tik which has a good aromatic scent. Rice like Kemne and Mei gei are used in making rice cake, tortilla and baby porridge.

Traditional rice beers are also made from all rice varieties and cultivars, special rice produces better quality rice beer which are used in weakness to provide energy and strengthen the body. Rice is also used for

medicinal purpose; white rice is consumed to improve gastrointestinal problem, porridge and glutinous rice are consumed during weakness to provide energy and strengthen the body. The soaked rice water is used to wash and treat the hair problems. The fine ground rice flour is used to treat skin inflammation, it has a cooling and soothing effects for conditions like small pox and measles. It is also used in treating diarrhoea in children.

Table 2: Rice specialty and its utilization

Vernacular Name	Specialty	Utilization Pattern
Kemne	Aromatic, good taste, glutinous	Used in making rice beer, stickysteam rice, sticky-rice cake, sticky tortilla, rice flour
Kemne mei tik	Aromatic, good taste and color, soft and glutinous	Used in making sticky rice cake, sticky steam rice,rice beer, tortilla,rice flour
Mei gei	Good taste	Used in making puff rice and boil rice
Hegwang mei	Good taste	Used in making puff rice and boil rice
Mei tik	Good taste and soft	Used in making rice beer, cooked and eaten on daily basis, used in rice dish with meat and vegetables
Nki rei	Good taste and soft	Used in making rice beer, cooked and eaten on daily basis
Keimdai rie ketik	Good taste and aromatic	Used in making rice beer, mixed with other rice variety and cook and consumed on occasions
Keimdai rei keha	Good taste and aromatic	Used in making rice beer, cooked and consumed on occasions
Gotkha rei	High yield	Cooked and consumed on a daily basis, used as glue, and in making rice beer

Ranjit kete	High yield	Cooked and consumed on a daily basis, used as glue, and in making rice beer
Ranjit kedui	High yield	Cooked and consumed on a daily basis, used as glue, and in making rice beer
Mei tak	High yield	Cooked and consumed on a daily basis, used as glue, and in making rice beer
Arai rei	High yield	Cooked and consumed on a daily basis, used as glue, and in making rice beer

Conclusion

The present research presents a comprehensive study on the diversity of rice cultivated in Jalukie 'B' village of Peren district. Rice is the primary source of food as well as the main product of agriculture in the area. Both jhum and paddy cultivation was found to be in practice in the region. The farmers in the area preferred wet paddy cultivation as it is more economical, resourceful and less labour intensive than the jhum cultivation. Some farmers still continuing jhum fields practice mix cropping with other food crops and vegetables.

The study found a profound connection between the people of Jalukie 'B' village and rice. The utilization of rice goes beyond just consuming rice. Different rice cultivars and varieties are used and chosen for specific purposes, reflecting cultural significance. This knowledge ensures a balance diet and strengthen the cultural identity. Rice is a crucial commodity as it brings the people together in times of festivity and community gatherings. Special rice is gifted to the newlyweds couples to mark their new beginning as a sign of prosperity and good health. Rice also plays an important role at the time of death; special varieties and cultivars of rice are presented to the bereaved family to show their love and respect. Traditional rice utilization and post-harvest management practices holds immense value for ensuring food security and culture continuity.

Our study suggests that, in addition to adopting high yielding varieties, the people of Jalukie 'B' village must focus on preserving traditional landraces to prevent the genetic erosion. The villagers have increasingly adopted high yielding improved rice varieties (11 cultivars), and in our survey we found only two local varieties, Kemne and Kemne mei tik. The farmers preferred the cultivars over varieties for their higher yield, disease resistance, faster growth, better quality, adaptability and economic profit. Focusing only on the improved varieties will reduce the genetic diversity of rice in the area, making crops more vulnerable to pests, diseases, or changes in climate. Local varieties often have cultural significance and are adapted to traditional farming systems. Their replacement could lead to a loss of cultural heritage and local agricultural knowledge. Furthermore, it is important to preserve the indigenous rice varieties, which can ensure food security and safeguard cultural heritage of the community.

Acknowledgement

The authors are thankful to the villagers and the local farmers of Jalukie 'B' village for sharing their valuable knowledge. The authors are also grateful to the ICAR-KVK Peren and Department of Botany, Patkai Christian College (Autonomous), Chümoukedima-Seithekema, Chümoukedima District, Pin- 797103, Nagaland, India for their help in identifying the rice varieties and cultivars.

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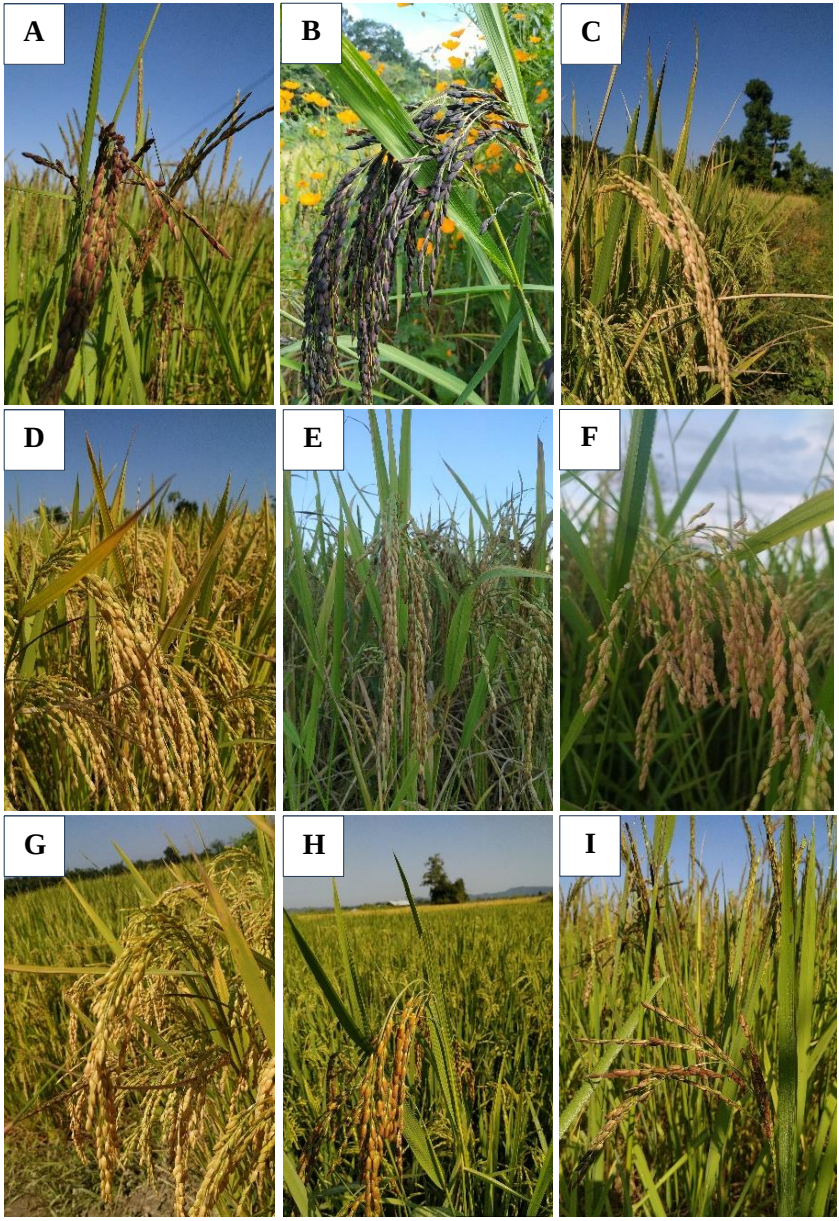
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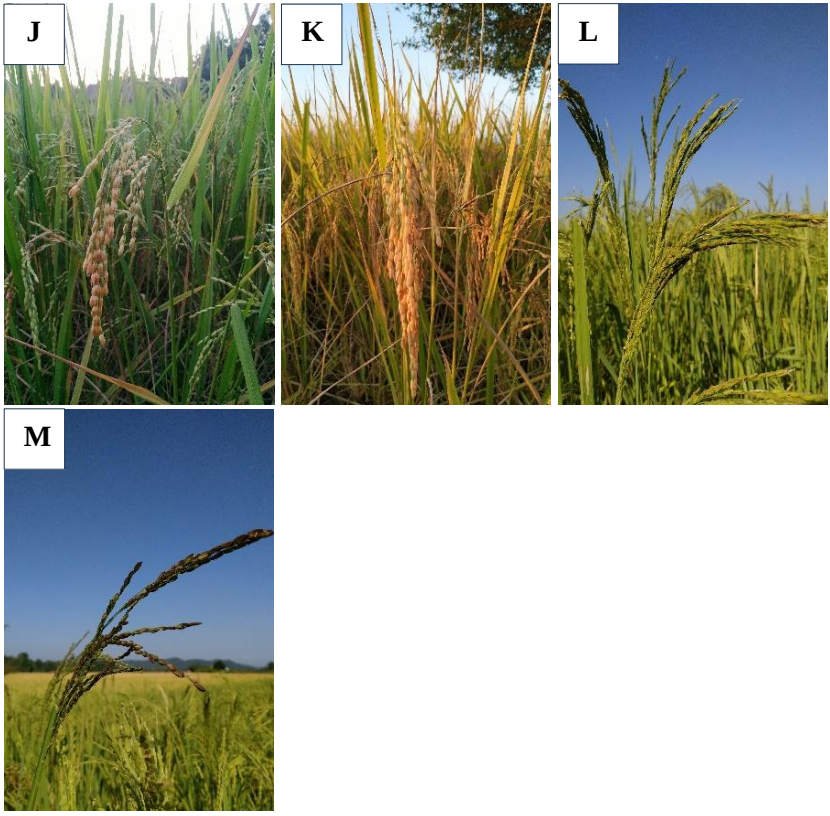
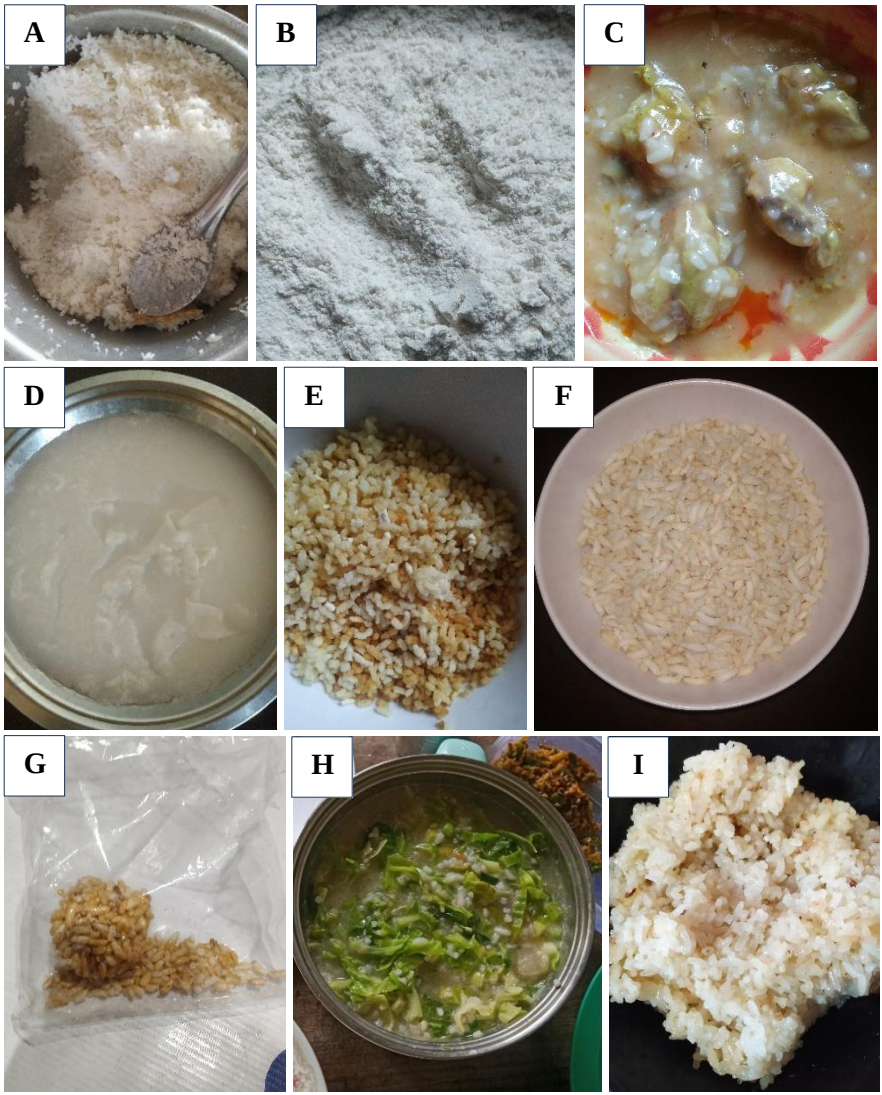


Figure 1: Rice varieties and cultivars of Jalukie B village (A) Kemne; (B) Kemne mei tik; (C) Mei tak; (D) Gotkha rei; (E) Ranjit kedui; (F) Arai rei; (G) Ranjit kete; (H) Mei gei; (I) Mei tik; (J) Hegwang mei; (K) Nki rei; (L) Keimdai rei keha; (M) Keimdai rei ketik

Figure 2: Measuring container (A) Tinibung; (B) Ntui

Figure 3: Traditional granaries for storing harvested rice



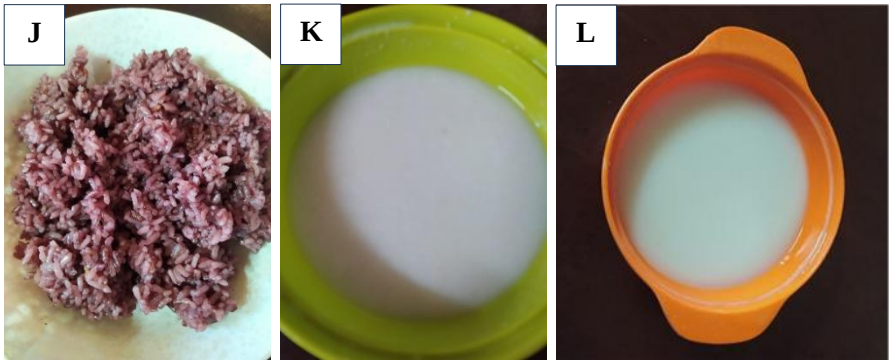


Figure 4: Different uses of rice in culinary applications (A) Boil rice; (B) Rice flour; (C) Chicken dish with rice; (D) Porridge; (E) Puff fried rice; (F) Puff rice; (G) Sweet puff rice; (H) Rice curry with vegetables; (I) Sticky white steam rice; (J) Sticky steam black rice; (K) Porridge; (L) Filtered rice water

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CHAPTER-7

AQUATIC INSECTS OF PANGTI VILLAGE, WOKHA DISTRICT, NAGALAND, INDIA

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ABSTRACT

Aquatic insects live in lakes, rivers, streams, ponds, and puddles and play an important role in the ecosystem function and are good indicators of the anthropogenic impact of the aquatic environment which are further used in bio-monitoring methods. The present study was conducted in Pangti Village, Wokha district from December 2022 to February 2023. The study sites include two rivers, three streams, and two ponds. Overall, a total of 30 species were recorded belonging to 10 orders, 22 families, and 30 genera. The order Hemiptera (12 genera) was dominant followed by the order Odonata (5 genera), Ephemeroptera (4 genera), Trichoptera (2 genera), Coleoptera (2 genera), Plecoptera, Blattodea, Neuroptera, Orthoptera, Diptera single genus each. The order Ephemeroptera, Plecoptera, and Trichoptera (EPT) are very much intolerable to any presence of pollutants in the water bodies thus the presence of EPT in the present study indicates that the study sites were healthy and the water quality was good and the habitat is within the tolerance limit of the species.

Keywords: Aquatic Insects, Ecosystem, Pangti Village, Nagaland

Introduction

Insects are the most successful group in the animal kingdom regarding richness and abundance and thus are the largest and the most assorted group of invertebrates (Baskar et al., 2021). Among all the insects, aquatic insects are diverse because they are a specialized class and exhibit rich adaptability. Aquatic insects live in the water and can be found in lakes, rivers, ponds, puddles, reservoirs, and streams. Micro and macro habitat distribution of aquatic insect populations is due to their

CHAPTER-8

STUDY OF CABBAGE PESTS IN PFUTSERO, PHEK DISTRICT, NAGALAND

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ABSTRACT

Cabbage (*Brassica oleracea var. capitata*) is a vital vegetable crop globally, rich in nutrients and antioxidants, and a significant source of income for farmers. However, it is highly susceptible to pest infestations, leading to yield loss and reduced quality. This study was conducted during rabi 2023-2024, in six different cabbage fields of Pfutsero, to investigate the prevalence of cabbage pests and farmer practices. Thirteen different pest species were identified, highlighting the severity of pest infestations in the region. Among the thirteen pests of cabbage *Brevicoryne brassicae*, *Murgantia histrionica*, *Spodoptera exigua*, *Trichoplusia ni*, and *Pieris brassicae*, were the highest in population. These pests cause significant damage to cabbage crops, resulting in reduced yields, lower-quality produce, and economic losses for farmers. Despite this, farmers in Pfutsero lack knowledge about Integrated Pest Management (IPM) practices and rely solely on handpicking. Farmers in this region often spend sleepless nights in the field to protect their crops, which is labour intensive. This approach is time-consuming, resource-intensive, and ineffective in addressing the root causes of pest infestations. Therefore, this study emphasizes the need for IPM strategies that combine physical, cultural, biological, and chemical controls to ensure sustainable agriculture and environmental stewardship in Pfutsero.

Keywords: Pfutsero, Cabbage, Pests, IPM (Integrated Pests Management)

Introduction

Cabbage (*Brassica oleracea var. capitata*) of Cruciferae family, is the most popular crop worldwide. Originating from the Mediterranean region, it is among the oldest known vegetables, with a cultivation history

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PREFACE

Nestled in Northeast India, Nagaland's rich biodiversity and vibrant indigenous practices form the backdrop for this book, '*Nagaland Ethnobiology: Traditional Practices and Contemporary Research'* which presents a comprehensive account of traditional knowledge and contemporary scientific research.

The chapters provide insights into the intrinsic link between its people and nature and emphasize the deep understanding these communities have developed over generations in managing their local ecosystems. The book covers topics ranging from zootherapeutic and ethnomedicinal practices to the consumption of insects and wild edible plants, as well as the diversity of rice, cabbage pest and aquatic insect studies. The book also includes evaluation of fruit quality and DNA barcoding of the Naga Tree Tomato (*Solanum betaceum*) and its invitro regeneration and genetic fidelity, and phytochemical and antimicrobial analysis of *Parkia roxburghii.*

We hope that the book will acts as a bridge between tradition and science, seeking to motivate conservation and empower local communities to protect their ecological heritage. By paying tribute to the work of researchers and indigenous knowledge holders, it promotes the blending of tradition and innovation in the conservation of Nagaland's biodiversity. This book is a call to celebrate and conserve the delicate harmony between humans and nature- a harmony that supports both heritage and ecological resilience.

-K. Pamai & T. Rhetso

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CONTENTS

CHAPTER-9

PHYTOCHEMICAL ANALYSIS AND ANTIMICROBIAL ACTIVITY OF *Parkia roxburghii* G. DON LEAF AND FRUIT EXTRACTS

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ABSTRACT

Parkia roxburghii is a medium size tree belonging to the family Fabaceae, it is a multipurpose plant used as an insecticides, pesticides, cosmetic purposes and human food due to its high nutritional and medicinal value. The objective of the study was to screen the bioactive compounds present in *P. Roxburghii* and assess their efficacy as antimicrobials. The leaf and fruits were extracted with the solvent methanol and petroleum ether by using the Soxhlet. The phytochemical screening revealed the presence of, flavonoids, glycoside, steroids, saponins, alkaloids and coumarins. The extract from leaf and fruit of *P. roxburghii* were investigated for antibacterial (*Citrobacter freundii*) and antifungal activity (*Rhizoctonia solani*) using agar disk-diffusion method. The methanolic fruit extract showed significant effects against *C. freundii* with ZOI of 18 mm and 17 mm in *R. solani*. Whereas the methanol leaf extract showed inhibition only against *C. freundii* with ZOI of 13 mm. The petroleum ether leaf and fruit extracts of *P. roxburghii* showed inhibitory effect against *C. freundii* with ZOI of 10 mm and 13 mm but had no inhibitory effects on *R. solani*. The highest activity was observed in methanolic fruit extract with MIC at 40µg/ml. The present study indicates that *P. roxburghii* methanol extract inhibition activity was due to the presence of various secondary metabolites. As a result, this plant may be exploited as a source of bioactive phytocompounds that could be used as active ingredients in medications designed to control and inhibit infectious microbial species.

Keywords: *Parkia roxburghii*, Phytochemical screening, Anti-microbial activity

Introduction

Medicinal plants play a very important role in the development of alternative drugs without adverse effects of the synthetic drugs (Savadi et al., 2020). Medicinal plants have become more popular in the treatment of many diseases due to popular belief that herbal medicine is safe, easily available and with fewer side effects. Therefore, there has been a global resurgence in the use of herbal preparations in disease management in all continents of the world and most developing countries are now integrating phytomedicine into their health care systems (Abioye et al., 2013).

Parkia roxburghii G. Don belonging to the family Fabaceae is a medicinal plant that grows in North East Indian states and other South East Asian countries. It is a medium sized tree (Figure 1) having a greyish-brown bark with 15-25 m height. The leaves are bipinnate compound, alternate bearing 500-3500 leaflets in a single leaf. The flowering take place from September to October and harvested from January to April. The pods form in clusters of 10-15 that remain suspended on long heads each measuring 25-40 cm in length and 2-4 cm in breadth. Inflorescence arises terminally in a racemes type. It is a head of flowers dangling at the end of a peduncle up to 45 cm long. It is considered to be the most complex across the genus, producing only 9-17 fruits from its thousands of fertile flowers in a capitulum (Singha et al., 2021).

Figure 1: (A) *Parkia roxburghii* tree; (B) Leaf; (C) Fruit

Parkia roxburghii is a multipurpose plant used as an insecticides, pesticides, cosmetic purposes and human food due to its high nutritional and medicinal value (Singha et al., 2021). The different parts of the plant are processed as paste, decoction and juice for the treatment of various ailments. Traditionally, the leaves are applied as lotion to cure sores and skin infections (Saleh et al., 2021). The leaves and fruits are consumed either raw or boiled with other ingredients to treat various diseases and pods are eaten raw as salads which contribute health benefits among the ethnic people. The pods and kernels have been traditionally used as a supplementary food source and to treat leprosy and hypertension (Angami et al., 2018).

The plant *Parkia roxburghii* is rich in protein, minerals, essential amino acid, fatty acid, oleic acid, linoleic acids and various other nutrients and supplements, it also has a high antioxidant property and a good source of phytochemicals (Ralte et al., 2022). Therefore, the present study focused on the extraction of the bioactive compounds from leaf and fruit of *P. roxburghii* using methanol and petroleum ether solvent; screening of the phytochemical compounds and examine the antimicrobial activity.

Materials and Methods

Collection of the plant material

Fresh leaves and fruits of *Parkia roxburghii* were collected in the month of January 2023 from Chozuba Village, Phek District, Nagaland, India (Latitude 25.719456˚ Longitude 94.319897˚) (Figure 1). The collected plant was identified from the Department of Botany, Patkai Christian College (Autonomous), Chümoukedima-Seithekema, Nagaland.

Preparation of plant materials for extraction

The collected plant parts were washed carefully, cut into small pieces, shade dried till all the moisture contents were removed. After drying, the plant materials were ground well using electric grinder into a fine powder and transfer into airtight containers for further use.

Soxhlet extraction

Parkia roxburghii leaf and fruit was extracted separately using Soxhlet extractor. Twenty gram of powdered plant material was uniformly

packed into a thimble and extracted with 250 ml of two different solvents. The solvents used in this extraction were methanol and petroleum ether. The process of extraction continues till the solvent in the siphon tube of an extractor became colourless. The boiling point of the solvent used in the extract of leaf and fruit of *P. roxburghii* were 55°C for methanol and 40°C for petroleum ether. Dried extract was kept in the refrigerator at 4°C for further use in the preliminary phytochemical analysis and antimicrobial activities.

Preliminary phytochemical screening of *Parkia roxburghii*

Phytochemical test was carried out on the methanol and petroleum ether extract (1mg/ml) of the leaf and fruit of *Parkia roxburghii* using the methods of Yadav & Agarwala, 2011.

1. Test for Phenols and Tannins:
   Two ml of the plant extract was mixed with 2 ml of 2% solution of $FeCl_3$ (2 gm of $FeCl_3$ was dissolved in 20 ml of distilled water). A blue-green or black coloration indicated the presence of phenols and tannins
2. Test for Flavonoids (Alkaline reagent test):
   Two ml of the plant extract was mixed with 2 ml of 2% solution of sodium hydroxide (NaOH). An intense yellow colour was formed which turned colourless on addition of few drops of diluted acid which indicated the presence of flavonoids.
3. Test for saponins:
   Two of the plant extracts was mixed with 5 ml of distilled water in a test tube and it was shaken vigorously. The formation of stable foam was taken as an indication for the presence of saponins.
4. Test for glycosides (Liebermann's test):
   Two ml of the plant extract was mixed with each of 2 ml of chloroform and 2 ml of acetic acid was added to it. The mixture was cooled in the ice for one minute. After that, 2 ml of concentrated H_2SO_4 was added to it carefully. A colour change from violet to blue to green indicated the presence of steroidal nucleus, i.e., glycone portion of glycoside.

5. Test for Steroids:
   Two ml of the plant extract was mixed with 2 ml of chloroform and concentrated H_2SO_4 was added sidewise carefully. A red colour produced in the lower chloroform layer indicated the presence of steroids. Another test was performed by mixing the plant extract with 2 ml of chloroform. Then 2 ml of each concentrated H_2SO_4 and acetic acid were poured into the mixture. The development of a greenish coloration indicated the presence of steroids.
6. Test for Terpenoids:
   Two ml of the plant extract was dissolved in 2 ml of chloroform and evaporated to dryness. To this, 2 ml of concentrated H_2SO_4 was added and heated for about 2 minutes. A greyish colour indicated the presence of terpenoids.
7. Test for Alkaloids:
   Two ml of the plant extract was mixed with 2 ml of 1% HCL and heated gently. Wagner's reagents were then added to the mixture. Turbidity of the resulting precipitate was taken as evidence for the presence of alkaloids.
8. Test for Coumarins:
   Two ml of plant extract was mixed with 1 ml of 10% solution NaOH (10 gm of NaOH was dissolved in 100 ml of distilled water) and added few drops of chloroform. Yellow colour appeared indicated the presence of coumarins (Ismail et al., 2017).

Anti-Microbial Activity

The methanol and petroleum extracts of *Parkia roxburghii* leaf and fruit were tested for their Minimum Inhibition of Concentration property against Microbes (*Rhizoctonia solani* and *Citrobacter freundii)*.

Culture Preparation

Culture Media Preparation for Fungi

Potato Dextrose Broth (PDB: Potato-200 g, Dextrose-20 g, Distilled water-1000 ml) 30 ml was prepared in 2 Erlenmeyer flasks by boiling 6 g of Potato in 30 ml distilled water and filtered. Dextrose (0.6 g) was added into the filtrate and the final volume was made up to 30 ml respectively with distilled water. It was autoclaved at 121℃ for 15

minutes. Later, *Rhizoctonia solani* was inoculated in respective flask and incubated at 25°C for 72h (Magaldi et al., 2004).

Culture Media Preparation for Bacteria

Luria Bertani (LB) broth was prepared using Tryptone 10 g, Sodium chloride 10 g, Yeast extract 6 g, Distilled water 1000 ml and 30 ml was prepared in Erlenmeyer flasks by adding Tryptone 0.3 g, Sodium chloride 0.3 g, Yeast extract 0.18 g, Distilled water 30 ml and autoclaved at 121 ℃ for 15 minutes. Later, *Citrobacter freundi* strain (MTCC 7027) was inoculated in 30 ml of sterilized LB broth flask and incubated at 37 ˚C for 24h (Valgas et al., 2007).

Sample Preparation

Extracts (10 mg) were dissolved in 1 ml of Dimethyl sulfoxide (DMSO) respectively. Different concentration of sample was prepared by pipetting 10 µl (100 µg), 20 µl (200 µg), 30 µl (300 µg), 40 µl (400 µg) and make up to 50 µl by using DMSO.

Media preparation for MIC

For fungal plate

Potato Dextrose Agar (PDA) media was prepared using Potato (200 g), Dextrose (20 g), Agar (20 g), Distilled water (1000 ml) and 250 ml was prepared in 3 flasks by boiling Potato 50 g in 100 ml distilled water and filtered respectively, final volume was made up to 250 ml with distilled water. Dextrose (5 g) and Agar (5 g) was added in each flask and autoclaved at 121°C for 15 minutes (Magaldi et al., 2004).

For bacterial plate

Luria Bertani (LB) agar media was prepared using Tryptone 10 g, Sodium chloride 10 g, Yeast extract 6 g, Agar 20 g, Distilled water 1000 ml and 250 ml of it was prepared in 2 Erlenmeyer's flask by adding Tryptone 2.5 g, Sodium chloride 2.5 g, Yeast extract 1.5 g, Agar 5 g, Distilled water 250ml and autoclaved at 121°C for 15 minutes (Valgas et al., 2007).

Platting for MIC against organisms

Approximately 25 ml of the media (PDA and LB agar) was poured into the sterilized petriplates and allowed it to solidify. Prepared bacterial 200

µl inoculum and fungus culture was poured respectively on agar plates and spread thoroughly using a plate spreader. Five wells measuring 0.6 cm was made in each plate using the borer and 50 µl of prepared sample were loaded into the respective plate wells, the bacterial plates incubated at 37°C for 24h and fungal plates incubated at 25°C for 72h. Later, MIC was recorded in mm (millimetre).

Results and Discussion

In the present study, Soxhlet extraction, phytochemical screening and antimicrobial activity (*Rhizoctonia solani* and *Citrobacter freundii*) of *Parkia roxburghii* leaf and fruit extracts were carried out using methanol and petroleum ether solvent.

Yield of Soxhlet extracts

The Soxhlet extraction process resulted in 5 g (leaf) and 4.7 g (fruit) from methanol extracts and 3.2 g and 2 g from petroleum ether leaf and fruit extracts (Table 1). Soxhlet method is a better method for extraction for bioactive compounds (Hawthrone et al., 2000; Tambun et al., 2021).

Table 1: Yield of the Soxhlet extracts

S. No.	Dry weight of the plant material (20 g)	Solvent	Weight of the extract (g)
1	Leaf	Methanol	5
2	Fruit	Methanol	4.7
3	Leaf	Petroleum ether	3.2
4	Fruit	Petroleum ether	2

The solvent selection, drying of the plant materials are important for extraction process and Soxhlet apparatus is useful in phytochemical research (Gopalasatheeskumar, 2018). Among the different solvent (methanol, ethanol, ethyl acetate and n-hexane) extractions, the successive Soxhlet method found to have higher recovery over maceration and fractionation extraction methods (Murugan & Parimelazhagan, 2014).

Preliminary phytochemical screening

Medicinal plants have great importance in modern health care system. Phytochemical analysis of leaf and fruit of *Parkia roxburghii* showed the presence of different compounds of medicinal value as well as physiological importance. Most of the secondary metabolites isolated from natural sources are used in pharmaceuticals, fragrances, food additives, pesticides and herbicides (Ismail et al., 2017). In the present study, preliminary phytochemicals analysis in leaf and fruit extracts showed the presence of phytochemicals such as flavonoids, saponins, glycosides, steroids, alkaloids. The observations made in the phytochemical tests are presented in Table 2. Several other studies have reported similar phytochemical compounds from *P. roxburghii*, these compounds are known to be biologically active and thus may contribute to the antimicrobial, anti-inflammatory, analgesic, anti-allergic effects, cytostatic and antioxidant properties of *P. roxburghii* (Abioye et al., 2013; Saleh et al., 2021).

Flavonoids exhibit a wide range of biological activities at nontoxic concentration as a promising anticancer agent (Narasimhan & Sathiyavani, 2014); Khangembam et al., 2018). Alkaloids are reported to be an end product of the plant metabolism, which at the same time; serve as reservoirs for nitrogen, an essential plant nutrient, toxicity against cells of foreign organisms. These activities have been widely studied for their potential use in the elimination and reduction of human cancer cell lines (Habib et al., 2023). Saponins have hypoglycaemic and anti-diabetic effects which are very useful in the management of diabetes mellitus and interfere with the replication of cell DNA, thereby preventing the multiplication of cancer cells (Abioye et al., 2013, Auwal et al., 2014). Glycosides are used in the treatment of heart related diseases and are known to have pronounced physiological action with cardiac glycosides being the drug of choice for the treatment of congestive heart failure (Oloo and Menge, 2020; Auwal et al., 2014).

Table 2: Preliminary phytochemical screening of *Parkia roxburghii* methanol extracts

S. No.	Name of Compounds	Observation	MLF	MFE	PELE	PEFE
1	Phenols and Tannins	No blue-green or black colouration observed	-	-	-	-
2	Flavonoids	Alkaline reagent test: Yellow colour turned to colourless	-	-	+	+
3	Saponins	Foam formation	-	-	+	-
4	Glycosides	Libermann's test: A colour change from violet to blue to green	+	+	+	+
5	Steroids	Greenish colour	+	+	+	+
6	Terpenoids	No greyish colour was observed	-	-	-	-
7	Alkaloids	Brownish precipitation	+	+	+	+
8	Coumarin	Yellow colour	+	+	+	+

MLF: Methanol leaf extract; **MFE:** Methanol fruit extract; **PELE:** Petroleum ether leaf extract; **PEFE:** Petroleum ether fruit extract

Antimicrobial activity

The antimicrobial activity of leaf and fruit extract of *Parkia roxburghii* were tested for their minimum inhibition concentration at 10 µg, 20 µg, 30 µg, 40 µg/ml against two microbes *Rhizoctonia solani* (fungi) and *Citrobacter freundii* (bacteria). The antifungal and antibacterial assay showed ZOI against the tested leaf and fruit extracts (Table 3-6, Figure 2-5). *Citrobacter freundii* was most susceptible to both methanolic and petroleum ether extract of *P. roxburghii* leaf and fruit. The methanol fruit extracts showed maximum ZOI against *C. freundii* (18 mm) and *R. solani* (17 mm) at minimum inhibition of concentration of 40 µg/ml whereas the petroleum ether fruit extracts showed a maximum ZOI against *C. freundii* (13 mm). The methanol and petroleum ether leaf extracts and petroleum ether fruit extracts showed no activity against *R. solani.*

Therefore, in this study, it was observed that methanol fruit extract was the most effective to inhibit *C. freundii* and *R. solani*. The antibacterial activity seen in the crude extract may be due to the presence of various secondary metabolites (Jauro et al., 2018; Kone et al., 2008; Sakha et al., 2018).

Table 3: MIC of *Parkia roxburghii* methanol leaf extract

Organism	Zone of inhibition (in mm) of Parkia roxburghii leaf petroleum ether extract (in µg)			
	10 µg	20 µg	30 µg	40 µg
Citrobacter freundii	10	11	12	13
Rhizoctonia solani	-	-	-	-

Table 4: MIC of *Parkia roxburghii* petroleum ether leaf extract

Organism	Zone of inhibition (in mm) of *Parkia roxburghii* leaf petroleum ether extract (in µg)			
	10 µg	20 µg	30 µg	40 µg
Citrobacter freundii	9	10	10	10
Rhizoctonia solani	-	-	-	-

Table 5: MIC of *Parkia roxburghii* fruit methanol fruit extract

Organism	Zone of inhibition (in mm) of *Parkia roxburghii* leaf petroleum ether extract (in µg)			
	10 µg	20 µg	30 µg	40 µg
Citrobacter freundii	13	15	16	18
Rhizoctonia solani	12	14	15	17

Table 6: MIC of *Parkia roxburghii* petroleum ether fruit extract

Organism	Zone of inhibition (in mm) of *Parkia roxburghii* leaf petroleum ether extract (in µg)			
	10 µg	20 µg	30 µg	40 µg
Citrobacter freundii	-	11	12	13
Rhizoctonia solani	-	-	-	-

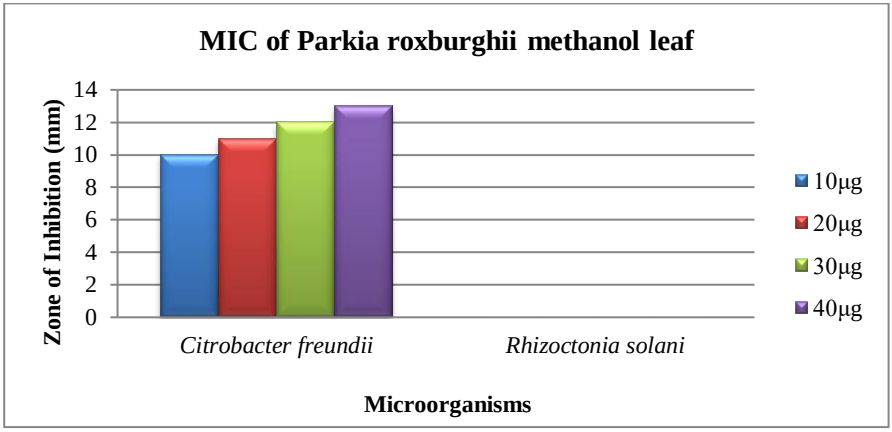

Figure 2: MIC of *Parkia roxburghii* methanol leaf extract

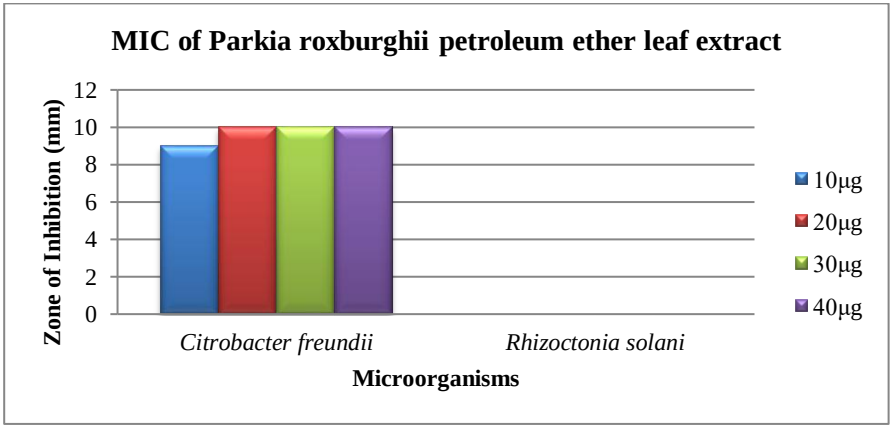

Figure 3: MIC of *Parkia roxburghii* petroleum ether leaf extract

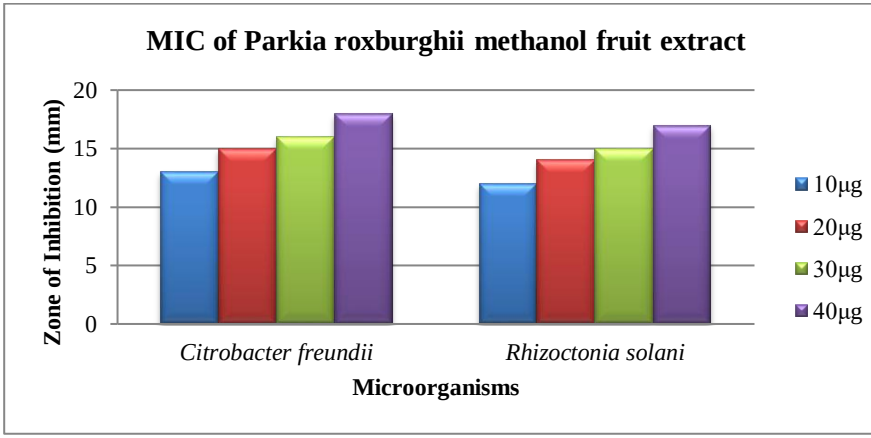

Figure 4: MIC of *Parkia roxburghii* methanol fruit extract

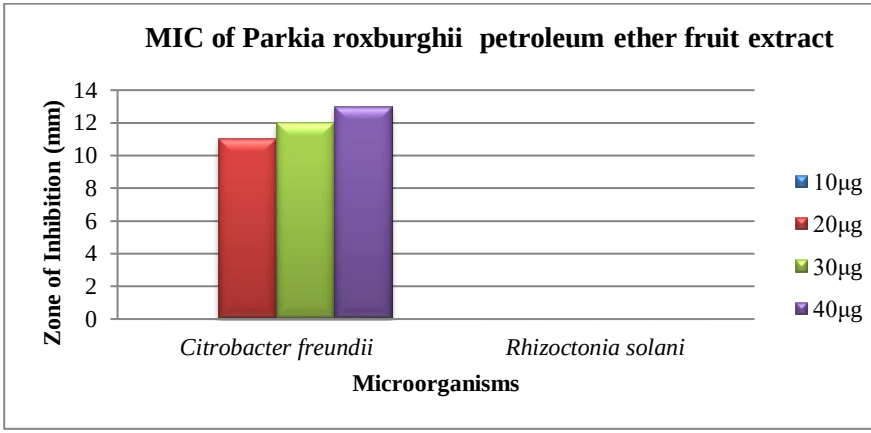

Figure 5: MIC of *Parkia roxburghii* petroleum ether fruit extract

Conclusion

Ethnobotanically, *Parkia roxburghii* is quite important and has high nutritional and medicinal values. Since time immemorial, this plant has been used to treat different kinds of ailments. Almost all parts of *P. roxburghii* are utilized for different medicinal purposes. Traditionally, the fruits are consumed either raw or boiled with other ingredients to treat various kinds of diseases. Decoctions of fruit and leaf parts are used to treat various diseases.

In this study, the phytochemical screening of leaves and fruit of *P. roxburghii* revealed the presence of flavonoids, saponins, glycosides,

steroids, alkaloids and coumarins. In the methanol extract it was observed that glycosides, steroids, alkaloids and coumarin are present, whereas in petroleum ether glycosides, flavonoids, saponins, steroids, alkaloids and coumarin are present. These compounds are known to be secondary metabolites and thus contribute to the antimicrobial activities. The antimicrobial activity of *P. roxburghii* leaf and fruit extracts was studied in different concentration (10 µg, 20 µg, 30 µg, 40 µg) against two microbes. The antimicrobial potential of the plant parts extracts was done in terms of zone of inhibition of bacterial and fungal growth. The study showed that methanolic and petroleum ether extracts of *P. roxburghii* leaf and fruit inhibited the growth of *Citrobacter freundii and Rhizoctonia solani*. *Citrobacter freundii* was most susceptible to both methanolic and petroleum extract of *P. roxburghii* leaf and fruit with zone of inhibition up to 18 mm. It was observed that *R. solani* showed 17 mm zone of inhibition in methanol fruit extract with MIC at 40µg/ml.

Thus, the study concludes that *P. roxburghii* leaf and fruit contains active bioactive compounds exhibiting antimicrobial property. Further study on the fractionation of active compounds and the mutual effect of active plant extracts may provide a better source for developing new therapeutic agents against infecting caused by microorganisms.

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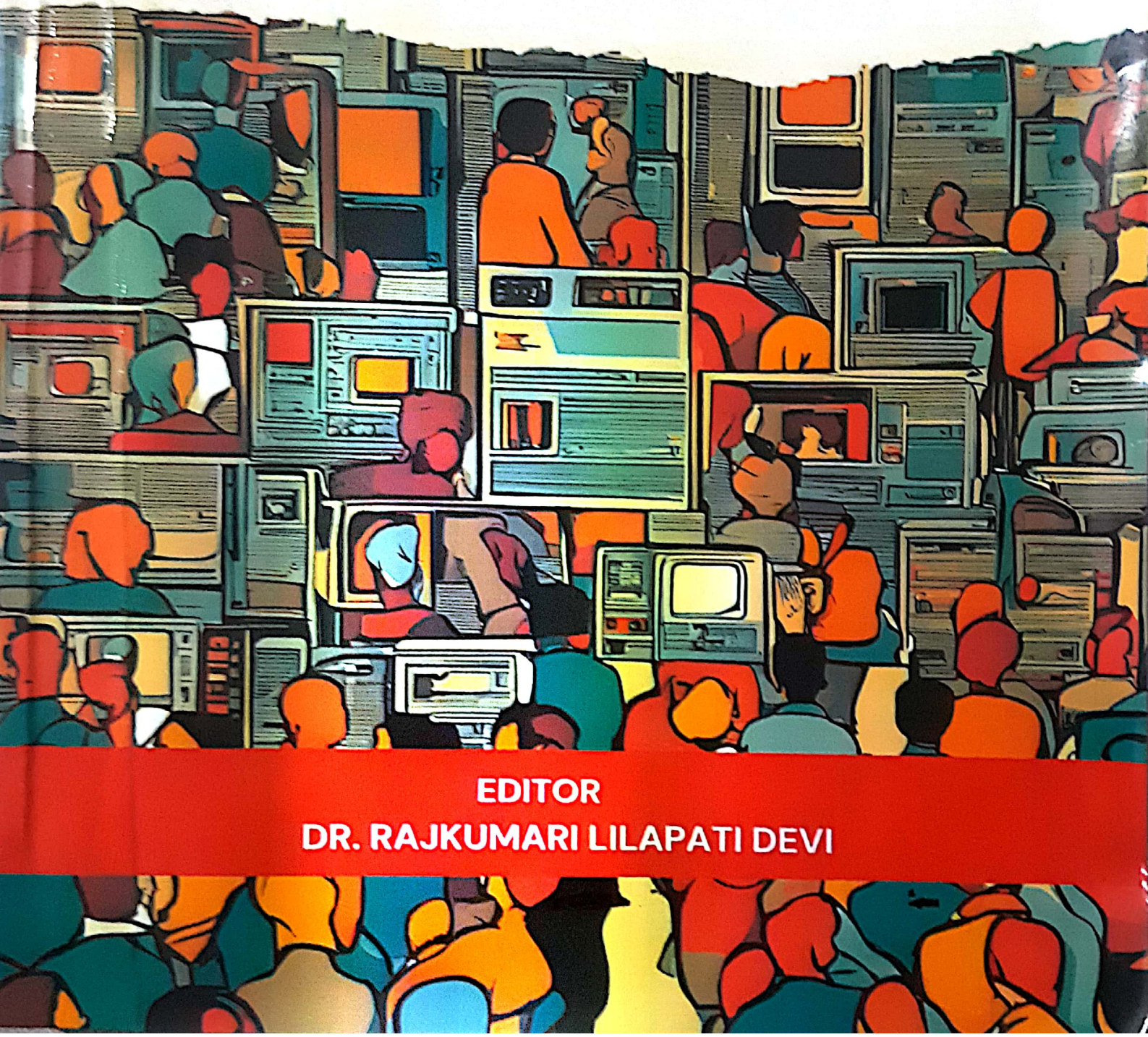

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12.
Unveiling Digital Dynamics: A Sociological Inquiry into Social Media's Impact on Youth in Nagaland

Wahengbam Rojenn

Introduction

Nagaland, situated in northeastern India, became the country's sixteenth state on December 1, 1963. Covering an area of 16,579 square kilometers, it had a population of approximately 1,980,602 according to the 2011 Census. The state is home to 17 major tribes and numerous smaller ones, each distinguished by unique customs, languages, and attire. Despite sixty years of statehood, Nagaland experiences a notable urban-rural digital divide, exacerbated by the limited availability of print publications and television channels (Suresh & Matharasi, 2020). Social media platforms have become essential for communication and idea exchange, benefiting millions (Yanthan, 2019, p. 479). The emergence of new telecom companies and government focus on technology is transforming urban residents' interactions with and perceptions of technology in Nagaland. Information and communication technology (ICT), particularly accessible to the youth, has proven highly beneficial. Social media is used by students and youths for education, leisure, and creativity, driving societal change. Despite challenges with rural internet accessibility, Nagaland's youth leverage social media to highlight issues like corruption and infrastructure deficiencies to policymakers, thereby fostering community cohesion (Ezung & Baksh, 2023).

Berson and Berson (2005) observed that contemporary youth are not merely consumers of internet media but actively use communication technology to innovate, adapt, and share ideas. The widespread integration of social media has significantly transformed interpersonal communication and cultural expression, particularly among young people who see these platforms as essential to their personal and social lives. In Nagaland, the adoption and usage patterns of social media among youth are shaped by diverse cultural and socio-economic factors. This investigation explores the evolving dynamics of the digital revolution in Nagaland, aiming to stimulate further discourse on its opportunities and challenges. Ultimately, our goal is to enhance understanding of how social media impacts young people in Nagaland.

This investigation, drawing from cultural anthropology, communication studies, and sociology, utilizes four key theories. Social Identity Theory (Tajfel & Turner) examines how social media facilitates identity expression and affiliation among Nagaland's youth. Uses and Gratifications Theory (Katz & Blumler) explores their motivations for social media use, such as self-expression and information-seeking. Cultural Dimensions Theory (Hofstede) investigates the impact of cultural norms on social media usage patterns, content preferences, and digital literacy. Technological Determinism (Veblen) analyzes how technology shapes social interactions and cultural production. Together, these theories provide a comprehensive framework for