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THEME :
PANORAMA OF INDIAN TRADITIONAL KNOWLEDGE :
A COMPREHENSIVE EXPLORATION

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DULIAJAN COLLEGE TEACHERS' UNIT
2024-25

EDITORS
MR. PABITRA SONOWAL
DR. KALYANI RAJKUMARI

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- Study on specific Indian traditional practice
- Recent Innovative methods based on traditional knowledge
- Review on Indian traditional knowledge or practices in specific fields
- Scientific basis of specific traditional practices
- Indian Traditional Knowledge and Sustainability
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Editorial

In an era dominated by technological advancement and globalized narratives, traditional knowledge systems often risk being marginalized, viewed as antiquated or irrelevant. However, India's vast and intricate heritage of Indigenous Knowledge Systems (IKS) stands as a testament to sustainable practices, holistic worldviews, and profound scientific insight. These knowledge systems—rooted in philosophy, agriculture, medicine, arts, linguistics, ecology, and spirituality—are more than cultural relics; they are living traditions with potent contemporary relevance.

Traditional Indian Knowledge Systems are not just historical artifacts to be preserved in archives or museums. They are dynamic systems of knowledge that have been shaped by centuries of empirical observation, cultural interaction, and ecological stewardship. As modern societies grapple with issues such as climate change, food security, mental health crises, and unsustainable development, the wisdom embedded in IKS offers alternative paradigms of sustainability, resilience, and wellness.

Take for example Ayurveda and Yoga—two branches of Indian knowledge that have gained global acceptance for their holistic approach to health and wellbeing. Similarly, traditional agricultural practices based on lunar cycles, biodiversity preservation, and natural pest management align closely with current movements toward organic and regenerative farming.

The revival and integration of IKS are no longer optional—they are imperative. This is where the **National Education Policy (NEP) 2020** marks a decisive shift in India's educational vision. NEP places a renewed emphasis on IKS, aiming to bridge the gap between modern scientific education and India's rich intellectual traditions. It promotes the integration of local knowledge into curricula, fostering a sense of pride, cultural rootedness, and contextually relevant learning among students.

While much of the discourse around Indian knowledge systems tends to center around the Vedic and classical traditions of the Indian heartland, it is imperative to acknowledge the unique and vibrant IKS of the Northeastern region. The eight states of the Northeast are not only home to over 200 distinct ethnic communities but also cradle a treasure trove of traditional ecological knowledge, healing practices, linguistic heritage, and cultural expressions.

The indigenous tribes of the region have cultivated intricate knowledge systems surrounding biodiversity, medicinal plants, shifting cultivation (like jhum), and natural resource management. Their understanding of the terrain, weather cycles, and forest ecology is the result of intimate co-existence with nature over generations. For instance, the Apatani tribe of Arunachal Pradesh has been globally recognized for their sustainable agricultural practices combining paddy cultivation with fish farming—an example of efficient resource use and community resilience. Similarly, traditional weaving practices in states like Assam, Manipur, Meghalaya, and Nagaland not only represent aesthetic excellence but are rich in mathematical patterns and cultural symbolism. Folk medicine, practiced by tribal healers using locally available herbs, holds immense potential for research in ethnobotany and pharmacology.

Despite these assets, the IKS of the Northeast remains underrepresented in national discourses. There is an urgent need to document, preserve, and mainstream these knowledge systems through inclusive research, community participation, and integration into the educational and developmental frameworks. The NEP's emphasis on local language instruction, regionally contextualized learning, and knowledge diversity presents an opportunity to uplift these rich traditions and empower their custodians.

To truly honor and harness the potential of Indian Knowledge Systems, we must move beyond tokenism. This involves creating platforms for intergenerational knowledge transfer, incentivizing scholarly research on indigenous practices, supporting community-led documentation initiatives, and ensuring that traditional knowledge holders—especially from tribal and marginalized communities—are recognized and rewarded. Digital technologies can be powerful enablers in this process. Digitizing manuscripts, creating multilingual content, and leveraging AI for knowledge mapping can make IKS more accessible to younger generations. Academic institutions must also foster interdisciplinary studies that link IKS with modern science, thereby dismantling the artificial divide between the two.

It gives us immense pleasure to present the inaugural peer-reviewed edition of *Pragyajyoti*, the ISSN-listed annual journal. This volume is dedicated to the theme, *"Panorama of Indian Traditional Knowledge: A Comprehensive Exploration."* The journal seeks to provide a scholarly platform for critical engagement with the rich and diverse heritage of traditional Indian knowledge systems, encompassing disciplines such as philosophy, science, medicine, art, literature, and culture.

We extend our sincere gratitude to the contributors, reviewers, and editorial board whose rigorous efforts have shaped this edition. We hope that this volume will serve as a valuable resource for academics, researchers, and practitioners engaged in the study and revitalization of indigenous knowledge traditions.

Mr. Pabitra Sonowal
Dr. Kalyani Rajkumari
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CONTENT

Ethnozoological Anti-Malarial Medicines From North East India : A Review

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Abstract :

Traditional medicine plays an important role in health care in both developed and developing countries. Traditional remedies using locally accessible resources have been used for generations to treat and prevent various diseases, especially in underprivileged and rural areas where access to cutting-edge conventional medical care is limited. These treatments are not only easily available and affordable but at the same time are believed to have fewer side effects. Moreover, conventional medicine can also serve as a useful foundation for creating novel pharmaceuticals. Traditional therapies and medications could be incorporated into contemporary healthcare to cure ailments more effectively and affordably while potentially saving lives.

Key words : *Traditional medicine, Indigenous populations, Malaria, Antimalarial drugs, Ethnozoology.*

Introduction :

Malaria continues to pose a major public health threat in India, with the country accounting for a sizable share of cases worldwide. The disease continues to pose a persistent threat despite intensive efforts to curb its spread [1,2]. However, traditional medicinal practices have long been an essential component of malaria treatment in

India, with a wide variety of plant-based remedies being used for many generations to prevent and cure the disease. This review aims to summarize the current knowledge on Ethnozoological anti-malarial medicines of North East India, their potential and conservation status.

1. Overview of Malaria in India

The global tally of malaria cases in 2022 was 249 million, well above the estimated cases before the COVID-19 pandemic and a rise of five million over 2021. India contributes about 66% of malaria cases in the South East Asian Region. India and Indonesia alone accounted for about 94% of all malaria deaths in this region [3,4]. About 95% of the Indian population resides in malaria-endemic areas which includes states like states like Orissa, Jharkhand, Madhya Pradesh, Chhattisgarh and the North Eastern states [5]. People living in forested areas are more susceptible to the disease. Between 2000 and 2019, about 32% of malaria cases and 42% of malaria-related deaths were reported in forested districts of India [6]. The prevalence of malaria among pregnant women in India was found to be 11.4 % of which 10.62% were asymptomatic cases and 13.13% were symptomatic. Pieces of evidence of malarial infection during pregnancy were found in nine very populous states of India including Madhya Pradesh, Tamil Nadu, Rajasthan, Maharashtra, West Bengal, Jharkhand, Chhattisgarh, Andhra Pradesh, and Telangana [7].

The two major species that cause malaria among the population of India are *Plasmodium falciparum* and *P. vivax. P. malariae* and *P. ovale* have also been reported to cause the disease on rare occasions. The malarial parasite is transmitted among humans through anopheline mosquitoes (genus *Anopheles*). There are 444 formally named species of *Anopheles* of which 58 are found in India. Of these, six species viz. *An. culicifacies, An. dirus, An. fluviatilis, An. minimus, An. sundaicus* and *An. stephensi* are considered to be the major malarial vectors [8,9,10].

2. Ethnozoological Anti-Malarial Medicines of North East India

The compilation of knowledge, abilities, and practices that constitute traditional medicine evolved from the theories, and life experiences of various indigenous cultures. The traditional medicine systems of some regions or communities are supported by large volumes of literature and records of the theoretical concepts and practical skills whereas; some other communities verbally pass down this knowledge from generation to generation. About 80% of the population living in developing countries, even in recent times, depend on traditional medicine either by choice or due to a lack of modern healthcare facilities. The most widely used traditional medicine systems include the Chinese, Indian, and African systems. In almost all of these medicine systems, medicinal plants play a major role [11,12]. However, a wide variety of animal/animal products are also used in these traditional medicines, the knowledge of which is conserved by the respective users.

The Indian medicine system includes about 2000 drugs of natural origin, almost all of which are derived from traditional practices. Of these, about 400 are of mineral

and animal origin while the rest are of plant origin. There are three major systems of traditional medicine in India - Ayurveda, Siddha, and Unani [12]. The concepts and practices of these systems are several thousand years old and a large proportion of the Indian population still relies on this traditional medical care. Apart from these three systems, Folk medicine, also known as "tribal" or "indigenous" medicine is also popular in most of the rural/indigenous/ethnic communities. This type of knowledge is usually passed verbally from ancestors to their descendants without any documentation [12,13].

Communities across NE India have a diverse knowledge of plant-based traditional medicine and utilize plants from families like Verbenaceae, Acanthaceae, Asteraceae, Rubiaceae, Rutaceae, Lamiaceae, Euphorbiaceae, etc., for their anti-malarial properties [14-18]. In addition, many indigenous communities of NE India also use traditional animal-based medicines as an alternative to conventional health care systems. Live animals as well as various animal byproducts such as hooves, scales, bones, feathers, tusks, etc. from a wide variety of animals like insects, fishes, reptiles, birds and even mammals have been used as essential ingredients for the preparation of some remedial drugs [19-29]. Table 1 represents a list of some of the animals and their parts used as traditional anti-malarial medicine by different tribes of NE India. Although most of the animals used for this purpose fall under the vulnerable to a critically endangered spectrum of the IUCN status, their scarcity has led to a decline in ethnobiological traditional medicines among the indigenous communities in recent times [19].

Table 1: Details of animals used in the ethno-zoological treatment of Malaria by different communities of NE India :

Animal group	Animal species used	Indigenous community	State	Body parts used	Threat status (IUCN Red List)	Reference
Mammal	*Ursus thibetanus* (Himalayan black bear)	Monpa	Arunachal Pradesh	Gall bladder is dried, powered and immersed in water and the extract obtained is used as therapeutic agent.	VU	[20]
		Tangsa		Uncooked rice is put inside the freshly extracted gall bladder to be smoked and dried for preservation.		[21]

		Ao	Nagaland	Boiled in water anddrunk.		[22]
		Karbi	Assam	Raw bile is consumed.		[23]
			Mizoram	Smoked, Aqueous decoction of gall bladder is consumed.		[24]
Mammal	*Panthera paradus* (Leopard)	Monpa	Arunachal Pradesh	Meat is used as medicine for malaria	VU	[20]
Mammal	*Moschus moschiferus* (Musk deer)	Monpa	Arunachal Pradesh	Musk is used as a therapeutic agent against malaria	EN	[20]
Mammal	*Macaca assamensis* (Assamese macaque)	Monpa	Arunachal Pradesh	Monkey meat is used to treat diseases like malaria	NT	[20]
			Mizoram	Fresh blood is taken orally.		[25]
Mammal	*Trachypithecus pileatus* (Capped langur)	Monpa	Arunachal Pradesh	Meat is used to treat diseases like malaria	VU	[20]
Mammal	*Macaca mulatta* (Rhesus monkey)	Monpa, Adi	Arunachal Pradesh	Meat is used to treat malaria	LC	[20]
Mammal	*Hoolock leuconedys* (Eastern Hoolock Gibbon)	Monpa	Arunachal Pradesh	Meat is used to treat diseases like malaria	VU	[20]
		Tangsa		Flesh, liver and blood are cooked and consumed.		[21]
			Mizoram	Gall bladder- Dried, aqueous decoction is consumed. Raw is also eaten.Blood consumed mixing with alcohol.Liver- Aqueous decoction is consumed		[24]
Mammals	*Vulper bengalensis* (Bengal Fox)	Adi	Arunachal Pradesh	Eggs and adults are used in curing malaria	LC	[25]
Mammal	*Canis aureus* (Golden Jackal)	Biate tribe	Dima Hasao, Assam	Dried Gall bladder is swallowed whole	LC	[26]

Mammal	*Hystrix indica* (Indian porcupine)		Mizoram	Stomach/intestine is boiled in water and administered twice daily for 7 days	LC	[25]
				Smoked gall bladder is consumed. Some mix with water and consume		[24]
		Tangsa tribe, Wancho tribe	Arunachal Pradesh	Gall bladder/bile, Intestine, Stomach, Smoked dried and preserved, consumed whenever required in small amounts by boiling with water		[21]
			Sikkim	The stomach is either sun dried or smoke dried and given for consumption		[27]
Birds	*Falco peregrinus peregrinator* (shahin falcon)	Monpa, Adi	Arunachal Pradesh	Meat is used to treat diseases like malaria	LC	[20]
Birds	*Corvus culminatus* (Jungle crow)	Monpa, Adi	Arunachal Pradesh	Meat is used to treat diseases like malaria	LC	[20]
Reptile	*Melanochelys trijuga*(Turtle)		Mizoram	Cooked meat is taken to cure malarial fever	NT	[25]
Reptile	*Testudo* sp. (Tortoise)	Tangsa tribe	Arunachal Pradesh	A small piece of shell either sun-dried or smoke-dried, crushed and sprinkled on hot charcoal and the emitted smoke is inhaled by covering the head with a piece of cloth	NT	[21]
Reptile	*Daboia russelli* (Viper)		Mizoram	Fatty –oil and Bile used against Malarial fever	LC	[25]
Reptile	*Python molurus* (Python)		Mizoram	Smoked gall bladder is consumed. Sometime aqueous decoction consumed; Raw meat/ smoked meat is used to cure malaria	NT	[24]

Reptile	*Varanus bengalensis* (Monitor lizard)		Mizoram	Meat and skeleton of the lizard mixed together with coconut milk and boiled till the meat is completely dissolved.	LC	[25]
				Smoked gall bladder is consumed. Sometime aqueous decoction consumed		[24]
Fish	*Channa punctatus* (Spotted Snakehead)	Adi	Arunachal Pradesh	Whole fish is given to Malaria patients	LC	[25]
			Manipur	Bile of the fish is taken thrice a day can prevent malaria and taken till recovery		[28]
Fish	*Anabas testudineus* (climbing perch)	Adi	Arunachal Pradesh	Whole fish is given to Malaria patients	LC	[25]
Fish	*Mastacembelus armatus* (Spiny eel)	Tangsa tribe	Arunachal Pradesh	Whole body cooked and consumed for curing malaria	LC	[21]
Annelids	*Pheretima*spp (Earthworm)		Mizoram	Whole body is taken orally or grind and mixed with honey and drink.	DD	[25]
		Wancho tribe	Arunachal Pradesh	Small earthworm found in or on banana plants, vegetables, etc.; consumed in raw form to protect against malaria		[21]
Insect	*Bothroponera rufipes* (Black ant)	Nyishi, Galo	Arunachal Pradesh	Intake of crushed ant along with other edibles during morning hour is considered good for malaria.	DD	[29]
Insect	*Cimex lectularius* (Bed bug)		Mizoram	3-5 bugs inserted into empty capsule and takenorally two to five times to get rid of chronic fever.	DD	[25]
		Biate tribe	Dima Hasao, Assam			[26]

Note: LC: Least Concern; VU: Vulnerable; EN: Endangered; NT: Near Threatened; CR: Critically Endangered; DD: Data Deficient

Discussion :

In North-East India, ethnozoological practices have been an integral part of the region's cultural heritage, with many communities relying on wildlife for food, medicine, and other resources. The ethno-zoological treatment of malaria in different communities of North-East India includes various animals, species, and body parts. Mammals are the most preferred animal group used by the NE Indian tribes, with common species including the Himalayan black bear, Eastern Hoolock Gibbon, and Indian porcupine. In addition, a few species of birds, reptiles, fish, annelids and insects are also used as anti-malarial drugs.

The most documented cases of malaria treated ethnozoologically are from Arunachal Pradesh. *Ursus thibetanus*, often known as the Himalayan black bear, is one of the species that is utilized extensively. Its gall bladder is dried, ground, and mixed in water and the extract obtained is used as a therapeutic agent. Another frequently used mammal is the *Hoolock leuconedys* (Eastern Hoolock Gibbon), which is cooked and consumed for its meat, liver, and blood. The Monpa and Adi tribes of Arunachal Pradesh also utilize the meat of birds like the *Falco peregrinus peregrinator* and the *Corvus culminus*as as a remedy for malaria. The Tangsa tribe of Arunachal has documented the use of dried tortoise carapace as an anti-malarial agent. Fish from the *Channa* and *Anabas* species are used by the Adi tribe to treat malaria. To ward off malaria, the Wancho tribe reported eating raw earthworm species that were discovered in or on vegetables, banana plants, and other plants. Among the Nyishi and Galo tribes of Arunachal Pradesh, eating crushed ants with other delicacies in the morning is said to help prevent malaria.

In Mizoram, different animals are used to manage malarial fever in different ways. Smoked or dried gall bladder, fresh blood, liver, stomach and intestine decoctions are consumed from mammals such as *Hystrix indica*, *Macaca assamensis*, *Hoolock leuconedys* and *Ursus thibetanus*. Additionally, reptiles like *Melanochelys trijuga* (Turtle), *Daboia russelli* (Viper), *Python molurus* (Python) and *Varanus bengalensis* (Monitor lizard) are harvested for their meat, oil, gall bladder, bile and skeleton.

Other northeastern states preferring the use of animal products include Nagaland, Assam, and Sikkim. However, the assessment does point out that there is a dearth of data on traditional anti-malarial treatments based on animals that are utilized by indigenous populations, especially in Assam, Meghalaya, Nagaland, Tripura, and Sikkim. As a result, these findings cannot be considered definitive.

Most of the animals used in these treatment methods fall under the threat status of Vulnerable, Endangered and Near Threatened according to the IUCN Red List. Overhunting and overcollection of wildlife resources for food, medicine, and other uses have caused population decreases and even extinctions. Ethnozoological practices have resulted in habitat degradation and fragmentation, owing to shifting farming

and other human activities. As ecosystems are destroyed and fragmented, confrontations between humans and wildlife grow, resulting in negative consequences for both humans and animals [30].

Conclusion :

With a wealth of knowledge and experience gathered over centuries, traditional anti-malarial medications from northeast India present a viable route for treating and controlling malaria. The effectiveness and potential of these treatments warrant additional study and incorporation into traditional healthcare systems. The government should include the sustainable use of ethnozoological medicines in the current healthcare system in a way that guarantees the successful protection of the species utilized in foods, ethnomedicines, and cultural practices.

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Malaria and Scientific approaches behind its traditional treatment- A Brief Study

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Abstract

Malaria is wide-spread and threatened diseases all over the world. Malaria is generally spread through the bite of female anopheles mosquito. By the process of blood transfusion and by using contaminated needles, malaria cantransferred from one affected human to another normal human. Treatment of malaria is essential to cure the disease from its root. Use of traditional medicines is harmless, affordable and beneficial for health. It is very important to understand the science behind the working principles of all these traditional medicines for future prospective. To manufacture vaccine for malaria treatment, it is very crucial to identify the biology and chemical molecules that may present behind the medicinal plants.

Key Words : Malaria, disease, female anopheles mosquito, blood transfusion, vaccine.

Introduction

Malaria is one of the most dangerous, wide-spread, vulnerable, life threatening disease that cause tremendous death among million of people. Malaria is generally spread through the bite of female anopheles mosquito. By the process of blood

transfusion and by using contaminated needles, malaria can transferred from one affected human to another normal human. Symptoms of malaria are fever, fatigue, vomiting and headache.In human, there are four types of mosquito species that cause the malaria, namely –

1. *Plasmodium falciparum*
2. *Plasmodium vivax*
3. *Plasmodium ovale*
4. *Plasmodium malariae*

All these are intracellular protozoan parasites of genus plasmodium.

Life cycle of malaria parasite :

Malaria parasite maintains its life cycle in the body of female anopheles mosquito itself and in human body. Malaria infection begins when a person is bitten by an infected female *Anopheles* mosquito, injecting *Plasmodium* parasites, in the form of sporozoites, into the bloodstream of human.The sporozoitestravel quickly into the human liver.The sporozoites multiply with asexual reproduction in the liver cells within the next 7 to 10 days, without causing any symptoms. In the form of merozoites, the parasite release from the liver cells in vesicles andtravel through the heart to the capillaries of the lungsand then settles in the lung capillaries. The vesiclesare collapsed byreleasing the merozoites into the bloodstream to develop and multiply in erythrocytes.This cycle happens in repeated manner. Clinical symptoms, including fever, occur in synchrony with the rupture of infected erythrocytes and the release of erythrocyte and parasite debris, including malarial pigment (hemozoin) and glycophosphatidylinositol, (putative malaria toxin). In the infected erythrocyte, presence of HRP-1, EMP-1,HRP-2 and EMP-2 proteins are observed. Among all the infectedmerozoites, some cells instead of replicating asexually develop into sexual forms (gametocytes) thatcirculate in the bloodstream.When a mosquito bites an infected human, it ingests the gametocytes, which develop further into mature sex cells called gametes in the body of female anopheles mosquito. The fertilized female gametes develop into actively moving ookinetesthat actively burrow through the mid-gut wall of the mosquito and form oocysts, inside the oocyst, thousands of active sporozoites develop. The oocyst eventually bursts, releasing sporozoites into the body cavity of mosquito that travel to the mosquito's salivary glands. The cycle of human infection begins again when the mosquito bites another person.

There are some challenges to prevent, diagnosis and treatment of malaria in a population. Some of them are as follows :

1. Resistance of malaria parasite against anti-malarial agents,drugs and chemicals and has probably contributed to the resurgence of infection that increases in malaria-related deaths in recent years.

2. Unavailability of proper instrument, infrastructure and resources for detection and treatment of malaria and its control in developing and underdeveloped countries.
3. Living in unhygienic environment can increase the spreading of malaria parasite.

According to WHO, two approaches are used for controlling, treating and preventing malarial infection, these are:

- To prevent malaria, reduction in human-vector contact and lifespan of mosquitoes by using insecticidal nets, indoor residual spraying and administration of entire course of anti-malarial drugs in the population at high risk in due course of time are very important.
- To cure malaria among population, treatment of affected human being with chemotherapy such as ACTs (artemisinin-based combination therapies) are very essential.

Diet and nutrition can show a major impact to cure malaria disease. Sopatients are advised to follow a nutritionally balanced diet that includes cereals, pulses, vegetables, fruits, milk, milk products, fish, chicken soups, stews, sugar, honey, etc. that provides adequate nutrition and maintains fluid balance which may increase the health of malaria patient.

Objectives of the Study

Analyzing the importance of current issue, the researcher has found out the key objectives in present study as –

- Toanalyze the concept of malaria and it's causing parasite.
- To identify different traditional medicine for curing malaria.
- To examine the scientific reason behind the use of all traditional medicine.

Methodology of the Present Research

As the current work is based on health related issue, the researcher has followed descriptive scientific research method and the data are collected as primary and secondary data collection methods.

Traditional Medicines that are used for the Treatment of Malaria Disease

There are different traditional medicines which may cure malaria without affecting other body organs. Use of traditional medicines is harmless, affordable and beneficial for health. It is very essential to understand the science behind the working principles of all these traditional medicine for future prospective. Some of these medicines are as follows –

Chloroquine : Chloroquine can cause a harmful effect on the parasite and at the end, the death of the malaria parasite may happen. The scientific mechanisms behind the action of chloroquine are –

1. Inhibiting the detoxification of hematin in the malaria parasite's digestive vacuole.
2. Chloroquine inhibits the action heme polymerase in malaria to prevent the conversion of heme to hemozoin.
3. Chloroquineintercalates into DNA to disrupt the replication, transcription and translation of paracite's DNA.

Artemisinin **:** It is a widely used anti-malarial drug which is generally obtained from the sweet herb wormwood and used as a first-line treatment against Plasmodium parasite. The scientific mechanisms behind the action of artemisinin are –

1. Its chemical structure that is tetracyclic 1,2,4-trioxane.
2. Artemisinin inhibits nucleic acid and protein synthesis in malaria parasite.
3. Artimisin inhibits heme polymerization to destabilise the protein synthesis in parasite's membrame.

Quinine **:** Quinine is an alkaloid derived from the bark of cinchona tree. It has been used as an antimalarial drug since long period of time. Quinine affects the malaria during its asexual stage of lifespan.Scientific approachesbehind the working mechanism of quinine are –

1. Drugs interfere with the parasite's ability to break down and digest hemoglobin.

Acanthospermumhispidum **:** A. hispidumis an annual plant in the family Asteraceae.A. hispidum show antibacterial and antifungal properties. It is traditionally used for the treatment of malaria, jaundice, vomiting skin aliments cough, cephalgias, abdominal pain, convulsions, stomachache, constipation, eruptive fever, snake bite, epilepsy, skin ailments, cough, bronchitis, and blennorrhoea and bronchitis. It is also used as an antifeedant. Scientific mechanisms behind the action of A. hispidum are –

1. A. hispidum appears to contain phytoconstituents that may be useful adjuvant for antibiotic formulations.
2. This plant also contains sesquiterpene lactones of the germacranolide group.
3. It also contains tannins, glycosides, sugars, alkaloids and saponins. Anti-inflammatory properties have also been shown, which helps treat malaria.

Carpolobia**lutea :** Carpolobialutea shows various medicinal properties against diarrheal, ulcer and malaria. A clinical study on mice examined that a 2450 mg/kg dose was safe for traditional use against malaria. Scientific mechanisms behind the use of C lutea are **–**

1. C. lutea contains some molecules in different parts of its body axis; some of these chemical molecules are like triterpenicsaponins (roots), tannins, anthraquinones, cardiotonic glycosides and alkaloids. These molecules can kill the malaria parasite.

Future Prospectives

Now days, people want to going back to their ancient life style for solving different health related issues. Traditional medicines have great value in today's time and traditional medicines are affordable also. By looking all these aspects, it is very easy to say that all these medicinal plants have so much future prospective.

Conclusion

Malaria is one of the most threatened diseases all over the world. To develop malaria vaccine with affordable price, it is very essential to know the chemical formulas and biology. Traditional medicines and their scientific formulas are very important and helpful to develop vaccine for malaria.

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Traditional Agroforestry System : A Study on Jorhat District, Assam

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Abstract

India is a country where the rural agrarian communities are majorly dependent on agriculture for livelihood. Each community has traditionally developed their own methods of agricultural practices and prepared the tools on the basis of the available resources, socio- economic condition and geoecological setup of the region. Traditional agroforestry systems are human-managed land-use system in which woody perennials are intentionally grown in association with agricultural crops, pastures as well as livestock. Different agroforestry has traditionally been practiced by different communities in India. These practices are closely related to the associated physical environment and the socio- economic status of the area and are truly based on the farmer's experience. These traditional agroforestry systems have different environmental and economic benefits. In the Jorhat district of Assam, there are also some traditionally managed prevalent agroforestry systems. Spatial variation in these systems have also been noticed in in the study area. The paper tries to identify the available traditional agroforestry systems of the study area and classify them. The probable benefits of these systems have been tried to estimated.

Key Words: Traditional Agriculture, Agroforestry, Agriculture Land- management, Jorhat.

Introduction

Every region and every community have their own traditional agricultural methods, traditions and practices (Hamadani, *et. al.*, 122). India is a country where the rural

agrarian communities are majorly dependent on agriculture for livelihood. Each community has traditionally developed their own methods of agricultural practices and prepared the tools on the basis of the available resources, socio- economic condition and geoecological setup of the region. Therefore, the traditional agricultural practices are closely linked with the surrounding environment (Altieri and Koohafkan, 63). These practices and beliefs have been transferred from one generation to the other. Certain temporal and spatial changes can be noticed in such practices. Traditional agricultural practices are engaged with tilling, sowing, harvesting and other agricultural land management practices. These practices can be termed as sustainable agricultural practices as the materials used are bio degradable and based on local available resources, less costly, easily understandable and acceptable by the local people, environment friendly and helpful for waste management (Bernues, et. al, 135). Traditional agroforestry is one of the common traditional agricultural practices (Hamadani, et. al., 119). There is many traditionally practiced agroforestry systems in different parts of Assam. These agroforestry systems are considered the environment friendly and sustainable agricultural practices.

The traditional agroforestry is a traditionally practiced agriculture land management system, where the beneficial trees are planted along with the crops and rear the livestock simultaneously (Viswanath and Lubina, 96). The planted trees are usually fruits or wood producing trees (Levasseur and Olivier, 279). Agroforestry system have social, economic and environmental benefits. It is very beneficial for biodiversity conservation in local level (Chitapur, et. al, 930). In different parts of Assam, many agroforestry systems have been identified (Ulman, et.al., 415). The very commonly seen agroforestry system in the study area is the home garden. In the study area too some common traditional agroforestry systems have been noticed. Agroforestry system has many social, environmental and economic benefits. Agroforestry system helps in better land utilization, soil conservation, maintenance of soil organic carbon (Rao, et. al, 28; Fahad, et.al., 2022) and useful for maintaining micro- ecosystem conservation and overall improvement of the ecosystem in a sustainable way (Raj, et.al, 579). At the same time there are many economic benefits of this system. It helps the farmer in getting the needed food, fuel wood, fodder, timber, spices etc. easily from their own (Jaha, et.al, 22-23). It helps farmers during the days of crop failure (Jemal, et.al, 2017). Agroforestry system helps farmer to increase farm income (Tiwari, et.al, 301) and helps in sustaining the agriculture (Awazi, et.al., 381). Agroforestry is also helpful in maintaining social sustainability. The traditional agroforestry system has been practiced by the farmers from ages, therefore it is easy to adapt such practices for the society intensively. It promotes the health and living standard of society by providing diverse ecological system.

In the study area there are still some prevalent traditionally managed agroforestry systems. The present study tries to identify the agroforestry systems of the area and their respective significance. The study also attempts to analyze the community development bloc wise variation and prevalence of these practices.

Study Area

The present study is carried out in the Jorhat district of Assam. The administrative boundary of Jorhat district was newly demarcated in 2016, by excluding the former Majuli subdivision in the north. The geographical extension of newly demarcated Jorhat district is 93° 56' 24'' E to 94° 38' 24'' E longitude and from 26° 18' 36'' E to 26° 58' 48'' E latitude (Fig. 1). About 80% of the total geographical area of Jorhat is classified as rural area with 598 numbers of villages and 99% of the total population (Census of India, 2011). The rural economy of the Jorhat district is majorly dependent on agricultural activities. About 46% of the total population is directly or indirectly dependent on agricultural activities for their livelihood (Census of India, 2011). The district has diverse geoecological and socio- economic characteristics. In the northern part the area is formed by the newer fluvial deposits of the Brahmaputra River and it's tributaries and the Naga-Patkai hill range of Nagaland covers the district along the northern part. In the district there are many Scheduled Tribe and Sc communities live and their main livelihood is agriculture. Though modern agricultural methods and techniques have been adopted in different parts of the district, the farmers still follow some significant traditional agricultural practices. These practices can be seen along different communities in the area and are connected with the surrounding geoecological condition. These traditional methods re related to agricultural land management practices, sowing, tilling, harvesting, pest management, fertilization etc.

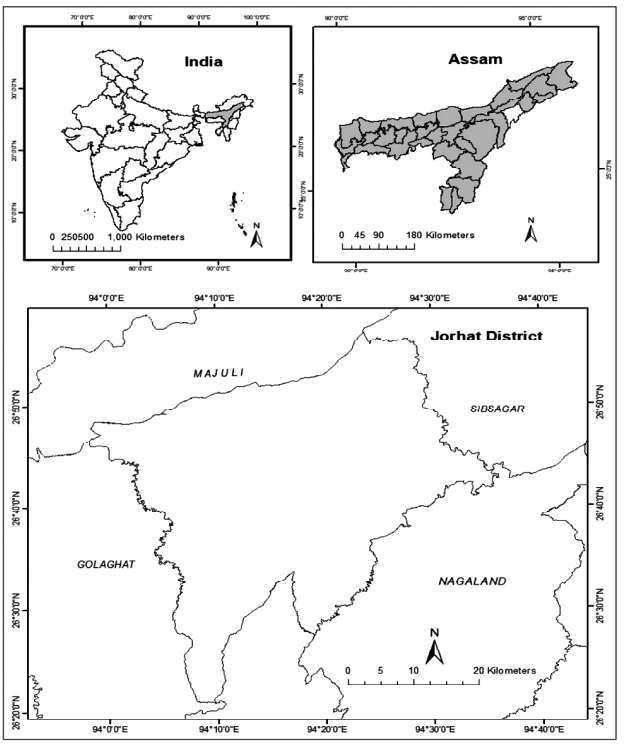

Figure 1: Location Map of Jorhat District

Database and Methodology

The present study primarily based on the empirical observation, information collected through interview and focused group discussion. Primary survey has been carried out in the district during 2022-23. Sample villages are selected from each Community Development Blocks. 4% villages from each CBD were selected by using stratified sampling method considering the factors like number of cultivators, nearness to town, geo- ecological condition, transportation facility etc. from each selected villages, 10-12% of the households are selected randomly and from each household two members are selected to fill one interview schedule. The collected information has been cross-checked by conducting focused group discussion comprising farmers from different socio-economic backgrounds. Field visit have been done throughout the year for the empirical observation. The classification and relevance of the documented traditional agroforestry systems, is done on the basis of extensive literature review. The collected data are analysed by adopting qualitative approach.

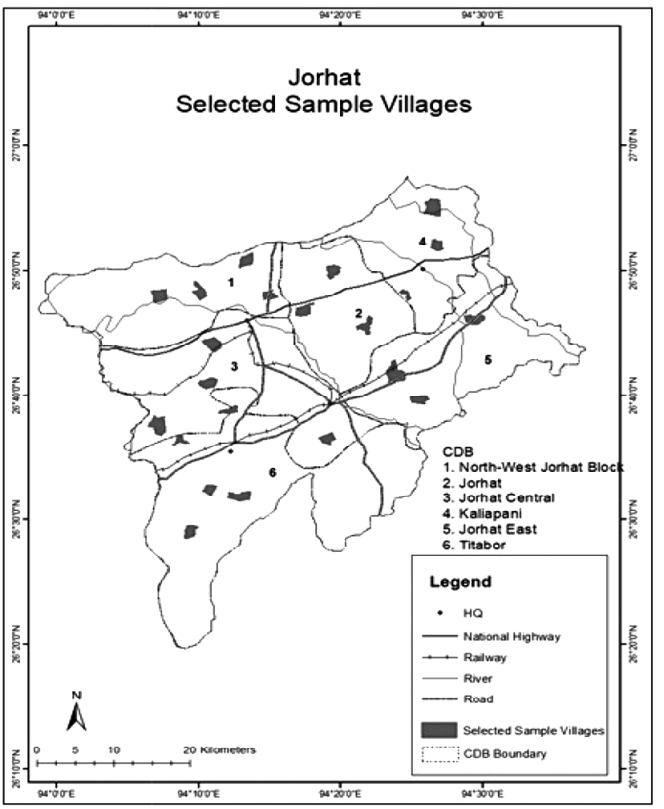

Figure 2: Location of Selected Sample Villages

Result and Discussion

Identified Traditional Agroforestry Systems in the Study Area

In the study area there are different agroforestry system, which have been developed traditionally in accordance with the concerned ceosystem. Agroforestry system is mainly visible in the areas of Mariani and Titabor than in the northern plain area. As the southern area is not suitable for field crops, therefor home gardens with different crop/ plant combination are noticed. In the northern parts Aquaforestry is commonly seen. Overall in almost every household some kind og agroforestry can be seen in the area. The prominent traditional agroforestry system of the study area are mentioned in the table 1.

Table 1 : Identified Traditional Agroforestry System in the Study Area

Sl. No.	Agroforestry System	Combination	Prominent Areas	Identified Households (in %)
1	Commercial crop and Planted Tree	Tea+ Betelnut Tea+ Betelnut+ Black Paper Tea+ Sal Tree	Southern Villages bounded by Reserve forests Villages of Titabor Block	35%
2	Aqua- forestry	Pond+ Arecanut/Banana Tree on boundary Pond (with fish) + Bamboo Tree on boundary	Visible in majority villages of northern plain area and Titabor Block	45.7%
3	Home Garden/ Bari	Betelnut+ Black Paper Betelnut+ Betel Leaves Betelnut+ Black Paper+ Assam Lemon	Mostly seen in Mariani and Titabor Area	43.3%
4	Multiple Fruit Plant	Mango Tree+ Jack Fruit Tree + Betel Nut	Majority area	64.6%
5	Barrier Trees around Crop Fields	Crop Field+ Big Trees/ Bamboos on boundary	Whole study area	100%

Source : Field Survey, 2022-23

i. *Commercial crop and Planted Tree :* In the southern villages of Mariani and Titabor, people plant commercial crop (Tea) in their home garden. Along with tea plantation, they plant shaded trees like Betel Nut and *Sal Trees*. Some people plant parasites, like Blak Paper and Betel leaves to climb at these shaded trees. Three main sub systems are identified under this category: a) Tea with Betelnut,

b) Tea with Betelnut and Black Paper, c) Tea with *Sal tree* (Fig. 3). This type of agroforestry is majorly seen along the southern areas nearby hilly and forest cover zone of East Jorhat CDB, Titabor CDB and Jorhat CDB. About 35% of the household has this type of agroforestry system in the district. In these parts due to animal aggression and pest attack, people face problems in growing of other food and fiber crops. The planted trees help in providing shade to tea and at the same time produce wood, nuts, spices, betel leaves. (fig. 3)

Figure 3 : Commercial crop and Planted tree with a) Tea+ Betelnut
b) Tea+ Betelnut+ Black Paper

ii. *Aquaforestry:* In many rural households a pond with serrounding trees is commonly seen in the study area. Banana, Betelnut, Bamboo trees etc. are planted, serrounding the pond. Beside the production of fruits, nuts and bamboo; these palants helps in maintaining the ecosystem of the pond. Traditionally these ponds are dug in the backyard of the houses for the purpose of drinking, bathing, washing and giving water to the vegetable gardens, rearing fish, ducks etc. Currently, the water of the ponds are not been used for drinking, bathing etc. as there are different sources of pure drinking water. Currently the households use the pond to rear fishes, ducks etc. Two systems of aqua- forestry are indentified in the region: a) Pond+ Arecanut/Banana Tree along the bank and b) Pond (with fish) + Bamboo Tree along the bank. This type of agroforestry system basically seen in the northern lowland ares of North-west Jorhat CDB, Kaliapani CDB abd northern Titabor CDB. About 45.7% householda of the district has this type of agroforestry system. (fig. 4)

iii. *Home Garden/ Bari:* In the backyard of the households, the uninhavitted area is usually used for planting different trees. The big trees are planted along the boundary. These big trees are supposed prevent wind speed along with production of fruits. In local term these homestead gardens are termed as *bari.* These bari portions are abondond area of the households. The identified home gardens are a) Betelnut+ Black Paper, b) Betelnut+ Betel Leaves, c) Betelnut+

Black Paper+ Assam Lemon. This type of baris is identified in 43.3% of the total households of the district. The majority of betelnut gardens are identified in the Mariani and Titabor region of the district. (fig. 5)

Figure 4 : Aquaforestry a)Pond + Arecanut/Banana Tree on boundary
b)Pond (with fish) + Bamboo Tree on boundary

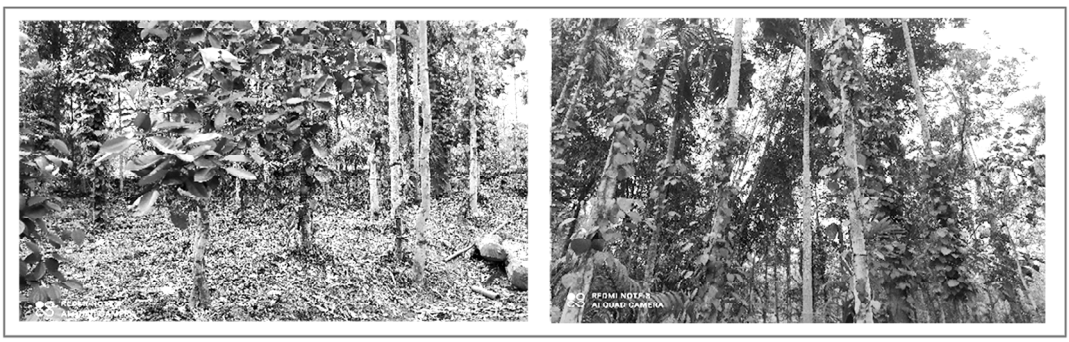

Figure 5: Home Garden/ *Bari* a) Betelnut + Black Paper/ Betel Leaves Plant
b) Betelnut+ Black Paper + Assam Lemon

iv. *Multiple Fruit & Nut Plant:* In the study area, some households having large campus, they plant fruit plants like Mango, Jack Fruit, Indian gooseberry, Olive trees etc. in their home garden along with betel nut. The idea behind was to use the uninhabited area to be self sufficient for seasonal fruits. Majority household of each CDB has this type of agroforety system. In the whole district about 64.6% of the total households practice this agroforestry system. (fig. 6)

v. *Barrier Trees around Crop Fields:* Around the paddy fields of the study area, big trees or bamboo trees are Planted. In some places couple of trees are planted in between the crop fields. The barrier trees are helpful in preventing high speed storms and can minimize crop damage up to certain extent. The planted trees helps in maintinind the ecosystem by providing shelter to birds and other pollinators, which inturn helps in crop pollination. In the study area almost every paddy field have this kind of barrier trees. (fig. 7)

Figure 6: Multiple Fruit & Nut Plant

Figure 7: Barrier Trees around Crop Fields

Conclusion

The traditional agroforestry system is beneficial for sustainable land management and rural economy. It has multiple environmental benefits too. These traditional agroforestry systems have developed on the basis of the age-old experience of the farmers and have been handed over from generation to generation. The importance of these agroforestry systems in the rural agricultural economy can not be overlooked. In the study area the identified agroforestry system are mainly concentrated in the rural areas and due to changes in the land-use and land-cover. Adoption of other agricultural practices have also brought challenges in the adoption of these traditional agroforestry system. The identified agroforestry system of the study area can be studied further by the agriculture scientists for further modification to get more profit. These agroforestry can help the farmers in emergency and can provide additional financial benefit by the production of food and fodder. The identified agroforestry in the study area has numerous benefits regarding economic and social. syatems can also be adopted in the other similar physiographic regions.

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Traditional Therapeutic Uses of Copper

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Abstract

Copper is an essential trace metal for the human body. It plays vital roles in many physiological functions of the body like regulation of heart rate and blood pressure, activation of immune system, development and maintenance of bones and connecting tissues. Ancient Ayurvedic practitioners used copper vessels for preparation of different drug formulations due to its sterile property. Recent researches have shown that copper surfaces have antimicrobial activity against microbes such as *Escherichia coli, Staphylococcusaureus*,influenza virus and fungi. Ayurvedic practitioner since the *Samhita* period used copper based drugs for the treatment of wounds and different ailments of liver, spleen and heart along with abdominal pain, anaemia, tumours, tuberculosis, etc. "*Tamra Bhasma*" is one of such popular drug used in traditional Ayurveda, used for treatment of ulcers, haemarrhoids, skin disorder, dyspnoea etc. It is in fact a powder of copper nano-oxide made edible and compatible to the human body.

Keywords : Copper, Ayurveda, Antimicrobial, *Tamra Bhasma*, Nano-oxide.

Introduction :

Ayurveda and the use of metals :

The ancient Indian medicinal knowledge and well-being practices, popularly known as "Ayurveda", was established on the idea that mental, physical, and spiritual wellness are interdependent and require careful balance. Various factors, including as stress, a poor diet, and environmental pollutants, can upset this balance. According to Ayurveda,

"vata", *"pitta"*, and *"kapha"* are the three *"doshas"*. *"Doshas"* are biological energy of the body or the regulating forces of nature. *"Vata"* is the principle of movement. It is responsible for the nervous system, creating and all kinds of movement in the body. "Pitta" is the principle of metabolism. It governs digestion and body temperature and helps keep a clear mind. *"Kapha"* is the principle of body structure. It provides the body with firmness and stability and helps maintain the body's fluid balance. These *"doshas"* or energies must be in balance for optimal health because they are in charge of the body's upkeep and growth.

The history of Ayurveda can be divided into three distinct periods depending on the predominance of the system of management of health and disease, *viz. Vaidika* period, *Samhita* period and *post-Samhita* period. Ayurveda formed a substantial part of of *Atharvaveda* of the *Vaidika* period. In this period emphasis was given on strengthening and maintenance of health through management of healthy life style. The *Samhita* period scholars expanded their vision to pharmacotherapeutics exploring the medicinal properties of plant, animal products and minerals. Although more emphasis was given to the use of plant based drugs due to their easy assimilation in the human body, but at several times minerals were also used in combination with plants forming herbo-mineral drugs. The use of independent mineral drugs was also not uncommon. Metals and metallic minerals were vigorously processed to make it physically soft, edible, assimilable and compatible with human body. Gradually, a new class of drugs termed as *"Rasaushadhi"* with a new science termed as *"Rasashaastra"* appeared in Ayurvedic system.[1]

Ayurveda endorses the use of metals such as gold, silver and copper for purification of water. The therapeutic properties of metals such as gold, silver, copper, iron, lead, tin and bronze metal are described in *Samhita* period literature.[1] Copper was one of the earliest metals to be used by mankind and it is considered sacred in many cultures. It is an important component in Ayurvedic medicine. The use of copper water or copper infused water has long since been practiced by our ancestors following ayurvedic principles and is still prevalent in many households.[2] Copper has antibacterial qualities and consuming water stored in a copper vessel for eight hours is believed to have a cooling effect on the body along with multiple benefits balancing the three *doshas* in our body. According to Ayurveda, copper has properties that aids in the process of peristalsis, that is the movement of food through the food canal and removes the undigested or poorly digested food particles from the walls of the small intestine and improves nutrients absorption and digestion of food. These undigested foods according to Ayurveda are the toxins and are responsible for all the diseases. Copper charged water has additional properties that induces fat loss. With such historic background, copper has found its way into the water purification industry. Drinking water stored in a copper bottle overnight is the very first step of the Ayurvedic morning routine which plays a very important role in keeping healthy and preventing diseases. This helps to

flush out all the toxins from the intestines which prevents many diseases. [1] Traditionally, Indian homes stored drinking water in copper and silver pots. When water is stored overnight in copper, small amounts of ions dissolve into the water and destroys microorgan-isms through a process known as oligodynamic effect. The oligodynamic effect is a biocidal effect of metals, especially heavy metals, that occurs even in low concentrations. This effect is attributed to the higher affinity of cellular protein for metallic ions. The microbes absorb the metal ions which damage their cell membranes. The cumulative effect of the ions within the microbial cells causes them to die even if the concentration of ions in the solution is negligible.[3]

The use of copper as antimicrobial medicine spread worldwide in the 19th and 20th centuries. A variety of inorganic copper preparations were used to treat diseases like eczema, impetigo, scrofulous, tubercular infections, syphilis etc. These treatments continued until the emergence of commercial antibiotics in the year 1932.[4]. Modern medical research continues to investigate the use of copper in medicine and its therapeutic benefits. Ancient societies had a very different concept of health and illness and they clearly believed that copper possessed therapeutic characteristics. This ancient wisdom is now supported by modern medical research which has helped to understand these qualities better. According to some recent studies, copper as a matter of fact have a variety of health advantages. These include its potential to aid in wound healing, antibacterial, and anti-inflammatory qualities.[5] Studies have also shown that copper have antioxidant qualities that help protects cells from damage caused by free radicals. Copper has also been explored and utilised as an antibacterial agent in wound dressings. Another way to benefit from the healing properties of copper is to wear copper bracelets. The use of copper bracelets is a traditional practice in many cultures, and many people believe that copper ions can be absorbed through the skin, providing many health benefits. Copper's therapeutic benefits have gained widespread recognition, it is still employed in a number of medical procedures.[1]

Importance of copper in human body :

Copper is a toxic but an essential trace element for the survival of living organisms. Today more than 50 types of copper containing proteins are known like lysol oxidase, tyrosinase,cytochrome c oxidase etc.[4] It is present in all tissues of the human body and is known to play a role in the production of red blood cells, the regulation of heart rate and blood pressure, the absorption of iron, the prevention of prostatitis or inflammation of the prostate, the development and maintenance of bones, connective tissues and organs such as the heart and the activation of the immune system.[6] It binds to ceruloplasmin, albumin and other proteins with significant biochemical functions. It is necessary for the production of energy, increasing the number of red blood cells and the development of brain and heart tissue. Lack of copper can lead to many health problems such as anaemia, osteoporosis, etc.[7]

Copper infused water is believed to be antibacterial in nature and has many health benefits such as better digestion, boosting immunity and curing arthritis. Copper makes the water alkaline, which helps maintain the body's pH balance. But in the modern world, metal utensils have been replaced by plastic and steel utensils which have caused many diseases and lifestyle abnormalities in the human body.[8]

Copper is an essential trace mineral that is vital for physical and mental health. But due to widespread occurrence of copper in our food, hot water pipes, medicinal tablets etc, the chances of copper toxicity increases. Copper may not be poisonous in its metallic state, but some of its salts such as copper sulphate in higher doses acts as a poison causing gastric and intestinal irritation. Copper is a powerful inhibitor of enzymes. It is needed by the body for several functions, mainly as a cofactor for a number of enzymes such as ceruloplasmin, cytochrome c oxidase, dopamine β-hydroxylase, superoxide dismutase and tyrosinase. It is present in several haematinics and its salts are also used therapeutically because of their astringent and antiseptic properties. But, sometimes copper salts are poisonous for human organ system. Copper toxicity occurswhen retention of copper occurs in the kidneys. Copper first start to deposit in the liver and disrupts its ability to detoxify elevated levels of copper in the body. This adversely affects the nervous system, reproductive system, adrenal functions, connective tissues etc. Toxic amounts of copper can leach into foods that has been cooked in unlined copper cookware. Such corroded cookware create reactive salts which are often poisonous like blue vitriol (copper sulphate), verdigris (copper sub-acetate). These salts when consumed in large amounts causes severe vomiting, abdominal pain, headaches and can even cause convulsion or paralysis. [9]

The role of copper complexes in medicines is not always straight forward and their role largely remains underestimated. Copper in food is processed by the liver and is transported and concealed in a safe manner. Inorganic copper mainly derived from drinking water or supplements mostly bypasses the liver and enters the free copper pool of the blood directly. This copper is potentially toxic as it can pass through the blood-brain barrier. About 50% of the daily dietary copper intake which is about 1-1.5 mg is absorbed by the stomach and small intestine. This is transported to liver bound to albumin and to the peripheral tissues bound to ceruloplasmin. Copper is incorporated into several metalloenzymes involved in haemoglobin formation, carbohydrate metabolism, biosynthesis of catecholamine, antioxidant defines mechanisms and cross-linking of collagen, elastins and hair keratin. The copper containing enzymes like cytochrome c oxidase, superoxide dismutase, ferroxidases, monoamine oxidase etc helps to reduce reactive oxygen species in the body. Copper deficiency in humans is rare but its deficiency may lead to normocytic, hypochromic anemia, leukopenia and osteoporosis. [6,7,9] Copper is crucial element for brain development during fetal and post-natal growth and maintenance of brain health including effective anti-oxidative defences throughout life. Copper plays important roles to communicate between nerve

and cells, maintain healthy skin and connective tissues and to heal wounds. It is essential for structural integrity and function of heart and blood vessels and growth of new blood vessels. Copper helps to maintain proper structure and function of circulating blood cells and formation of the new blood cells of our immune system for maintaining a healthy and effective immune system. It is also useful for generation and storage of energy in mitochondria-the power houses of our cells.[6]

Antimicrobial properties of Copper :

Bacteria, yeast, fungi and viruses are rapidly killed on metallic copper surfaces. This process is termed "contact killing".[4] Modern studies confirm that copper is a naturally hygienic metal that slows down the growth of germs such as *Escherichia coli, Mycobacterium tuberculosis*, methicillin resistant *Staphylococcusaureus (MRSA), Clostridiumdifficile*, influenza A virus, adenovirus,and fungi. [8,10,11,12] Copper alloy surfaces are sterile and have intrinsic properties to destroy a wide range of microorganisms. That is why ancient Ayurveda practitioners used copper vessels for the preparation of different drug formulation for both external as well as internal use.[13] The U.S. Environmental Protection agency has also registered copper as the first solid microbial material. The process of contact killing of microbes was believed to proceed by successive membrane damage, copper influx into the cells, oxidative damage and DNA damage followed by cell death.[4]

Influenza A is a viral pathogen that causes significant mortality and morbidity, in the elderly and in high-risk groups. Influenza easily spreads through direct or indirect contact with respiratory secretions when contacting surfaces contaminated with the influenza virus. This virus can survive on a variety of environmental surfaces, including stainless steel. A recent study suggested the application of copper-based surfaces to reduce the transmission of influenza A virus, where rapid inactivation occurs after 6 hours. [14] Other studies have confirmed the antimicrobial properties of copper against many pathogenic bacteria, including *Escherichia coli* O157, *Salmonella enterica, Campylobacter jejuni, Staphylococcus aureus,* etc. [2,8,10,11,12] After surfaces have been contaminated, fingers can transfer viral particles to up to seven other clean surfaces, suggesting that materials with innate antiviral properties may act to prevent further contamination. The mechanism of reduced infectivity after exposure to copper is not clearly known. The redox properties of copper, which generates hydroxyl radicals is believed to cause cellular damage in microbes. Another route of copper ion toxicity was suggested to be the displacement of iron from iron-sulphur clusters and zinc from important binding sites of proteins.[4] Test results with methicillin-resistant *Staphylococcus aureus* suggest that copper ions have the ability to disrupt DNA by binding and cross-linking between and within the strands. Viral replication may also have inhibited by copper-related RNA-negative genome damage of the influenza A virus.[14]

The spread of pathogenic microorganisms cannot be achieved by one single way. With the emergence of potentially pandemic viral strains like SARS COV, requires the highest level of hygiene control, which needs multi-barrier protection. Simply replacing steel appliances with copper does not prevent the transmission of influenza. However, studies showed that copper surfaces can contribute to the number of control barriers capable of reducing virus transmission, especially in environments such as schools and health care units, where viral contamination can cause serious infections. The best approach to controlling the flu is to prevent the infection itself through excellent hygiene standards and vaccination programs.[14]

Copper nanoparticles : "Tamra Bhasma" in Ayurveda

According to Ayurveda, *"bhasmas"* are drugs based on metal or metal oxides. Metals and metal oxides gained the true status of drugs in the field of medicine during the *'Samhita'* age of Ayurveda. A complex and elaborate procedure for the preparation of bhasma was described by sage *Nagarjuna* around 800 AD in *Rasashaastra*. According to Ayurvedic metallurgy, bhasma is product of herbo-metallic product and contains both metallic and herbal ingredients. It is basically a calcined form of metals or minerals treated with herbs. This process has been meticulously followed even today. *Bhasmas* were believed to be more efficacious than any other healing system in ancient India. These *bhasma's* are infact nanomedicines with nanosized (10^{-9} m) particles. They are more biocompatible as compared to any chemically produced entity because they are insoluble and can absorb and enter into the blood stream very easily due to its size to volume ratio. *Bhasmas* as compared to their herbal drug counterparts are stable over a longer period of time, require lower doses, are easy to store with sustainable availability.[15] Currently, there is an urgent need for the practitioners of modern and traditional systems to standardize the synthesis procedure, rigorous scientific analysis for the quality, safety of these metal-based bhasma's. One of the widely used metal oxide based Ayurvedic drug is *Tamra Bhasma* derived from metallic copper. It is recommended for different ailments of liver and spleen, dropsy, abdominal pain, heart disease, colitis, tumors, anemia, loss of appetite, tuberculosis, as well as eye problems. The ancient Egyptian medical texts mentions the use of copper for the purpose of sterilizing chest wounds, which provide evidences of first use of copper as healing drug. The Greeks, Romans and Aztecs also used copper or copper compounds for the treatment of headaches, burns, intestinal worms, ear infections and for general hygiene. [4] Inorganic methods of copper synthesis have been found to be effective in treatment of eczema, impetigo and tuberculosis infections.

Copper and its salts are also known to produce gastric intolerance. That is why *Ayurvedic* practitionersused copper in "bhasma" form and as a part in compound formulations termed as *"Yoga"*. The prescribed dose of bhasma ranged from 15 to 60 mg with different adjuvants termed as *"Anupana"*. The most commonly used *anupana* or

adjuvant was honey, followed by zinger juice, cow ghee, beetle leaf, pepper powder, sugar and warm water. Importance of these specific adjuvants, especially honey and ghee, is that they enhance the potency of the ingredients as well as facilitate their journey to the intended destination due to their carrier property. In some formulation *Tamra* has been used indirectly in a form of preparation medium or in form of vessel for the preparation of some formulations where *Tamra Bhasma* are not directly used. Often pestle made from *Tamra* is used for grinding and mixing of the formulations.[6] Several synthesis techniques have been employed to prepare these metal oxide nanoparticles. These techniques play a vital role in giving the uniqueness to the final nanoparticle and thereby influencing its medicinal properties [16]. The classical texts of *Ayurveda* and *Siddha* says that it is the distinctive methods of preparations which gives significance to the metal oxide nanodrugs [17]. The preparation method of these herbo-metallic oxide nanoparticles involve complex and repetitive processing steps of annealing, detoxification, and calcination.[5] It is believed that during the synthesis process, the metals from their raw state, in combination with the herbs, get converted to their respective oxides, which eliminates the metal toxicity and provides medicinal properties.[17]

Copper oxide nanostructures finds multiple applications in the field of biomedicine. It is found to exhibit anticancer, wound healing, antibacterial properties, anti-inflammatory and antitumor property.[18], There are also reports of the usage of purified form of copper oxide in the treatment and management of obesity, tuberculosis, cough, asthma, skin diseases, and obesity [19]. Copper nano-oxides have been used as coating in metallic dental implants along with several other biomedical applications. *"Thamira parpam"* is a copper containing herbo-metallic oxide nanocomplex. It is known as *"Gunma kalan"* in *Siddha* literature and has been in human use since ancient times for the management of ulcers. [5].

Tamra (copper) is one of such metals which are being used in therapeutics in different forms since centuries. *Tamra Bhasma* has been used in the Indian system of medicine for the treatment of different ailments like peptic ulcer (*Parinamashula*), anaemia (*Pandu*), abdominal pain (*Udara shoola*), haemarrhoids (*Arsha*), skin disorder (*Kushtha*), dyspnoea (*Shwasa*) etc.[20] Copper is the ingredient of many profusely used herbo-mineral formulations like *Arogyavardhini Vati, Hridayarnava Rasa, Panchamrita Parpatietc.*[6] The use of Tamra is described in *Shuddha Dhatu Varga* used by *Rasavaidyas* in therapeutics since *Samhita* period. In this period, it was used in the form of simple powder (*bhasma*) with nopharmaceutical processing. After 10th Century A.D., during the post-Samhitaperiod, different texts of *Rasashaastra* describes the use of Tamra systematically in the form of its types, preparative methods (*Grahyagrahytva, Shodhana, Marana*), pharmacological actions, therapeutic uses etc. Since then *Tamra* is a well known material, successfully used to treat various diseases in the form of *Bhasma* as single or compound preparation with other herbo-mineral drugs. [13]