MKR GOVT. DEGREE COLLEGE

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Affiliated to Mahatma Gandhi University

DEVARAKONDA, NALGONDA, TELANGANA

A REPORT

ON

Student Study Projects

ORGANIZED

BY

DEPARTMENT OF BOTANY

S. No.	Year	Project Title
1	2019-20	**The uncultivated and wild greeny leafy vegetables consumption in Devarakonda- A tribal area.**
2	2020-21	**A Study on Diversity and observation of Lichens in Devarakonda Fort, Devarakonda.**
3	2021-22	**Mass multiplication of *Azolla* (Bio-fertilizer) for Sustainable Agriculture**
4	2022-23	**Vegan milk: An alternate to cow's milk for sustainable health.**

The Student Jignasa Study Project

The uncultivated and wild greeny leafy vegitables consumption in Devarakoda- A tribal area.

PROJECT REPORT

Done by

B.Sc. Life Sciences II nd Year students- 2019-20.

Submitted to

The Commissioner of Collegiate Education
Government of Telangana
Hyderabad

M.K.R. GOVERNMENT DEGREE COLLEGE,

DEVARAKONDA, NALGONDA, 508242.

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CERTIFICATE

This is to certify that this project report entitled, **"The uncultivated and wild greeny leafy vegitables consumption in Devarakoda- A tribal area"** is the bonafied work of B. Sc. Life Sciences Second year students during the academic year 2019-20 under the supervision of Dr. Ch. Rama Raju, Assistant Professor of Botany.

Signature of the Principal

PRINCIPAL
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DECLARATION

We the students of B.Sc. Life Sciences, Second year, declare that this work has been originally carried out by us under the supervision of **Dr. Ch. Rama Raju,** Assistant Professor of Botany, M.K.R. Governament Degree College, Devarakonda, Nalgonga and this has not been submitted to any other institution/ university.

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B.Sc. B.Z.C.Second year students- 2019-2020.

The uncultivated and wild greeny leafy vegetables consumption in Devarakoda - A tribal area.

INTRODUCTION

"An eminent doctor told me that proper use of green leaves could revolutionize the customary notions of food. That, of course, means elaborate research and examination of the nourishing properties of the innumerable leaves that are to be found hidden among the grass 's that grow wild in India." – **Mahatma Gandhi.**

The overlapping nutritional and medicinal benefits of green leafy vegetables provide a better support for human wellbeing. There are hundreds of edible herbs which are used in day to day kitchen in different forms. The usages of green leafy vegetables are limited to a specific geographical location. The chemical constituents present in green leafy vegetables are of great pharmacological or medicinal importance. Phytonutrients present in green leafy vegetables produce many common health benefits like protection from eye problems, oxidative stress, iron deficiency, etc. (Sreeramulu, 2013).

In the present study, we have used word "uncultivated" in a more general way to denote one of the following three categories.

- The greens from land that are not cultivated such as plant, creeper, etc.
- The greens that are not cultivated but are available as per partner crop in a cultivated field, etc.
- The greens that are available from cultivated plants, but the product was not the explicit objective of the cultivation.

The term "wild" when applied to plants refers to those that grow spontaneously in self-maintaining populations in natural or semi-natural ecosystems and can exist indipendently of direct human action.

Green leafy vegetables (GLV) are used since ancient periods as source of food as they contain many nutrients and minerals which are helpful in maintaining human health.

The health and nutrition of expanding world populations are major upcoming challenges especially in developing countries. Man has tremendous knowledge on edible plants since before civilization. Traditional vegetables are valuable sources of nutrition in rural areas where exotic spp. are not available. Leafy vegetables hold an important place in well-balanced diets. Green leafy vegetables are the cheapest of all the vegetables within the reach of poor man, being richest in their nutritional value. The lack of knowledge especially on the nutritive value of these uncultivated GLV among the public in general is the main drawback in their lower consumption. The ingestion of phytochemicals found in traditional foods has direct implications for the well-being of people. Limited information is available on the medicinal properties associated with leafy vegetable consumption in Devarakonda-Telangana State. By documenting the traditional knowledge of GLV foods and describing their importance in terms of consumption, we highlight health, nutrition and cultivation relationships with potential impacts. GLV are sources of nutrients and micronutrients of great interest to nutritionists such as iron and vitamin C, which are lacking from staple foods.

Micronutrient deficiency is a public health problem affecting more than one-fourth of the global population. Vitamin A deficiency, iron deficiency and iodine deficiency disorders are the most common forms of micronutrient malnutrition globally. Nutritional anemia can be caused due to deficiencies of micronutrients such as iron, folic acid and vitamin B_{12}, with iron deficiency being the most common cause of anemia. In India, the prevalence of anemia was relatively low among men aged 15-49 years (22.7 percent) in comparison to women (53.1 percent) and children (58.5 percent) (Gonmei & Toteja 2018). To tackle the problem of malnutrition, the Ministry of Women and Child Development, GoI came up with a health program called, POSHAN Abhiyaan (earlier named as National Nutrition Mission, NNM). The mission is backed by a National Nutrition Strategy (NNS) prepared by the NITI Aayog- a premier think-tank of the Govt. of India, with the goal of attaining "Kuposhan Mukt Bharat" (malnutrition-free India) by 2022. Anemia Mukt Bharat strategy was launched as part of the POSHAN Abhiyaan. Several programs have been launched over the years in India to improve nutrition and health status of the population; however, a large portion of the population is still affected by micronutrient deficiency.

Historical note

Devarakonda is a town in the Nalgonda district of the Indian state of Telangana. It is a municipality in Devarakonda mandal of Devarakonda division. It is located about 60 kilometres (37 mi) from the district headquarters Nalgonda, 104 kilometres (65 mi) from the state capital Hyderabad.

Devarakonda Mandal, with population of about 99 thousand is located in Nalgonda district, Telangana. India. There are 26 villages in the mandal, among them Tatikole is the most populous village with population of 6418 and Yepoor is the least populous village with population of 190. Devarakonda Mandal is bounded by Chandampet Mandal towards South, Pedda Adiserla Pally Mandal towards East, Gundlapally (Dindi) Mandal towards west, Nampally Mandal towards North. Devarakonda City, Macherla City, Srisailam Project (Right Flank Colony) Township City, Nagarkurnool City are the nearby Cities to Devarakonda.

Demographics of Devarakonda Mandal

Telugu is the local language. Some people also speak Urdu. Total population of Devarakonda Mandal is 86,584 living in 17,726 houses, spread across total 104 villages and 22 panchayats. Males are 44,739 and Females are 41,845. Out of total population, 27,434 live in town and 59,150 live in rural.

The Devarakonda region of Nalgonda Dist., Telangana is situated in a semi-arid region. Devarakonda lies between 16° 42' 0"N, 78° 55' 59.88" E. The total geographical area of the district is 9 699 sq km, accounting for 3.5% of the total area of the state. Though semi-arid, lands here can receive erratic and heavy seasonal rainfall. Soils are highly degraded with soil depths in most places of less than 6 inches. Red soils dominate the land and productivity is regarded as generally low. However, the Tribals of Devarakonda have engaged in rural development activities to improve their nutrition. It is in this context that this research addresses agriculture of the poor and the role of uncultivated and wild food. Over the millennia, uncultivated foods and wild foods have been an essential part of life for the poor in this region. These are harvested at no cost by Tribal women farmers and consumed as vegetables, thus providing a rich source of nutrition and a source of food security.

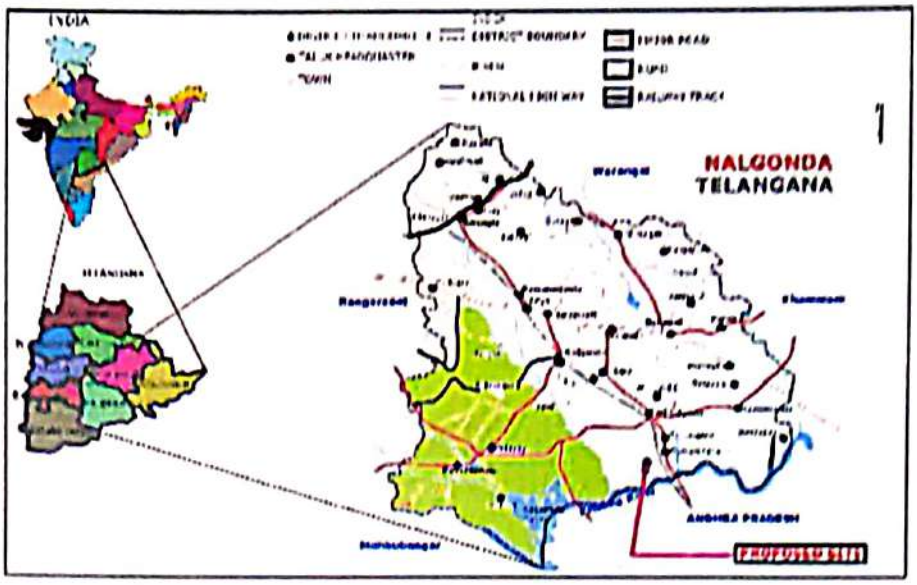


Fig.1 Location of Devarakonda (shown in green shade).

Socio-economic profile

Devarakonda is home to about 99 thousand people, among them about 51,000 (51%) are male and about 48,000 (49%) are female. 55% of the whole population are from general caste, 13% from schedule caste and 32% from schedule tribes (Lambadis). Child (aged under 6 years) population of Devarakonda mandal is 13%, among them 52% are boys and 48% are girls. There are about 22,000 households in Devarakonda and an average 4 persons live in every family.The majority of the population, nearly 60% (about 60,000) live in Devarakonda rural part and 40% (about 39,000) population live in the Devarakonda urban part.

Climate

The climate of the Devarakonda region is characterized by hot summers and generally dry weather with rain showers expected during the monsoon season. The year is divided into three seasons: winter (November to February), summer (March to May) and southwest monsoon (June to October). The average annual rainfall in the district is 896.7 mm.

Devarakonda, a tribal assembly constituency is situated in the semi-arid tract. Lands here are rainfed and highly degraded. Soil depths in most places are less than 6 inches. Red soils dominate the land. Consequently productivity is abysmally low.

Farmers feel extremely lucky if an acre of land produces two quintals of sorghum or cotton. Erratic rainfall which has become the hallmark of the last decade leaves even this level of productivity with a question mark seriously threatening the food security of the poor who mainly own these types of lands. It is in this context that one should look at the agriculture of the poor and the role of uncultivated food in their lives.

The value of wild edible vegetables in food security has not been given sufficient attention in these days. Consequently, there are no formal interventions that seek to encourage people to use traditional vegetables as sources of essential nutrients. For many years the importance of wild plants in subsistence agriculture in the developing world as a food supplement and as a means of survival during drought and famine has been overlooked. Nevertheless, whereas the rich indigenous knowledge on the medicinal use of wild plants has been relatively well documented, research, particularly concerning the socio-economic, cultural, traditional, and nutritional aspects of wild food plants still lacks adequate attention.

Tribal people of Devarakonda are endowed with a deep knowledge concerning the use of wild plants as food purposes. The study highlights some of the important uncultivated green leafy vegitables, which need to be documented for food security in future. The present study is on edible leafy vegetables available in Devarakonda and their importance in nutrition and contribution of these green vegetables towards the health of the poor, essential in this modern world to support the benefits of their consumption.

Significance of study

It has been observed that he traditional knowledge on uncultivated and wild food plants is on sharp decline. Unless efforts are made to educate the younger generations about their importance, it may be lost in near future. This type of study would contribute significantly in Government policies to improve food security in tribal areas, and in the improvement of wild vegetable status, whose potential as sources of nutrition is currently undervalued. Limited information is available on the medicinal properties associated with leafy vegetable consumption in Devarakonda-Telangana State. Documentation of traditional knowledge of green leafy vegetable foods and their importance in terms of consumption, health and nutrition is the need of the hour.

OBJECTIVES

- to conduct survey of the uncultivated and wild vegetable plants used by the tribal population in Devarakonda.
- to know the plant parts used by them for treating various diseases.
- to educate the younger generations about the importance of uncultivated and wild greens.
- to improve food security in tribal areas, and in the improvement of wild vegetable status, whose potential as sources of nutrition is currently undervalued.

LITERATURE REVIEW

Sanyasi Rao et al., (2014) investigated on uncultivated vegetables in the Dumbriguda agency region of Visakhapatnam District. The study also deals with community perspectives and utilization of wild vegetables in their food system. The study revealed that a total of 55 indigenous food plants formed the largest group which includes tubers, rhizomes, roots, young leaves, buds, bulbs, inflorescence, unripe / ripe fruits and seeds. Among them 24 species are used as leafy vegetables, 21 species for fruits, 6 species for tubers, 4 species for tender shoots, 2 each for seeds and flowers.

Abubacker et al., (2018) survey of some ethnomedicinal plants used by tribal population in Nilgiri Hills, Tamil Nadu, India was conducted. A total of 49 plant species belonging to 29 families were documented in their survey. They reported, six plants from Astraceae, 4 plants from Lamiaceae, 3 from Solanaceae and Rutaceae, 2 each from Scrophulariaceae, Apiaceae, Myrtaceae, Liliaceae and Poaceae. Common names of the medicinal plants, their parts employed as medicine and their ethnomedicinal uses were documented.

Reddy et al., (2007) documented the traditional wild food plants used by tribal people in Andhra Pradesh. A total of 156 species were documented as wild plants used for food purposes. They observed that the traditional knowledge on wild food plants is on sharp decline.

Monoranjan Chowdhury and Rajrupa Mukherjee (2012) worked highlighting those plants (Angiosperm and Pteridophytes) used as leafy vegetable and wild fruits among the

different local and tribal peoples in the remote areas of the district Maldah. A total of 84 angiosperms belong to 71 genera representing 46 families and 2 species of Pteridophytes belonging to 2 genera representing 2 families have been enlisted from the district. Different parts of wild plants like leaves, young twig, seeds, petiole, rhizome etc., are generally used as vegetables.

Food and Nutrition Security Analysis, India (2019) studied micronutrient malnutrition that lead to low immunity, higher disease burden and lower productivity. To tackle the problem of malnutrition, the Ministry of Women and Child Development, Government of India came up with a health program called, POSHAN Abhiyaan (earlier named as National Nutrition Mission, NNM).

METHODOLOGY

Several field trips were undertaken in villages of Devarakonda mandal during 2018-2019. At each time of the visit, different tribal hamlets and forest pockets were chosen in different seasons to collect more information. The information was accrued after discussions with several tribal persons, village head, elder women and other local informants. Repeated interviews through questionaires were made in different villages to authenticate the information. To derive the traditional food list 12 key informants (three different age groups) from each village met and created a freelisting of food. The study team visited areas where species were found extensively in situ with the help of a social mobiliser and collected unidentified specimens for discussion with key informants. Information about species habitats was recorded, and photos were taken for future reference. Plant specimens wer collected and identified with regional floras. All the specimens were deposited in herbarium of Department of Botany, MKR Govt. Degree College, Devarakonda.

RESULTS

During this study, it was observed that the people living in villages' food needs supplementing with uncultivated greens in their daily diet. They were well familier with the plants of surrounding forests and know what to eat and how to cook.

The full list of foods traditionally consumed by Dalit families is presented in Table 1. The plants are enumerated alphabetically with their botanical name, family,

local name. It is also interesting observation that tribal communities not only used for self consumption but they also try to sell by tribal women seasonally in weely markets to earn income.

The most popular and highly appreciated uncultivated greens were sanna payala, adavi pullakura, chemchali, kup i, bankanti kura and ponagantikura (refer Table 1 for Scientific Names).

A total of 38 plant species belonging to 20 families were recorded after conducting survey. Amaranthaceae recorded highest number of species (10 species) followed by Caesalpinaceae (5 species), Lamiaceae, Apiaceae, Malvaceae, Convolvulaceae, Aizoaceae (2 species each) and remaining all have one species each. Leaves are collected in different seasons, cooked and eaten with their staple food. Many tribal people are using leafy vegetable as a part of their food. These leafy vegetables are either collected from forest areas or found as weed in moist areas of cultivated and open fields. Women are found to play a major role in the collection and preparation of wild leafy vegetables. Most of the uncultivated greens are harvested during rainy season and winter and where water is flowing in banks of river, canals and moist areas. Interstingly tribal elders have tremendous knowledge in terms of utilization of neighbouring plant material for consumption for example *Cissus quadrangularis* tender shoots are commonly used as vegetable than older shoots.

Taxonomic identifications

Fresh plant samples were collected with the root system intact during the flowering or fruit bearing stage and labeled. They were identified using standard books (Pullaiah, 2015).

Medicinal importance of green leafy vegetables

Green leafy vegetables (GLV) offer a cheap but rich source of a number of micronutrients and other phytochemicals having antioxidant properties. They are the rich sources of provitamin A, vitamin C, folic acid and minerals like calcium, iron, phosphorus, sodium and potassium. Green leafy vegetables are known to contain antioxidants necessary in neutralizing free radicals which are known human chemical

Table 1. Uncultivated and wild plant species used as vegetables by tribal people of Devarakoda.

S.No.	Scientific name	Common name	Family
1	*Acalypha indica*	Kuppi	Amaranthaceae
2	*Achyranthes aspera*	Uthareni	Amaranthaceae
3	*Aerva lanata* (L) Juss.	Pindi	Amaranthaceae
4	*Allamania nodiflora* (L) Wt.	Nagali kura	Amaranthaceae
5	*Alternanthera sessillis*	Ponnaganti kura	Amaranthaceae
6	*Amaranthus spinosus*	Mulla doggali	Amaranthaceae
7	*Amaranthus viridis*	Doggali kura	Amaranthaceae
8	*Anisochilus carnossus* (L. F) Benth	Kodipunjuchettu	Lamiaceae
9	*Basella rubra*	Yerra bacchali	Basellaceae
10	*Boerharia diffusa* L.	Athaka mamidi	Nictaginaceae
11	*Canthium* spp.	Balusuku	Rubiaceae
12	*Cassia ariculata*	Thengedu puvvu	Caesalpinaceae
13	*Cassia fistula* L.	Rela	Caesalpinaceae
14	*Cassia italica* (Mill.) Andr.	Nela tangedu	Caesalpinaceae
15	*Cassia sophera*	Chennangi	Caesalpinaceae
16	*Celosia argentia*	Gunagu	Amaranthaceae
17	*Centella asiatica*	Gotukola	Apiaceae
18	*Cissus quadrangularis*	Nalleru	Vitaceae
19	*Cleome gynandra* L.	Vaminta	Cleomaceae
20	*Coeculus hirsutus* (L.) Diels	Dusseru	Menispermaceae
21	*Colocasia antiquorum*	Chama akulu	Araceae
22	*Corchorus olitorius*	Bankanti kura	Malvaceae
23	*Digera arvensis*	Jonnachemchali	Amaranthaceae
24	*Digera muricata* (L.) Mart.	Chenchelikura	Amaranthaceae
25	*Euphorbia hirta* L.	Reddyvarinanupalu	Euphorbiaceae
26	*Hibiscus cannabinus*	Punti kura	Malvaceae
27	*Hygrophila spinosa*	Nirmulli	Acanthaceae
28	*Ipomea aquatic* Forsk	Thootikura	Convolvulaceae

29	*Leucas aspera* (willd.) Link.	Tummi kura	Lamiaceae
30	*Merremia tridentata*	Seetamma jada	Convolvulaceae
31	*Moringa oleifera*	Munaga	Moringaceae
32	*Oxalis corniculata*	Adavi pulla koora	Oxalidaceae
33	*Portulaca olaracea* L.	Payala kura	Portulacaceae
34	*Solanum nigrum*	Nalla kasha	Solanaceae
35	*Tamarindus indica*	Chinta chiguru	Caesalpinaceae
36	*Trachyspermum copticum*	Vamaku	Apiaceae
37	*Trianthema decandra* L.	Tella garjala	Aizoaceae
38	*Trianthema portulacastrum* L.	Nalla galijeru	Aizoaceae

Table 2. Medicinal plants and their use.

S.No.	Common name	Plant part	Medicinal use
1	Kuppi	Leaves	skin problem, jaundice
2	Uthareni	Roots and leaves	internal piles and the roots are used as a brush to relieve pain and clean the teeth.
3	Pindi kura	Whole plant	Urinary problems.
4	Ponnaganti kura	Leaves	diuretic, cooling, tonic and laxative beneficial for the eyes properties,
5	Athaka mamidi	Roots	Used for gas troubles.
6	Thengedu	Flowers	for cleaning the hair
7	Nelatangedu	Leaves, Seeds	used as a hair treatment, luxative
8	Chennangi	Leaves, Seeds	Anthelmintic, luxative
9	Bramhi	Whole plant	for improving the memory.
10	Nalleru	Tender shoots	to heal broken bones and injured ligaments and tendons
11	Vaminta	Leaves	Anthelmentic, in ear diseases, gastro intestinal disorders
12	Nirmulli	Whole plant, Leaves	Urinary infections, dysuria, thirst, urinary calculi, urinary discharges, anemia, and abdominal disorders.

13	Tummi kura	Leaves	to relieve coughing and cold.
14	Munaga	leaves and flowers	Increase fertility in men, anaemia
15	Vamaku	Leaves	Flatulence, abdominal tumours, abdominal pains, piles, and bronchial problems.
16	Tella garjala	Whole plant, Leaves	Anti- inflammatory, hepatoprotective and antioxidant, kidney problems.
17	Nalla galijeru	Whole plant, leaves	Relieve obstructions of the liver, to treat venereal discharge.

hazards. Signs of blood deficiency include vertigo, blurred vision or spots before the eyes ('floaters'), fatigue and lassitude, insomnia, poor muscle tone, muscle tightness and cramping, numbness in the extremities, dry skin and hair, pale tongue (also lips and nailbeds), poor memory, difficult or no menstrual periods, a persistent feeling of cold, heart palpitations, and anxiety / nervousness. Iron or blood deficiency causes anemia which is a nutritional disorder afflicting large population groups in the world. It is prevalent amongst vulnerable infants, adolescent girls and pregnant women particularly in populations subsisting largely on plant food sources. Green leafy vegetables help increase iron in the diet and in the blood. Common Compounds and minerals present in green leafy vegetables that avoid eye problems are Ascorbic acid (vitamin C), Tocopherol (Vitamin E), Vitamin A (retinol and provitamin A), Lutein and zeaxanthine, Lycopene, Folate, Riboflavin, Niacin, Molybdenum, Selenium and Zinc. A majority of pharmacological studies on consumption of green leafy vegetables reported that the leafy vegetable intake is good for health; it acts as a blood tonic, joint pain reliever and helps in eye problem prevention.

Uncultivated crops played a key role in the health of poor people. They utilized these greens in different forms – curry, leaf extracts and tokku (chutney) to cure common ailments such as headaches, swellings, wounds, scabies, improper digestion, and major diseases such as jaundice and diabetes (Table 3).

Leaves, pods and unmatured seeds of *Senna italica* Mill.are used to treat fever, stomach complaints, jaundice, skin disease, veneral diseases, and used as purgative. Leaves are particularly used as henna which gives yellow glossy hair.

Importance of uncultivated greens as food

Most of the rural people consumed uncultivated crops at least 50 to 80 days in a year. While working in their fields, the poor gathered these greens and brought them home. Those who did not work as farmers went to nearby fields specifically to gather these greens. Doggali, payeli and pindi were consumed throughout the year. Pindi and doggali were eaten more than 20 times in a year by some families. Some of the greens e.g. ponaganti, doggali, yerra bacchali and puntikura were sold in nearby towns because they were liked by urban dwellers, and were recognized as good for health. Farmers celebrate this huge diversity present on their farms in various forms and while doing so they also celebrate the diversity of uncultivated greens present in their fields with great reverence. One such example is the celebration of "Kalegura panduga", a feast on Ganesh Chaturthi.

Reduced availability of uncultivated greens in fields using chemicals

Uncultivated greens were present mostly in farm fields where manure was applied or where chemical fertilizers were not applied. Very few greens were seen in fields treated with chemical pesticides especially herbicides. However, farmers felt it was not safe to eat these greens and they were generally not collected. For several reasons, people no longer ate wild seasonal uncultivated greens as in former years, which is a reason for low consumption in this population. Very few greens are seen in cotton growing fields as they die when they are young due to weedicide spraying. Due to this only wild varieties are available.

Uncultivated greens as tasty and rich sources of nutrition

Villagers testified that these greens were tasty and healthful. For example, Mutyamma of Mudigonda village reported that, "Doggali kura is more tasty than chicken". Generally they were cooked with pulses. Sometimes leaves of these greens were cooked by adding onions and tomato. Some time's different leaves of uncultivated

greens are cooked together (Kalegura). These foods do not need any special except a little bit of oil but still they are tastier (Tokku) according to Seshamma of Mudigonda village. Sometimes leaves of these greens are cooked by adding little bit of onion. Generally they are mixed with gram dal, red gram dal and green gram dal. The results revealed that *chamcheli*, one of the most common uncultivated green, contains 3237 mg of calcium per 100g of edible portion and 111.3 mg of iron; and *Tummikura,* which is highly auspicious and consumed by every family, is rich in iron with 81.6 mg per 100g of leaf (Gopalan 1996). The results once again proved that the knowledge and wisdom of our women is far superior.

Uncultivated crops: Source of food and income for poor

Most of the rural people especially the poor consume uncultivated vegetables at least one or two days in a weak. Earlier it was eaten for more number of days. Poor while working in their fields gather these greens and bring them to house. Those who don't work go around the near by fields specially to gather these greens. Doggali kura, Gangavayeli, Sannavayeli and Pindi are consumed throughout the year. Pindi, ponaganti kura and Doggali kura are eaten more than 20 times in a year by some families. When monitorized each family consumes uncultivated crops worth Rs.500-1000 out of their total expenditure on vegetable depending on family size. Uncultivated foods like chenchali, puntikura, payalkura, ponagantikura, chintachiguru and tootikura are also sold in towns, as they are preferred by people in towns, because they are good for health.

Utility of uncultivated crops during famines

Past history clearly indicates that uncultivated foods had a major share in the food consumed during famines and stress periods. In Devarakonda region when there was famine 40 years ago people survived for few months by eating these uncultivated greens specially Doggalikura, Gangavayeli, Sannavayeli, Pindi, Gunugu Kura, Uttareni. People ate more of curries made of these greens and negligible roti and rice. Pindi was even mixed in Jowar flour and rotis were made, as there was not enough flour. Poor people used to go for well digging and well restoration and collected these greens from near by sugarcane fields. According to Pilli Kanakamma aged 95 of Mudigonda village, rotis were made from jowar flour mixed with pindikura and boddikura, a common practice in those famine periods (Rajakarla period).

Fig. 2 Collecting information from an old women at Mudigonda village

Fig. 3 A woman showing the uncultivated green used as food

Fig. 4 Collecting information from women and men in the fields and houses.

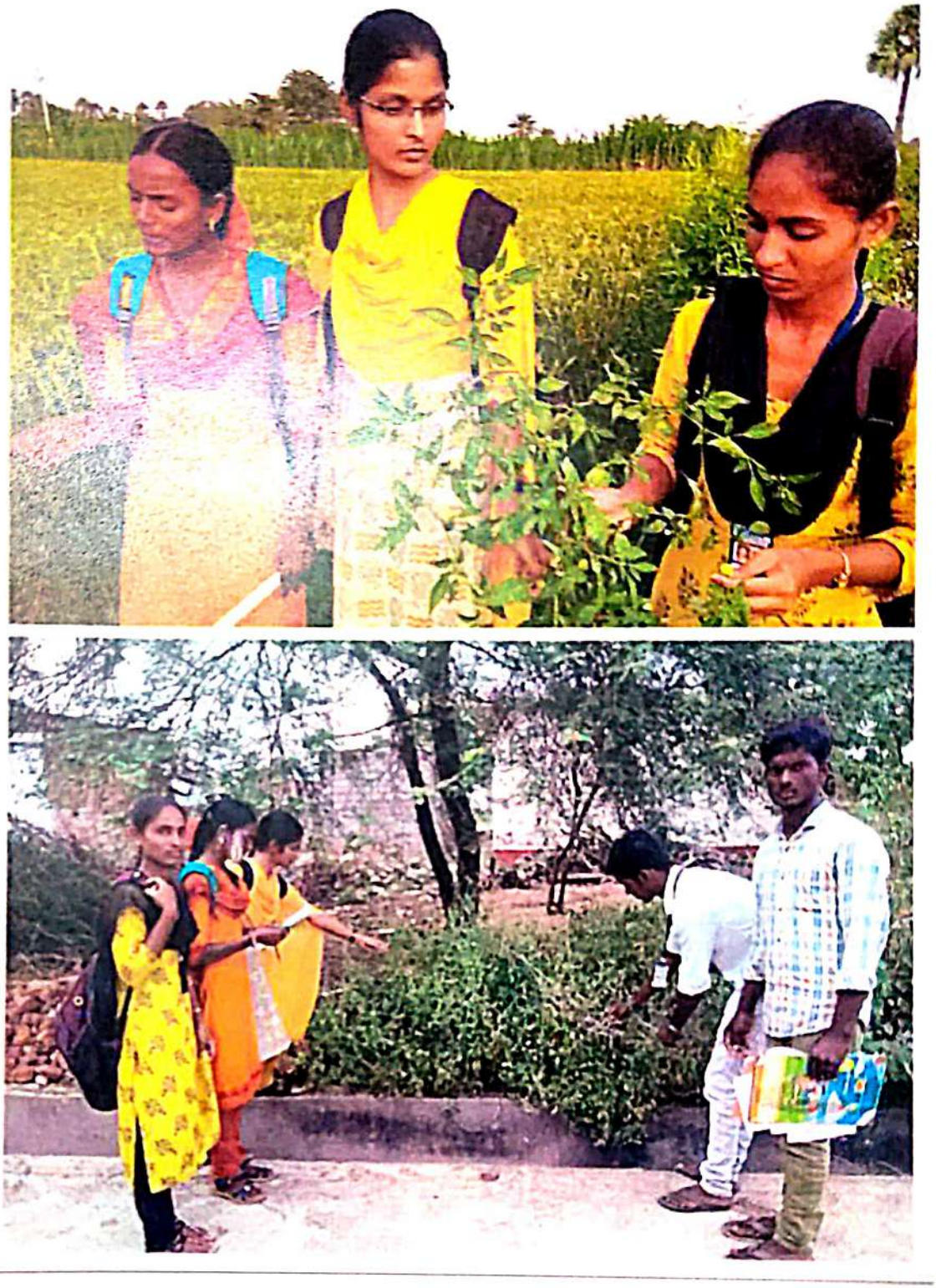
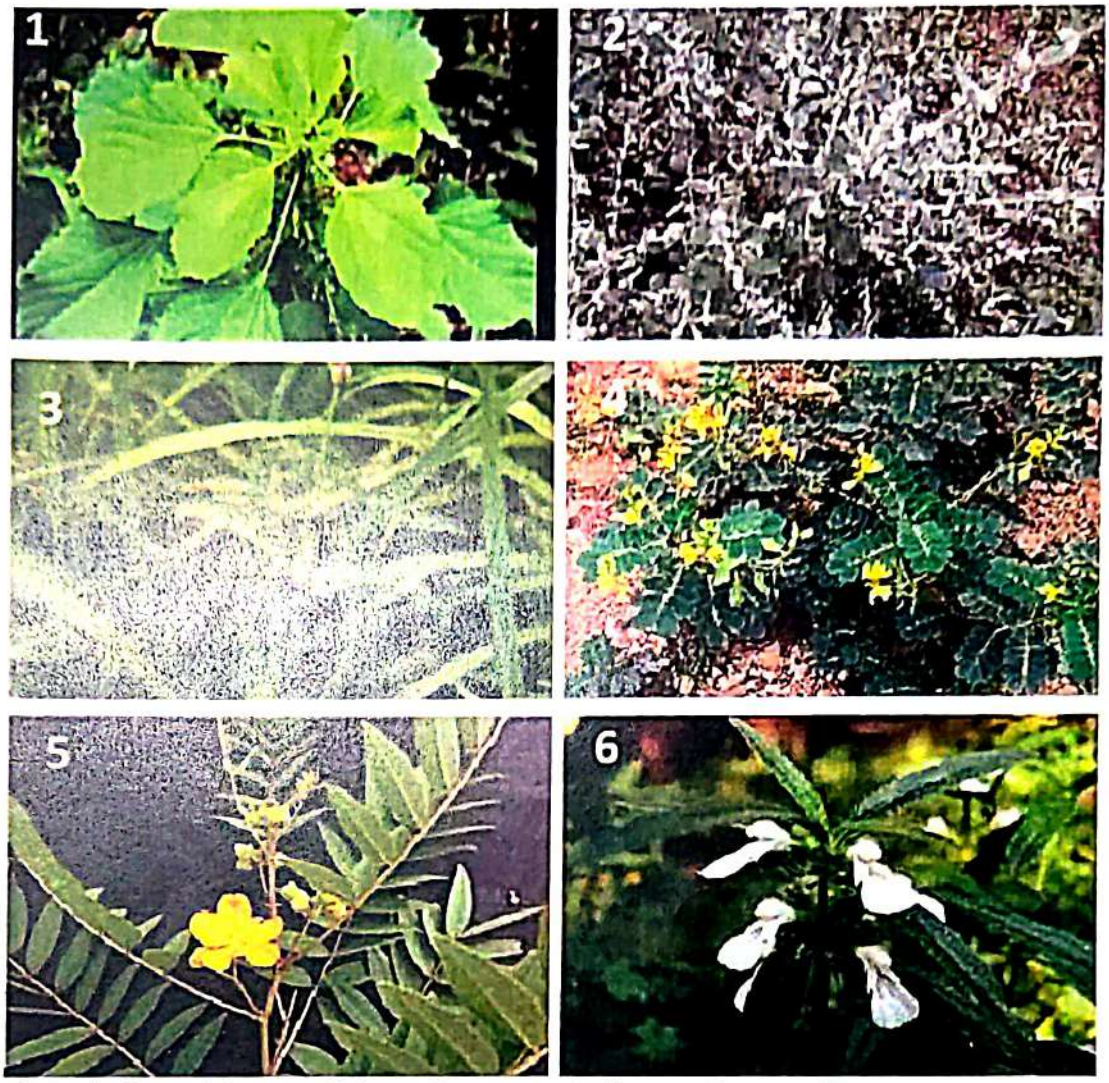


Fig. 5 Collection of uncultivated and wild greens in villages

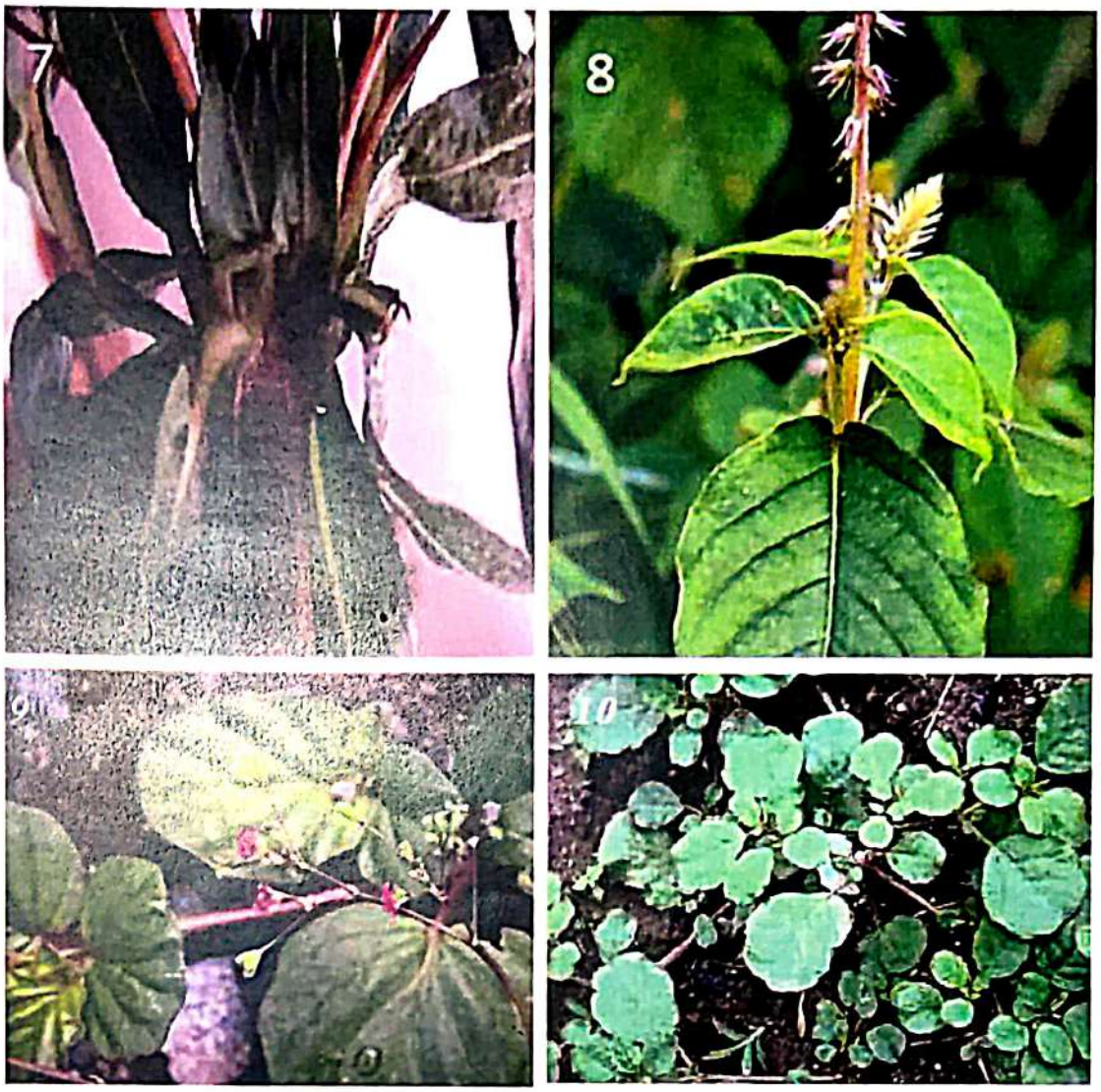
Fig. 6 Collecting information from the villager in house and in the fields.



1.Acalypha malabarica *2.Aerva lanata* *3.Alternanthera sessilis*

4.Cassia italica *5.Cassia sophera* *6.Leucas aspera*

Fig. 7



7.Hygrophila spinosa *8.Achyranthes aspera*

9.Boerharia diffusa *9. Trianthema portulacastrum*

Fig. 8

DISCUSSION

Nutritional data analysis shows that vitamins and minerals are in rich amounts in wild edible greens compared to cultivated greens. The leaves of ponagantikura and gunugukura are popular wild varieties in the area and tribals are consuming them frequently i.e., once a weak. Most of them are rich source of β carotene and minerals, thus making them as multivitamin cum multi-mineral package. As source of micronutrients these foods are matchless. They are like natural multivitamin and mineral capsules containing high amounts of calcium, iron, β carotene and vitamin C. In the light of this knowledge we have to promote these foods and look for policy support in conservation and consumption. They radiate hope for the hopeless picture of India's malnutrition.

Fibre is an important non nutritional element that is missing in the present day food style; these foods offer plenty of fibre which has good role in prevention of certain types of cancer and constipation. It plays an important role in diabetic diets. Overall fibre is missing in our present day diets and these foods offer micro nutrients in plenty along with fibre, has a major supportive role improving the health and nutritional status of the people.

In remote rural settlements where vegetable cultivation is not practiced and market supplies are not organized, local inhabitants depend on indigenous vegetables, both cultivated in kitchen gardens and wild, for enriching the diversity of food. Knowledge of such foods is part of traditional knowledge which is largely transmitted through participation of individuals of households. These indigenous vegetables play important role in meeting the nutritional requirements of tribal population in remote parts of the country (Sundriyal and Sundriyal, 2004).

Agriculture of the poor is characterized by the celebration of bio-diversity on their lands. A minimum of 8 to 12 crops to be grown at the same time and space on their lands. The symbiotic relationship between these crops can be seen in a wide range of issues: soil management, fertility management, internal cycle of inputs, pest control, labour management, diet management, risk insurance and many others. Diets in India are traditionally cereal-based and usually lack diversity. This kind of dietary practices coupled with food insecurity in the past led to high levels of under-nutrition and

widespread micronutrient deficiencies. Now, there is a need to improve the diversity of Indian diets as reliance primarily on cereals for energy may lead to macro nutrient over-nutrition coupled with micro-nutrient deficiencies arising from the lack of diversity in the diet which is reflected in the rising levels of obesity. Policies and programs are needed to address the underlying determinants of anemia, stunting, wasting, and underweight, but to also face the challenge of overweight and obesity in both children and adults (Devesh Roy, 2017).

Many food companies compound the confusion by marketing products rich in refined flours, sugar, salt and industrial additives, exploiting added micronutrients or terms such as "organic," "local," or "natural" to supply a false aura of healthiness. Although reductionist policies may have some value to reduce specific additives, Ex., trans fats, sodium, added sugar-whole food based policies will be crucial to fully address diet related illnesses (Mozaffarian et al, 2018).

A major reason for celebration of diversity is the fact that uncultivated foods, over the millennia have been the source of life for the poor. It has made up a part of the quantum of the food they consume as well as the major source of nutrition for them.

Many types of green leaves are consumed as vegetables, and most of them are rich sources of calcium, iron, carotene, vitamin C, riboflavin and folic acid. These greens are inexpensive sources of many nutrients, which are essential for growth, and maintenance of normal health. Consumption of such greens in adequate amounts especially by pregnant and nursing women and by children should also be encouraged. If greens are included in the diet in adequate amounts the need for fruits as an essential item (which is relatively costly) in diet is much reduced.

An average intake of about 50 gms of greens provides the required amount of vitamin-A to the child. Regular intake of greens in such amount will also help to build up a store of the vitamin-A in the body to provide for the lean seasons. An intake of about 100 gms of a mixture of greens daily by pregnant woman will ensure adequate storage of vitamin-A in the liver of infants at birth. Consumption of adequate amounts of greens, which are rich in folic acid, helps to correct Megaloblastic anemia. Iron deficiency anemia can be prevented by daily consumption of greens. Most of the greens are alkali-producing foods, fiber to the diet. Greens are particularly rich in riboflavin. In general greens are rich sources of calcium, iron, magnesium, etc. In recognition of all above said

merits practically every health and nutrition agency advises people to grow greens in kitchen gardens, nutrition gardens, school gardens, bio-intensive kitchen gardens, etc.

Trachyspermum (vamu) possess antifungal potency which is due to the thymol content present in Trachyspermum ammi's extract (Tripathi et al., 1986). *Senna italica* Mill possess anti-inflammatory, analgesic, anti-neoplastic and antiviral activities (Vijaya Bharathi, 2018).

Cissus quadrangularis (Nalleru) traditional usages are mostly catered around treating feminine disorders (menopause, libido, and menstrual disorders) or treating bones (increasing bone mass or accelerating fracture healing rates) which gives it the traditional name of the 'Bone Setter'; some other traditional usages are in regards to its supposed antiulcer properties, antihemhorroid properties, and pain relieving properties (Brahmkshatriya et al., 2015). *Cassia sophera* leaves possess antiasthmatic activity, hepato-protective activity, anti-inflammatory activity, antidiabetic and antioxidant activity. Seeds of *Cassia sophera* possess anticonvulsant and analgesic activity and the mucilage obtained from the seeds is used as a binder in tablet formulations (Lakshmana Rao et al., 2012).

Leucas aspera is used traditionally as an antipyretic and insecticide. Medicinally, it has been proven to possess various pharmacological activities like antifungal, antioxidant, antimicrobial, antinociceptive and cytotoxic activity and presence of various phytochemical constituents mainly triterpenoids, oleanolic acid, ursolic acid and β-sitosterol, nicotine, sterols, glucoside, diterpenes, phenolic compounds (M. S. Prajapati et al., 2010). Different parts of *Trianthema portulacastrum* Linn. are traditionally used as analgesic, stomachic, laxative, treatment of blood disease, anemia, inflammation, and night blindness. Scientifically proved activities are co-related with traditional concepts. Scientific evidence exists with respect to their major and minor constituents (Manoj et al., 2010).

However, what are people's practices, consumption patterns and food sources to access this most important component part of nutrition is an area that hardly attracts attention. Uncultivated foods as the richest source of nutrition for the poor and as unique practice of the poor to sustain their food security offer a wonderful opportunity for an exciting study.

CONCLUSION AND SUGGESTIONS

Many types of green leaves were consumed as vegetables and are naturally fortified with most of the micronutrients - like β-carotene, vitamin C, Calcium, Iron, etc., and therefore should be encouraged in the place of fortification and supplementation by artificial means. These greens were inexpensive sources of many nutrients essential for growth and maintenance of normal health. Green leafy vegetables contain several chemical constituents which are pharmacologically important as they are proved to be beneficial in many specific diseases like cancer, diabetes, hepatotoxicity, nephrotoxicity and many microbial attacks.

The experience shows that uncultivated plants are an integral part of food systems in this region. The protection of agriculture biodiversity in the ecosystem, and the agricultural practices (mixed farming, multi-cropping and avoidance of herbicides and pesticides) will ensure the continuity of uncultivated foods in our cuisine and culture. These factors bring certain advantages to the very poor besides being relevant to the well being of the majority population and enabling local command over food.

This is very important way to reduce food scarcity in the country like India. Some of preferred leafy vegetables can be included for cultivation as alternative crops. On the other hand rest of the fragmented ecological habitat where from the people collecting those wild edible plants also very important to conserve from socio-economic point of view. Hence, conservation of these medicinal plants is of utmost importance and utilizes the traditional ethnomedicinal heritage of tribals to mankind.

SUMMARY

There are hundreds of edible herbs which are used in day to day kitchen in different forms. The usages of green leafy vegetables are limited to a specific geographical location. Consumption of green leafy foods benefits human health by improving nutritional status and reducing risks of specific diseases like diabetes, cancer and hepatotoxicity.

Green leafy vegetables are the cheapest of all the vegetables within the reach of poor man, being richest in their nutritional value. The lack of knowledge especially on the nutritive value of these uncultivated green leafy vegetables among the public in general which is the main drawback in their lower consumption. The value of wild edible vegetables in food security has not been given sufficient attention in these days. Consequently, there are no formal interventions that seek to encourage people to use traditional vegetables as sources of essential nutrients.

It has been observed that the traditional knowledge on uncultivated and wild food plants is on sharp decline. Unless efforts are made to educate the younger generations about their importance, it may be lost in near future. This type of study would contribute significantly in Government policies to improve food security in tribal areas, and in the improvement of wild vegetable status, whose potential as sources of nutrition is currently undervalued. Limited information is available on the medicinal properties associated with leafy vegetable consumption in Devarakonda-Telangana State. Documentation of traditional knowledge of green leafy vegetable foods and their importance in terms of consumption, health and nutrition is the need of the hour.

A total of 38 plant species belonging to 20 families were recorded after conducting survey. Family Amaranthaceae recorded highest number of species (10 species) followed by Caesalpinaceae (5 species), Lamiaceae, Apiaceae, Malvaceae, Convolvulaceae, Aizoaceae (2 species each) and remaining all have one species each. They are Kuppi, Uthareni, Pindi, Nagalikura, Ponnaganti kura, Mulla doggali, Doggalikura, Kodipunjuchettu, Yerrabacchali, Athakamamidi, Balusuku, Thengedu, Rela, Nelatangedu, Chennangi, Gunagu, Gotukola, Nalleru, Vaminta, Dusseru, Chama akulu, Bankantikura, Jonnachemchali, Chenchelikura, Reddyvarinanupalu, Puntikura, Nirmulli, Thootikura, Tummikura, Seetammajada, Munaga, Adavipulla koora, Payalakura, Nallakasha, Chinta chiguru, Vamaku, Tellagarjala and Nallagalijeru.

Women are found to play a major role in the collection and preparation of wild leafy vegetables. Most of the uncultivated greens are harvested during rainy season and winter and where water is flowing in banks of river, canals and moist areas. Uncultivated foods like chenchali, puntikura, payalkura, ponagantikura, chintachiguru and tootikura are also sold in towns, as they are preferred by people in towns, because they are good for health. Interestingly tribal elders have tremendous knowledge in terms of utilization of neighbouring plant material for consumption like *Cissus quadrangularis* tender shoots are commonly used as vegetable than older shoots.

Uncultivated and wild greens are used as food and medicine, which are tasty and rich sources of nutrients. They were present mostly in farm fields where manure was applied or where chemical fertilizers were not applied. Very few greens were seen in fields treated with chemical pesticides especially herbicides. However, farmers felt it was not safe to eat these greens and they were generally not collected. For several reasons, people no longer ate wild seasonal uncultivated greens as in former years, which is a reason for low consumption in this population.

Vamaku possess antifungal potency which is due to the thymol content present in it (Tripathi et al., 1986). Nalleru traditional usages are mostly catered around treating feminine disorders or treating bones which gives it the traditional name of the 'Bone Setter'; some other traditional usages are in regards to its supposed antiulcer properties, antihemhorroid properties, and pain relieving properties (Brahmkshatriya et al., 2015). Nelatangedu possess anti-inflammatory, analgesic, anti-neoplastic and antiviral activities (Vijaya Bharathi, 2018). Chennangi leaves possess antiasthmatic activity, hepato-protective activity, anti-inflammatory activity, anti-diabetic and antioxidant activity. Seeds possess anticonvulsant and analgesic activity (Lakshmana Rao et al., 2012). Tummi is used traditionally as an antipyretic, and antifungal, antioxidant, antimicrobial and insecticide (Prajapati et al., 2010). Different parts of Galijeru are traditionally used as analgesic, stomachic, laxative, treatment of anemia, inflammation, and night blindness (Manoj et al., 2010).

Many types of green leaves were consumed as vegetables and are naturally fortified with most of the micronutrients. These greens are proved to be beneficial in many specific diseases like cancer, diabetes, hepatotoxicity, nephrotoxicity and many microbial attacks. The protection of agriculture biodiversity in the ecosystem, and

the agricultural practices (mixed farming, multi-cropping and avoidance of herbicides and pesticides) will ensure the continuity of uncultivated foods in our cuisine and culture.

Additionally, the behaviour change communication strategy should focus on addressing gender disparities and cultural norms. Gender sensitive, nutrition-centric behavior communication strategy should be developed and implemented.

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A Student Study Project
On
A Study on Diversity and observation of Lichens in Devarakonda Fort, Devarakonda.

PROJECT REPORT

Done by

B. Sc. Life Sciences students- 2020-21.

Supervisor

Dr. Ch. Rama Raju

Submitted to

Department of Botany
MKR Government Degree College
Devarakonda. Dist: Nalgonda

M.K.R. GOVERNMENT DEGREE COLLEGE,
DEVARAKONDA, NALGONDA, 508242.
Reaccredited by NAAC with B++
ISO 9001:2015

CERTIFICATE

This is to certify that this project report entitled, **"A Study on Diversity and observation of Lichens in Devarakonda Fort, Devarakonda."** is the bonafide work of B. Sc. Life Sciences students during the academic year 2020-21 under the supervision of Dr. Ch. Rama Raju, Assistant Professor of Botany.

Ch Rama Raju

Signature of the Principal

PRINCIPAL (FAC)
M.K.R. Government Degree College,
Devarakonda, Nalgonda Dt. 508248

DECLARATION

We the students of B.Sc. Life Sciences, Second year, declare that this work has been originally carried out by us under the supervision of **Dr. Ch. Rama Raju,** Assistant Professor of Botany, M.K.R. Government Degree College, Devarakonda, Nalgonga and this has not been submitted to any other institution/ university.

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B.Sc. B.Z.C. Life Science students- 2020-2021.

A Study on Diversity and Conservation of Lichens in Devarakonda Fort, Devarakonda.

ABSTRACT

The lichen mycota of ecologically interesting and biodiversity-rich Devarakonda Fort is explored. The study revealed the occurrence of 6 species of lichens from 14 localities. A total of 6 species recorded from Devarakonda fort is the first ever study of lichens. Among the different growth forms, the crustose lichens exhibited the maximum diversity followed by foliose, and squamulose. The saxicolous species and corticolous species were also observed. In Devarakonda fort is rich with lichen diversity within the Devarakonda area.

Key Words: *Biodiversity, Devarakonda, Nalgonda.*

INTRODUCTION

Lichens are complex organisms that involve a symbiotic relationship between phycobionts and a mycobiont and have attracted considerable attention because they perceived position on the ladder of evolution to land plants. They are often observed as the most significant bioindicators. They are universal in distribution and grow at an average rate of 1-5 mm per annum. India's plant resources are well known with rich diversity distributed in different ecological habitats. Therefore, it is important to understand the ecology and distribution of this diversity. The status of the lichen communities is severely threatened due to manmade activity that includes deforestation, denudation, and over-exploitation of forest produce. Present investigations have been undertaken to inventory the lower life forms like lichens. In the rich ecosystem of Devarakonda Fort of Telangana, there is a lack of knowledge regarding lichen diversity, ecology, anddistribution patterns. Therefore, the study of lichens is valuable to understanding the status oflichens in Devarakonda.

Linnaeus mentioned the occurrence of *Lichen fuciformis* (L.) DC. (*Roccella montagnei* Bél.) from India. In his masterpiece '*Species Plantarum'. Eric Acharius* (1810, 1814) the father of Lichenology describes lichens in his classical works '*Lichenographia Universalis'* and '*Synopsis Methodica Lichenum'*. Thereafter the Indian lichens have been described by various lichenologists. Recently Upreti and Sanjeeva Nayaka worked a lot on lichen diversity (1995, 2001, 2002, 2004, and 2008).

Lichens are self-supporting symbiotic associations of a fungus and one or several algal or cyanobacterial components. Lichens and lichen products have been used in traditional medicines for centuries and still hold considerable interest as alternative treatments in various parts of the world. In various systems of traditional medicine worldwide, including the Indian system of medicine, these lichen species are said to effectively cure dyspepsia, bleeding piles, bronchitis, scabies, stomach disorders, and many

disorders of blood and heart (Saklani and Upreti, 1992; Lal and Upreti, 1995; Negi and Kareem, 1996). Lichen metabolites exert a wide variety of biological actions including antibiotic, antimycobacterial, antiviral, anti-inflammatory, analgesic, antipyretic, antiproliferative, and cytotoxic effects (Muller, 2002). The utility of lichens is due to a range of secondary compounds produced by them. The biotic factors and edifice variation have played a dominant role in determining the nature of the forests growing in the Fort. The Fort comprises dry deciduous forests. Ground floor grass patches ferns and their eupatorium has come up in many open patches.

Demographics of Devarakonda

Telugu is the local language. Some people also speak Urdu. The total population of Devarakonda Mandal is 86,584 living in 17,726 houses, spread across a total of 104 villages and 22 panchayats. Males are 44,739 and Females are 41,845. Out of the total population, 27,434 live in town and 59,150 live in rural.

The Devarakonda region of Nalgonda Dist., Telangana is situated in a semi-arid region. Devarakonda lies between 16° 42' 0"N, 78° 55' 59.88" E. The total geographical area of the district is 9 699 sq km, accounting for 3.5% of the total area of the state. Though semi-arid, lands here can receive erratic and heavy seasonal rainfall. Soils are highly degraded with soil depths in most places of less than 6 inches. Red soils dominate the land and productivity is regarded as generally low. Devarakonda fort covers dry deciduous plants. It has enumerated herbs, shrubs, ferns, and grasses some of which are yet to be surveyed and listed. Tourist attraction spots are Fort entrance, Poorna Kumbam i.e., State symbol of Telangana, Temple of Shiva Parvathi and Ramalayam.

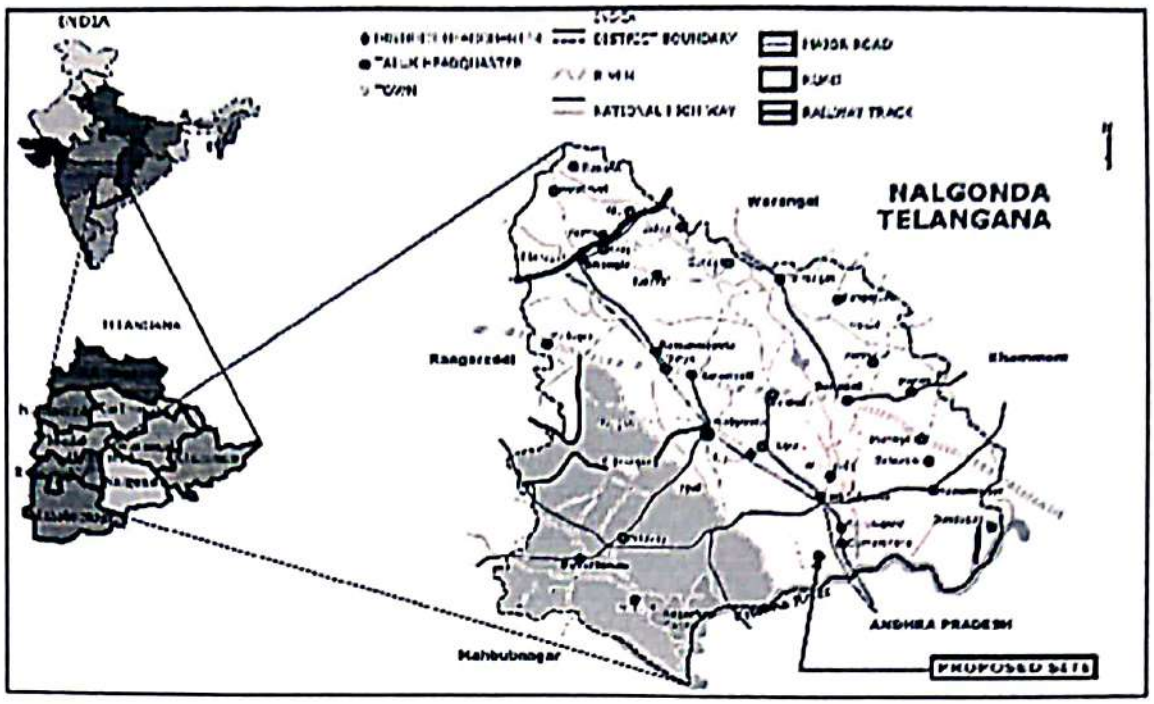


Fig.1 Location of Devarakonda (shown in the green shade).

Socio-economic profile

Devarakonda is home to about 99 thousand people, among them about 51,000 (51%) are male and about 48,000 (49%) are female. 55% of the whole population are from general caste, 13% from schedule caste, and 32% from schedule tribes (Lambadis). The child (aged under 6 years) population of Devarakonda Mandal is 13%, among them 52% are boys and 48% are girls. There are about 22,000 households in Devarakonda and an average 4 persons live in every family. The majority of the population, nearly 60% (about 60,000) live in Devarakonda rural part and 40% (about 39,000) population live in the Devarakonda urban part.

Climate

The climate of the Devarakonda region is characterized by hot summers and generally dry weather with rain showers expected during the monsoon season. The year is divided into three seasons: winter (November to February), summer (March to May), and the southwest

monsoon (June to October). The average annual rainfall in the district is 896.7 mm.

Devarakonda, a tribal assembly constituency is situated in the semi-arid tract. Lands here are rainfed and highly degraded. Soil depths in most places are less than 6 inches. Red soils dominate the land. Consequently, productivity is abysmally low. Farmers feel extremely lucky if an acre of land produces two quintals of sorghum or cotton. Erratic rainfall which has become the hallmark of the last decade leaves even this level of productivity with a question mark seriously threatening the food security of the poor who mainly own these types of lands. It is in this context that one should look at the agriculture of the poor and the role of uncultivated food in their lives.

AIM

This project mainly focuses on the diversity, distribution, ecology, and conservation oflichen in the Devarakonda Fort.

OBJECTIVES

1. To survey and collect the lichens from Devarakonda Fort
2. To study the lichen distribution pattern in different substrates
3. To conduct ecological studies utilizing different ecological parameters
4. To assess the threat to the lichen community and propose conservation measuresfor the lichens.

MATERIALS AND METHODS

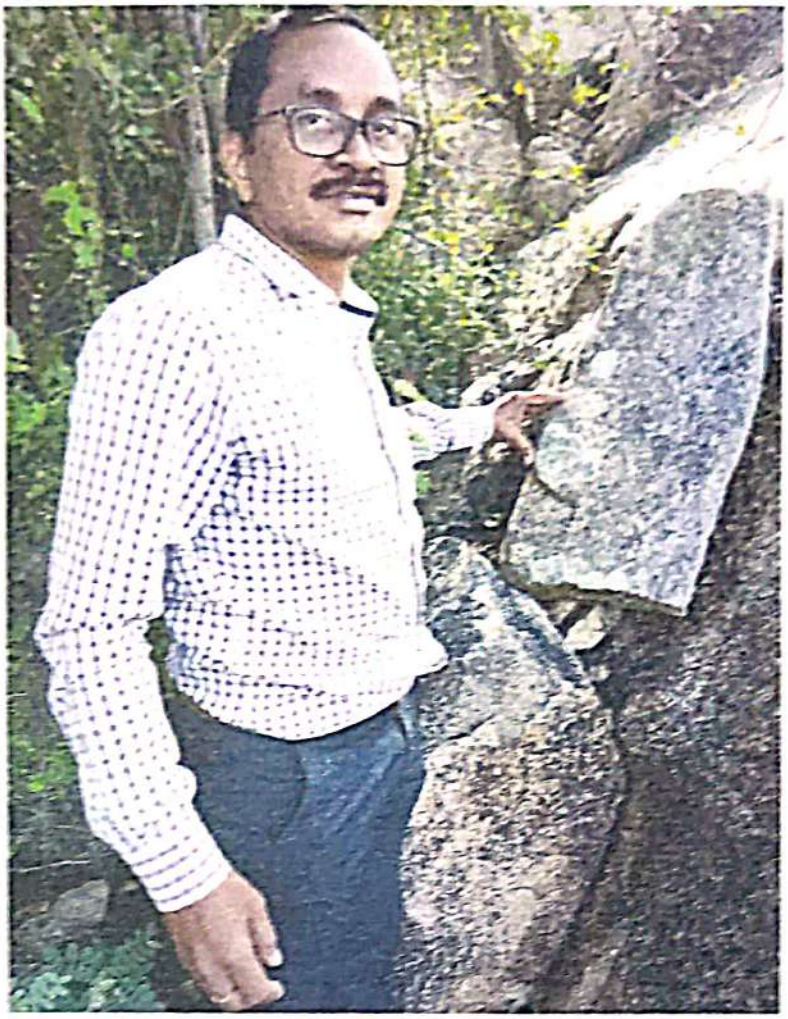
The present study is on Devarakonda Fort found in Devarakonda, Nalgonda district, Telangana State. The lichens were growing over tree trunks, exposed rocks, lime plaster, and on the monument. The morphological features of lichen thallus and ascomata were observed

under the Magnus microscope. The identification of lichens by studying their morphology, anatomy, and color tests. Ecological studies on lichens will be carried out by using standard ecological parameters.

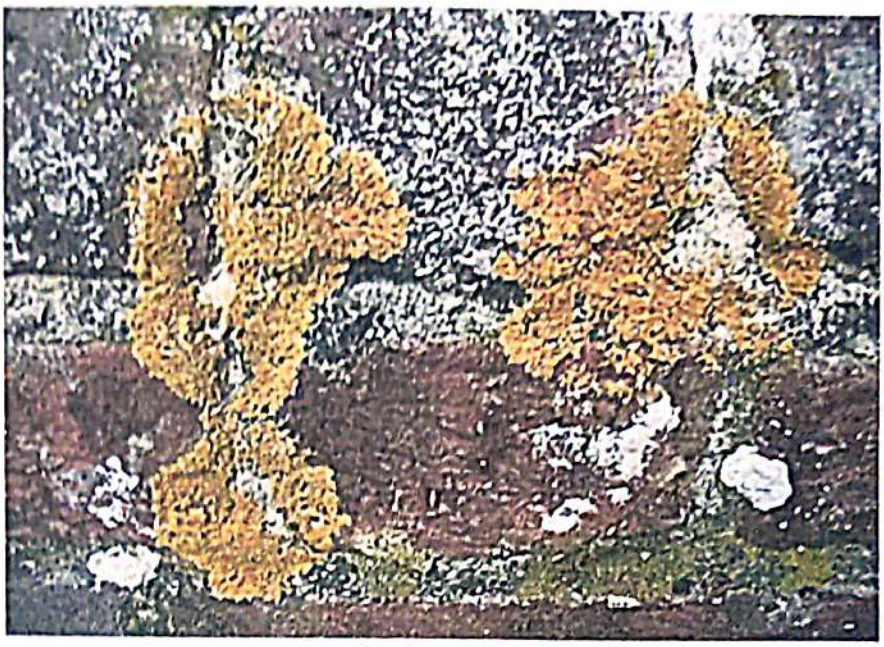
Spot tests for color reaction were carried out in a 10% aqueous solution of potassium hydroxide (K) and calcium hypochlorite solution (C). For anatomical investigation of fruiting bodies, a light microscope was used. All the measurements of anatomical structures were taken in water and a 10% aqueous solution of K.

Observation and Identification

The representative lichen specimens were observed with their substratum irrespectively of their growth form. Only the lichens that were very loosely attached to the substratum were scraped out and collected. The corticolous lichens growing on a tree trunk at reachable height are usually collected and canopy lichens found fallen on the ground were collected. Superficial bark was removed with the help of a chisel knife to avoid damage to the trees. In the case of saxicolous lichens, smaller pieces of the rock substrate were photographed.



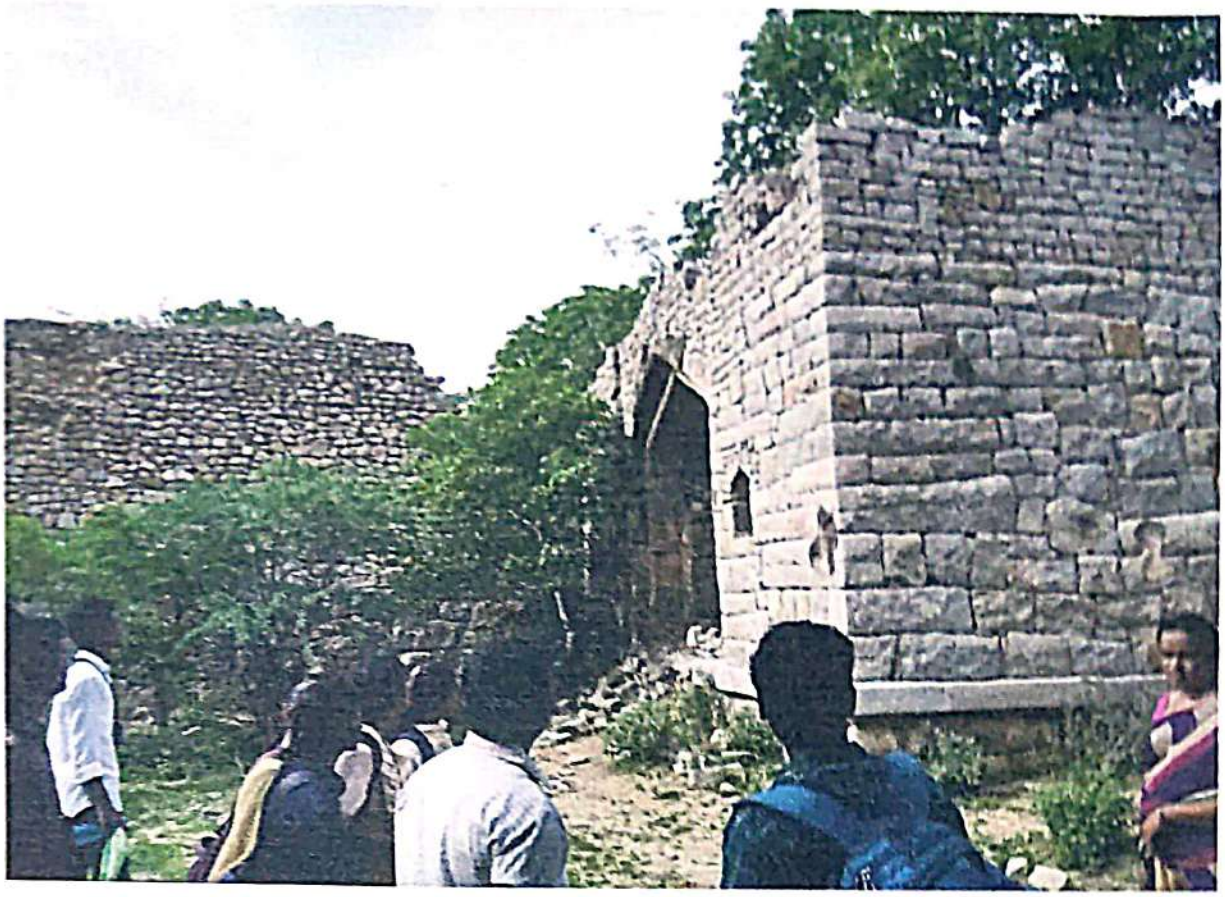
Dr. Ch. Rama Raju, Asst. Professor of Botany showing the rock having the natural habitat of lichens



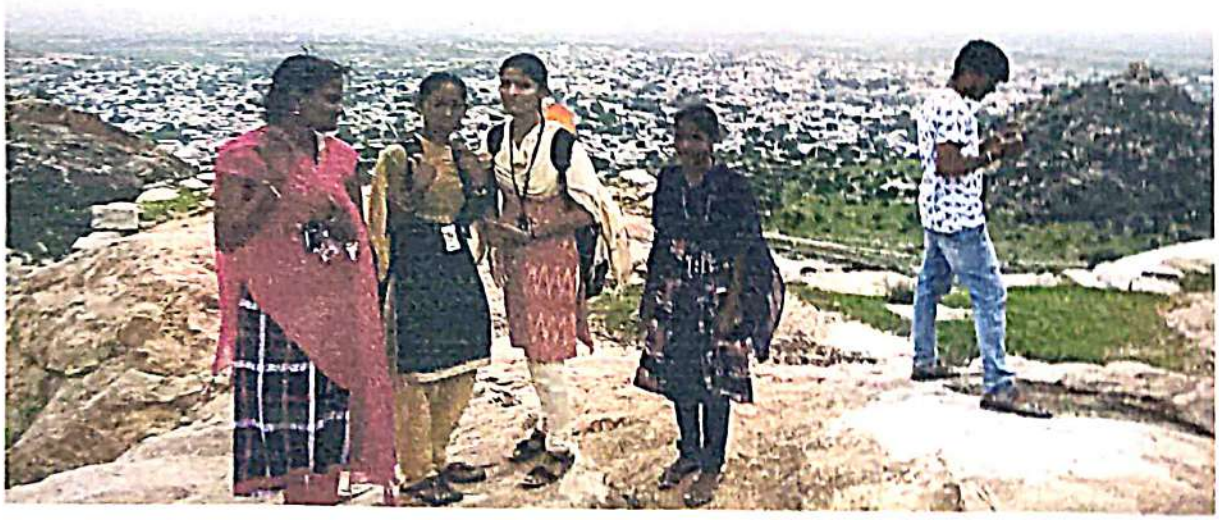
A photograph of lichens

Students observe the crustose lichens, foliose lichens, and fruticose lichens on the rock of Devarakonda Fort.

The Shivalayam temple on Devarakonda Fort



Students observe the structure of the fort.



A panorama view of the entire town of Devarakonda can be seen from the top of the fort

RESULTS AND DISCUSSION

A total of 6 species were encountered in all thesurveyed localities of Devarakonda Fort. The lichen flora shows a strong correlation with the climatic conditions and arboreal elements of the flora of the regions. The present study also shows te same results that the distribution of the lichens mutually varies with climatic variation in the deciduous forest regions that had a maximum number of macrolichens.

The saxicolous (growing on rocks, lime-plaster, and monuments) species of lichens exhibited the maximum diversity represented by 3 species followed by 1 corticolous (growing on the bark of trees) species (Fig. 4).

Other localities in the district have poor diversity of lichens ranging from 1 to 4 species. Probable reasons for the poor diversity of lichens in these areas may be the low altitude, dry forest areas, high temperature, low moisture, and frequent human interference.

The lichen species are varies with altitude in the study area. The higher altitudes contributed more number of fruticose lichens and at a lower altitude, more foliose and crustose lichens were found.

Microhabitat preference of particular lichens is responsible for their differential distribution. However, despite their abundance in the vegetation only a small fraction of trees harbored lichens on trunks. Many of these trees have somewhat smooth, medium, and rough bark textured. We studied the texture, pH, and moisture content of barksof different host trees in different forest types. In the case of altitudinal gradient, the higher altitude supports more number of fruticose lichens. In low land areas, most foliose species like *Parmotrema, Heterodermia, Leptogium,* and *Pyxine* species were present. Parmeliaceae and Physciaceae were either attached to the upper canopy branches or on rocks with sufficient canopy openings that regions will receive more lights and wind in this region.

Threats and Conservation of lichens

The factors responsible for the loss of lichen diversity in the study area include a change inthe ecological conditions, forest cover, loss of habitat, and an increase in the urban and industrial areas. The anthropogenic activities in hilly regions such as mineral extraction, and tourism are leading to the rapid deterioration of lichen-rich habitats. The global scenario of evidence showsthat many lichen-rich sites are facing threats mainly associated with human activities such as air pollution, habitat destruction, unsystematic forestry practices, forest fire, tourism, over-exploitation and illegal collections.

CONCLUSIONS

Recommendation for conservation of lichens

Devarakonda Fort is a magnificent piece of the beautiful and valuable heritable site of Telangana. There are large numbers of livestock belonging to the villagers residing in andaround the Fort. Apart from grazing in the villages, the cattle enter even the corezones of the Fort. Most of the nearby people depend on the fort area for their daily need of fuel wood. Many a time this human intervention has been the major factor behind the fire outburst and the collection of firewood indirectly affects the lichen diversity and propagation. Therefore the collection of firewood should be strictly controlled.

All the above said management actions can be summarized as the following recommendations for a strategy to effectively conserve the biodiversity of lichens.

1. Forest fire should be prevented at any cost.
2. Alternative fuel sources should be made available to the villagers to stop thecollection of firewood.
3. Prohibit illegal harvesting of lichens for commercial purposes.
4. The feasibility of the developmental projects affecting a protected area balanceshould be reviewed before it is implemented.

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A Student Study Project

On

Mass multiplication of *Azolla* (Bio-fertilizer) for Sustainable Agriculture

PROJECT REPORT

Done by

B.Sc. (BZC) students

Supervisor

Dr. Ch. Rama Raju M.Sc. Ph.D.
Assistant Professor of Botany

Submitted to

Department of Botany
M.K.R. GOVERNMENT DEGREE COLLEGE
DEVARAKONDA, NALGONDA

CERTIFICATE

This is to certify that this project report entitled, **"Mass multiplication of *Azolla* (Bio-fertilizer) for Sustainable Agriculture"** is the bonafied work of B. Sc. (BZC) VI Semester students during the academic year 2021-22 under the supervision of Dr. Ch. Rama Raju, Assistant Professor of Botany.

Ch.RamaRaju 2/7/2022

Signature of the Principal

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DECLARATION

We the students of B.Sc. (B.Z.C) declare that this work has been originally carried out by us under the supervision of **Dr. Ch. Rama Raju,** Assistant Professor of Botany, M.K.R. Government Degree College, Devarakonda, Nalgonga and this has not been submitted to any other institution/ university.

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The production of this project has been made easier through the efforts of many people, to whom we indebted.

This project work would not have been possible without the kind support, the probing questions, and the remarkable patience of our Supervisor Dr. **Ch. Rama Raju**, Assistant Professor of Botany, M.K.R. Government Degree College, Devarakonda, Nalgonda. We would like to thank him for all his guidance and encouragement throughout this work.

We are extremely grateful to the Principal, M.K.R. Government Degree College, Devarakonda, Nalgonda, for providing necessary facilities to carry out our project work.

We would like to thank our batch mates of B.Sc. B.Z.C. students for their support.

B.Sc. B.Z.C. Students- 2021-2022.

Mass multiplication of *Azolla* (Bio-fertilizer) for Sustainable Agriculture

Abstract:

Azolla is an aquatic fern. It possesses a cavity in the dorsal leaves for the Cyanobacteria (*Anbaena Azolla*) that is capable in fixing atmospheric nitrogen through the symbiotic association with *Azolla*. *Azolla- Anbaena* association helps in enrichment and maintaining soil fertility and offers ecological sustainability on a long term basis. It has several other uses as green manure, water purifier, animal feed etc. It can either grow with the rice plantation as an intercrop or included into the soil well before the plantation of rice. The guarantee of year round production of *Azolla* in a pit is the essential element for the sustenance of the technology. It has been shown that *Azolla* can be grown in pits round the year and it is highly profitable. The cost benefit (CB) ratio is 1:2.8. This can be a model for *Azolla* cultivation. Individual farmer can take up this activity to supplement feed/fertilizer requirement. *Azolla* is highly susceptible to attack by insects and pests.

Keywords: *Azolla*, Biofertilizer, Nitrogen fixation, Agricultural sustainability.

1. INTRODUCTION

Azolla is a small plant with a diameter of 1-2.5 cm. Plants are generally, triangular or polygonal in shape and contain floating branched rhizomes bearing small alternate over lapping fronds with simple roots. The dorsal lobe of the frond is green in color and has an *Azolla* in its central cavity. *Azolla pinnata* is an ideal biofertilizer. It can fix nitrogen around 25 kg/ha. *Azolla* can be used as poultry, fish, and cattle feed. *Azolla* could be used as a biofertilizer in rice fields. It can be used as a bio-scavenger as it takes away all heavy metals. *Azolla- Anbaena* association helps in enrichment and maintaining soil fertility and offers ecological sustainability on a long term basis. It has several other uses as green manure, water purifier, animal feed etc. This biofertilizer is referred to as "green gold mine". This association has tremendous potential for exploitation. The quick decomposition of the biomass and availability of its nitrogen to the standing crop makes it useful in agriculture. *Azolla* is eco-friendly as it is friendly to the environment. At present many progressive farmers are employing *Azolla* in agriculture, green manure, poultry feed and fodder. In India *A. pinnata* has been distributed widely in stagnant and shallow waters. However, certain key scientific issues need to be addressed to make the association more compatible with the present day need and demand.

The azolla-anabaena super organism is unique. We know of no other symbiotic relationship in which a cyanobacterium and plant pass down together during reproduction from generation to generation. A few other plants have a symbiotic relationship with cyanobacteria, including some cycads and the anthophyte *Gunnera*, but the relationship has to be renewed each generation; it is broken after the plant dies and new cyanobacteria must re-colonize the plants in order to continue the relationship.

In contrast, azolla and anabaena are never apart; they have not been separated for almost a hundred million of years. They have evolved together continuously during this

immense period of time as the Earth's climate changed from a greenhouse world to the present phase of glacial-interglacial cycles.

Azolla's morphology is unlike that of other ferns and, in particular, its leaf structure has evolved to provide an environment that is ideal for anabaena. Azolla's life cycle also makes it possible for anabaena to pass uninterrupted from one generation of azolla to the next. This has enabled the two organisms to evolve continuously together for 80 million years, a relationship unknown elsewhere on the planet.

Azolla's leaves occur in two rows along each side of the plant's stem. Each leaf has a very thin ventral lobe and a thick, greenish or reddish photosynthetic dorsal lobe containing a cavity that is the key to the azolla and anabaena symbiosis.

The cavity is a highly specialized structure that is formed during azolla's growth by part of the leaf epidermis folding inwards during azolla's development (Peters & Meeks, 1989). The cavity measures approximately 0.15 x 0.3 mm and opens to the external environment through a pore that is surrounded by two cell layers.

Azolla's life-cycle

Unlike plant-cyanobacterial symbioses in vascular plants, the azolla-anabaena symbiotic system is sustained throughout the fern's life cycle, where the cyanobacterium and bacteria are always present (Carrapiço, 2010), either in the dorsal lobe leaf cavities or in the sexual structures (sporocarps). The azolla plants are never infected *de novo*, since anabaena is transferred between generations as akinete inocula.

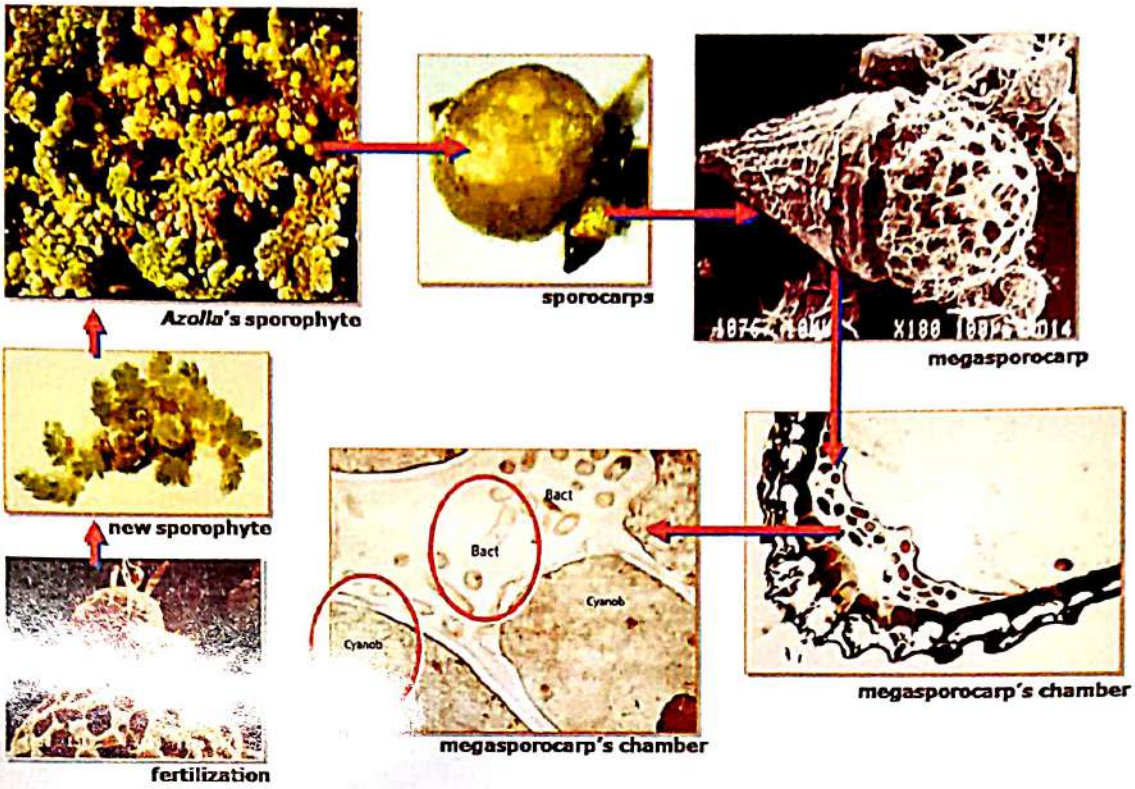

Fig.1. *Anabaena* is transmitted directly to successive generations via the azolla's reproductive spores. Figure modified from Carrapiço (2001).

During azolla's sporulation, filaments of anabaena are packaged into the developing sporocarps. As sporocarp gender is determined later in azolla's development, anabaena is present in both the megasporocarps and microsporocarps, but anabaena is only maintained by the megasporocarps, thus maintaining the symbiotic continuity.

Other bacterial symbionts

Azolla's leaf cavity provides an ideal micro-environment for a bacterial community that includes various strains of the genera *Anthrobacter*, and *Agrobacterium* plus the heterocyst-forming nitrogen-fixing filamentous bacterium *Anabaena azollae*.

Other bacteria are present in azolla's leaf cavities and include Arthrobacter which commonly occurs in soils. Like anabaena, these bacteria also occur throughout azolla's life cycle and have a developmental pattern that is identical to that of anabaena. Their role in the

symbiosis is not yet fully understood, but the present data indicate that anabaena is the only bacterial symbiont of azolla that fixes nitrogen.

The free-living species *Arthrobacter chlorophenolicus* is capable of degrading high concentrations of 4-chlorophenol, indicating its potential use for bioremediation

The Study Area

Devarakonda is a town in the Nalgonda district of the Indian state of Telangana. It is a municipality in Devarakonda mandal of Devarakonda division. It is located about 60 kilometres from the district headquarters Nalgonda, 104 kilometres from the state capital Hyderabad.

Devarakonda Mandal, with population of about 99 thousand is located in Nalgonda district, Telangana, India. The Devarakonda region of Nalgonda Dist., Telangana is situated in a semi-arid region. Devarakonda lies between 16° 42' 0"N, 78° 55' 59.88" E. The total geographical area of the district is 9 699 sq km, accounting for 3.5 percent of the total area of the state. Though semi-arid, lands here can receive erratic and heavy seasonal rainfall. Soils are highly degraded with soil depths in most places of less than 6 inches. Red soils dominate the land and productivity is regarded as generally low. The climate of the Devarakonda region is characterized by hot summers and generally dry weather with rain showers expected during the monsoon season. The year is divided into three seasons: winter (November to February), summer (March to May) and southwest monsoon (June to October). The average annual rainfall in the district is 896.7 mm.

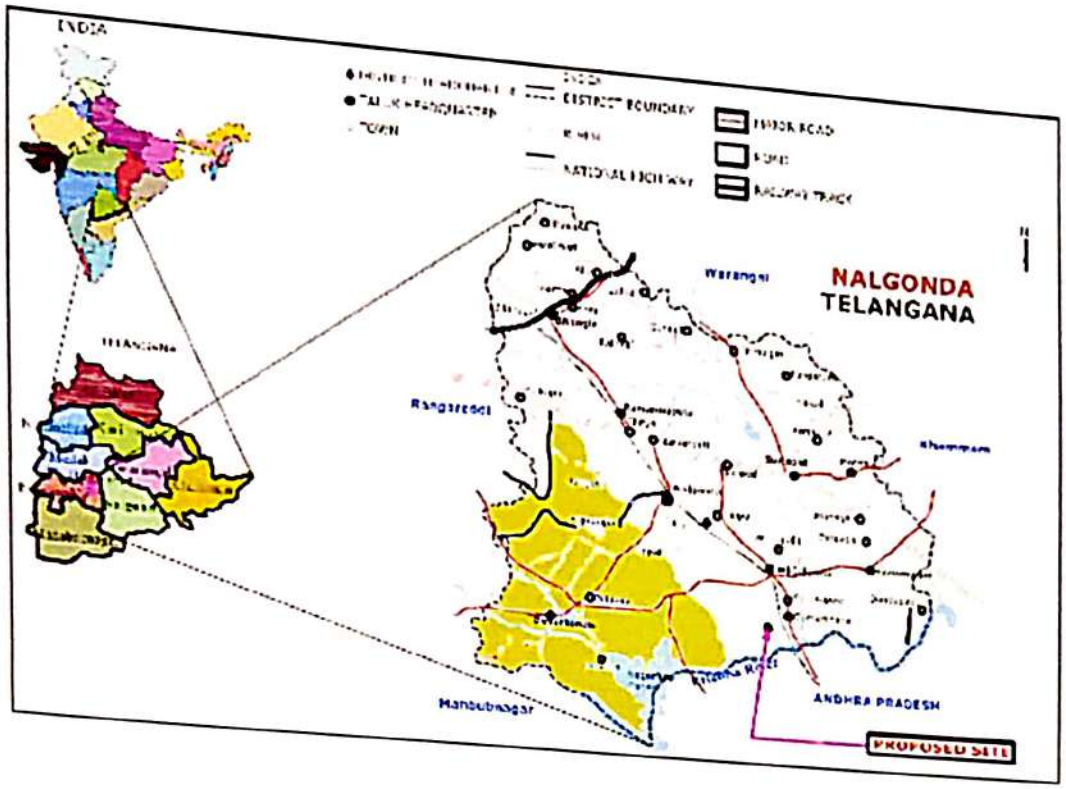

Fig.2 Location of Devarakonda (in green colour) in Telangana state in India.

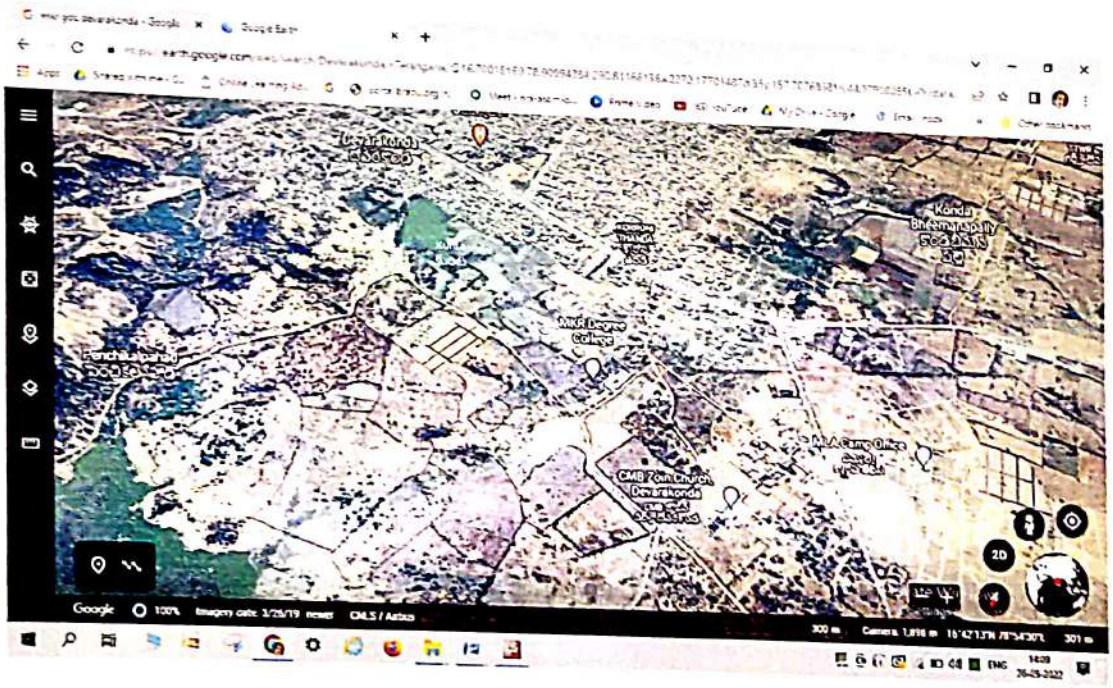

Fig. 3 MKR GDC Devarakonda location in Devarakonda town in Google Earth Map (Satellite image).

2. AIMS AND OBJECTIVES

1. to gain knowledge and experience in the multiplication of *Azolla* as a source of biological nitrogen, particular attention is being paid to the propagation of *Azolla*

2. to enhance the socio-economic situation of farmers by using *Azolla* as feed for livestock promotes the well-being and health of cattle.

3. ecological value will be created during the cultivation of *Azolla* in which no pesticides or chemicals are used.

4. social value creation relates to the employment and empowerment of local farmers.

5. Economical value is created by the setup of Azolla cultivation units on sustainable agriculture.

6. working in popularizing this wonderful technology throughout the region among livestock farmers.

3. METHOD AND MATERIALS

Cement pit, fertile soil, compost, cow/buffalo dung, powdered rock phosphate, a starter culture of *Azolla.*

Production technique:

- A water body is made, preferably under the shade of a tree, with the help of a cement pit.
- All corners of the pit should be at the same level so that a uniform water level can be maintained.
- About 10 – 15 kg of sieved fertile soil is uniformly spread over the pit.
- Slurry made of 2 kg cow dung and 30 g of powdered super phosphate mixed in 10 liters of water, is poured into the pit. More water is poured on to raise the water level to make it full.

- About 100 g of fresh starter culture of *Azolla* is placed in the water. *Azolla* will grow and fill the pit within 10 – 15 days.
- A mixture of 10 g of super phosphate and about 1 kg of cow dung should be added once every 5 days in order to maintain rapid multiplication of the *Azolla*.
- A micronutrient mix containing magnesium, iron, copper, sulphur can also be added at weekly intervals to enhance the mineral content of *Azolla*.
- After every 60 days, soil is removed from the bed and another 15 kg of fresh fertile soil is added into the bed to avoid nitrogen build up and also provide nutrient to the *Azolla*.
- A fresh bed has to be prepared and inoculated with pure culture of *Azolla*, when contaminated by pest and diseases.

Precautions

- *Azolla* should be harvested regularly to avoid overcrowding.
- Around 15-30 degrees Celsius should be maintained for good growth. Places with partial sunlight should be preferred;
- The pH of the medium should be between 5.5 to 7.5.
- The proper amount of nutrients such as cow dung slurry, micronutrients should be supplemented as and when required.
- Maintenance of pure culture free from contamination is essential for good growth.

Collections and storage of Azolla

Azolla multiplied rapidly and covered the complete pits within 7 days. Fully grown azolla (Plate 2) was harvested every week from the water trough. Harvesting azolla was cleaned and thoroughly washed and sundried for 2-3 days and dried till crispy dried and stored in air tight aluminium foils.

- *Azolla* should be harvested regularly to avoid overcrowding.

- Around 15-30 degrees Celsius should be maintained for good growth. Places with partial sunlight should be preferred;
- The pH of the medium should be between 5.5 to 7.5.
- The proper amount of nutrients such as cow dung slurry, micronutrients should be supplemented as and when required.
- Maintenance of pure culture free from contamination is essential for good growth.

Fig.5 Materials required for *Azolla* cultivation are exhibitted.

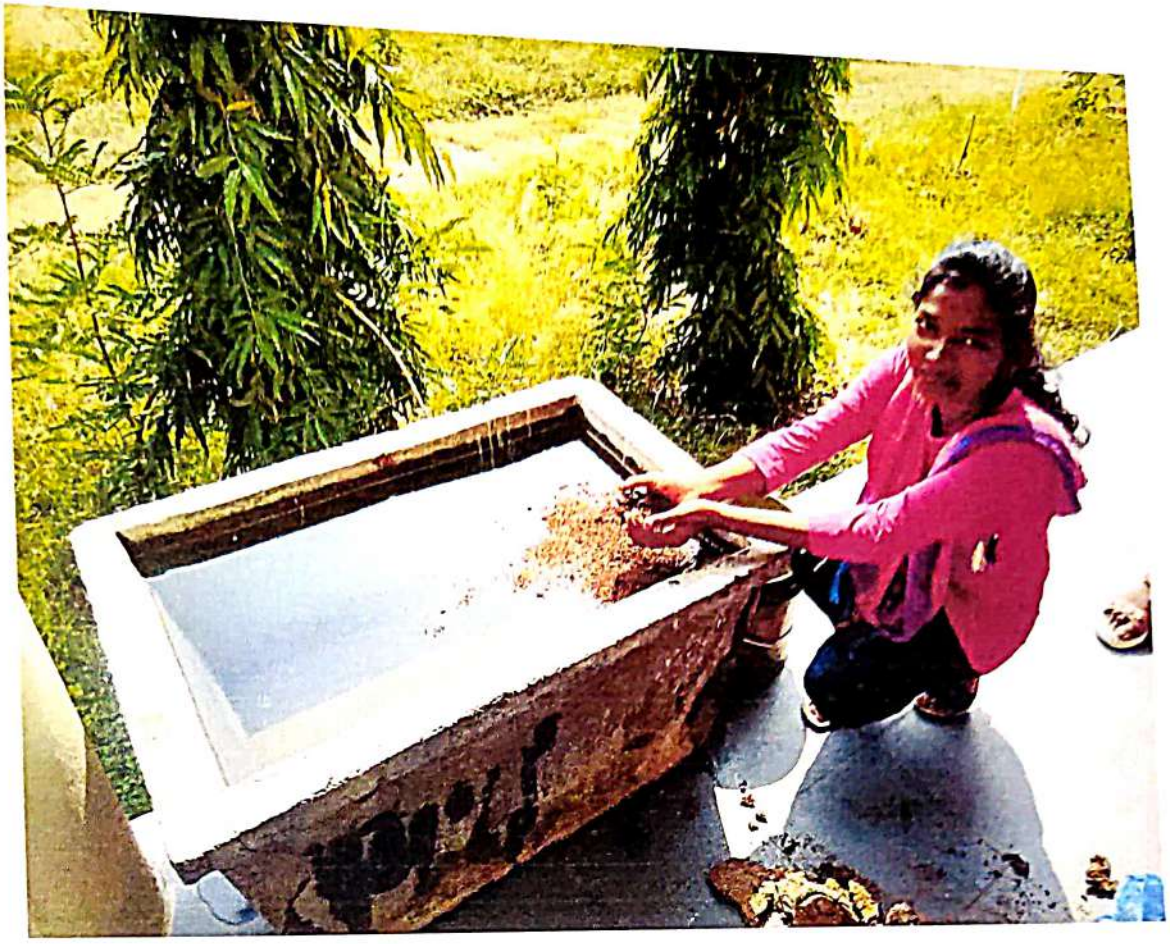

Fig.6 Adding of compost and soil to the water pit by the student.

Fig. 7 Mixing of compost and soil to the water

Fig.8 Fully grown *Azolla* in water pit.

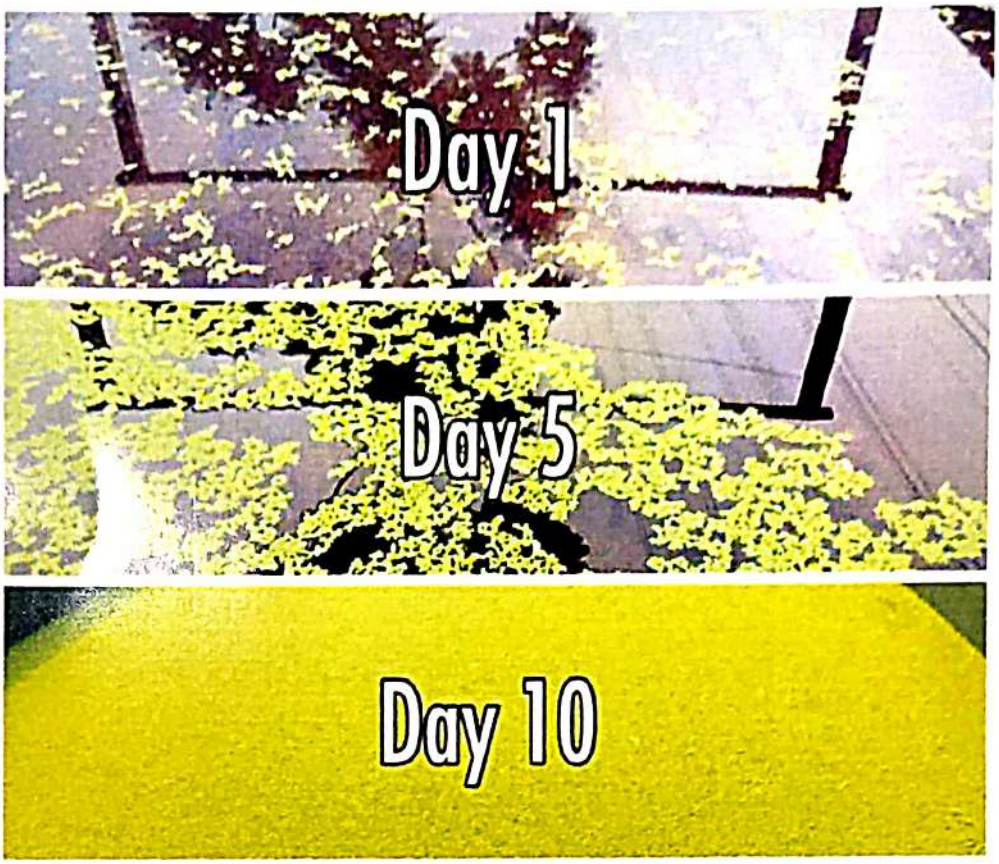

Fig. 9. *Azolla* plot in Day 1, 2, and 10

4. RESULTS AND DISCUSSION

Biology of Azolla

Azolla in a genus of the *Azolla*ceae family of cryptogamic, free-floating ferns. *A. pinnata* which is the most prevalent species in Asia. *Azolla* floats on the water surface with the fronds lying horizontally. The fronds of *A.pinnata* 1-2 cm in diameter. Adventitious roots hang vertically down into the water and can penetrate mud; *Azolla* has a sporophytic cycle.

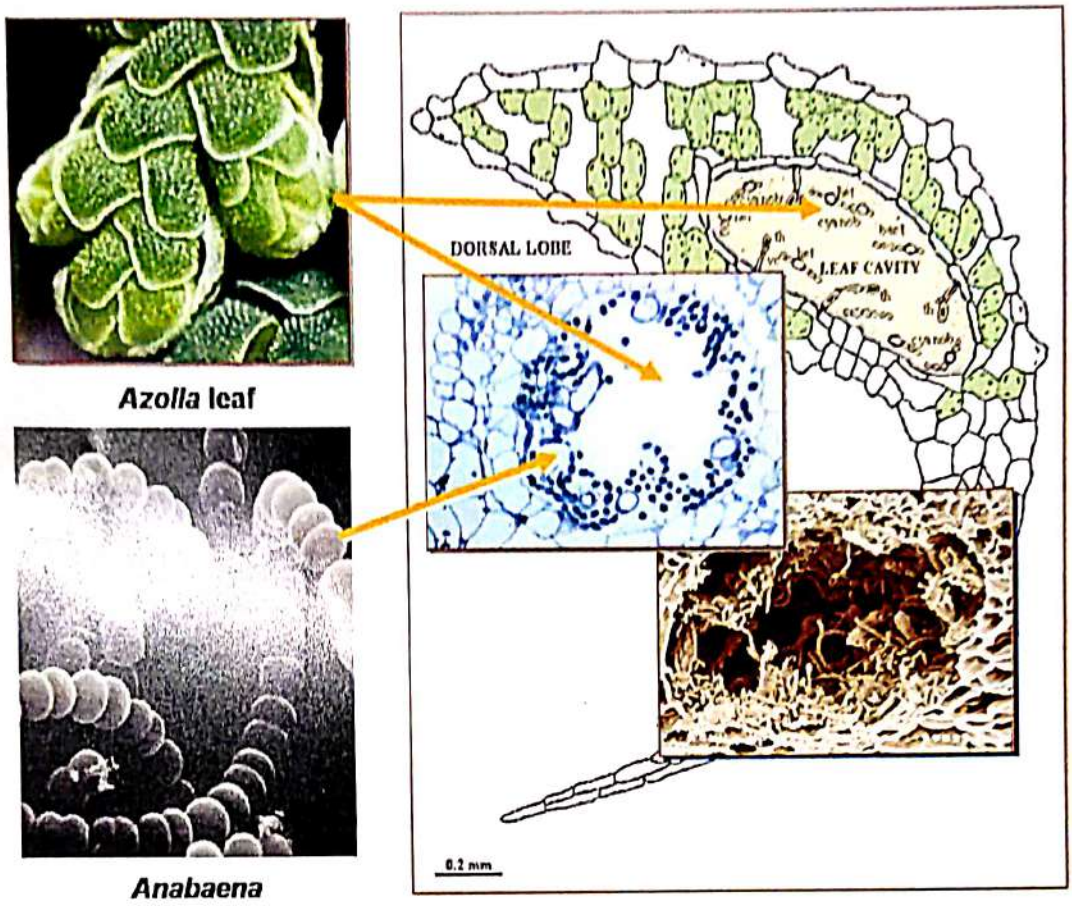

Fig. 4 Azolla's dorsal leaf cavities provide a home for anabaena. Figure modified from Carrapiço (2010).

Fixation of nitrogen

The importance of cultivating *Azolla* lies in the fact that it lives in association with a blue-green algal symbiotic which fixes enough atmospheric nitrogen for the rapid growth of the plant. The blue-green algal species is *Anabaena azolla* and it lives in cavities of the fern's upper lobes. Thus the *Azolla-Anabaena* complex offers a source of organic nitrogen fertilizer and may be considered as aquatic green manure and so, of particular interest in rice cultivation. The *Azolla-Anabaena* symbiosis can produce 103 kg (1 ton) of green manure per (hectare) per day. The average daily N2 fixing rate is reported to vary between 1.0 to 2.6 Kg N/ha. It has been reported that *A. pinnata* fixed 75 kg N/g dry weight/day and produced

biomass of 347 tons fresh weight/ha in a year.

Table. 1 Mineral profile of *Azollapinnata* (on per cent DMB).

Minerals	Percentage	Ppm
Calcium	1.64	
Phosphorus	0.34	
Potassium	2.71	
Copper		9.1
Manganese		2418
Zinc		325
Iron		1569
Cobalt		8.11
Chromium		5.06
Boron		31
Nickel		5.33
Lead		8.1
Cadmium		1.2

Environmental requirements

Azolla is found in ponds, ditches, and wetlands of warm temperate and tropical regions throughout the world. It must grow in water or wet mud, and it dies within a few hours under dry conditions. Azolla can survive a water pH range of 3.5–10, but optimum growth occurs when the water is between pH 4.5 and 7. The optimum temperature for azolla is required 18 to 28^0 C. The growth rate gradually declines as salinity increases. Azolla grows in partial shade 50% sunlight, with growth decreasing quickly under heavy shade. Azolla is established by vegetative propagation. Nursery ponds are generally used to supply a large enough volume to a wetland field to ensure quick coverage.

Costing of Azolla cultivation plot:

The cost involved in setting up *Azolla* cultivation pit varies between Rs 1330 to Rs 4210. The basically cost is in the form of manual labour, which can be contributed bythe family members. While estimating the cost of cultivation pit, two units of pits have been considered to maintain regular yield of *Azolla*. Number of units can be increased depending upon the requirements.

Individual farmer can take up this activity to supplement feed/fertilizer requirement. Alternatively, an entrepreneur can take up *Azolla* cultivation as income generating activity in larger scale to supply requirements of dairy farmers, cattle growers, and poultry.

Table.2 Economics of *Azolla* production

Kuccha Trench	**Cost (Rs.)**	**Pucca Trench**	**Cost (Rs)**
Digging charges of trench (size of unit (6.0 x 1.0 x 0.2 mt)	200.00	200 Bricks @ Rs. 5/- Brick	**1000.00**
Cost of silpauline sheet (120 G)	450.00	Cement 3 bags @ Rs. 310/-	**930.00**
		Gitti + Sand	**600.00**
Nylon Shady net 50 %(7 x 2 mt) @ Rs. 30/- mt	420.00	Nylon Shady net 50 %(7 x 2 mt) @ Rs. 30/- mt	**420.00**
Azolla 2 kg @ Rs. 50/-kg	100.00	Azolla 2 kg @ Rs. 50/-kg	**100.00**
Cow dung 50 kg (10-15 kg.+ 5kg./month)	150 .00	Cow dung 50 kg (10-15 kg.+ 5kg./month)	**150 .00**
Super phosphate 240 gms @20 gm. / month	10.00	Super phosphate 240 gms @20 gm. / month	**10.00**
		Labour charge	**1000**
Total	**1330.00**	**Total**	**4210.00**

Advantages of *Azolla*

1. It can easily grow under controlled conditions.
2. It can use as green manure.
3. It adds available nitrogen for crop uptake and organic carbon content to the soil.
4. It solubilizes Zn, Fe, and Mn and makes them available to the crop.
5. *Azolla* suppresses algal weeds such as *Chara* and *Nitella* in a paddy field.
6. *Azolla* releases phytohormones and vitamins which enhance the growth of the crop plant.
7. It increases the utilization efficiency of chemical fertilizers.
8. It reduces the evaporation rate from the irrigated rice field.

Utilization of Azolla as cattle feed

Azolla should be harvested with a plstic tray having holes of 1 sq.cm mesh size to drain thewater. The tray along with Azolla should be kept in a bucket, half filled with water. Azollashould be washed to get rid of the cow dung smell. Washing also helps in separating the small plantlets which drain out of the tray. The plantlets along with water in the bucket can be poured back in to the original bed. Azolla fed to cattle after mixing in concentrate ratio in 1:1 ratio.1.5 to2.0 Kg of Azolla may be fed to milch animal per day. However, it is advisable to mix Azollainregular feed in 1:1 ratio at the beginning, for one week. After a fortnight of feeding on Azolla mixed with regular feed, livestock may be directly fed with Azolla, without the addition of regular feed material.

Constraints in usage

There are several constraints that hamper the successful use of *Azolla* as biofertilizer. *Azolla* growth is optimum at 25-30oC temperature. Higher temperature leads to pest infestation. It is to grow in partially shaded conditions. It is not directly exposed to bright sunlight. The pH for the growth of *Azolla* is 5.0- 7.0. The growth and multiplication require minerals, especially phosphorous. *Azolla* is highly susceptible to attack by insects and pests. Insects and pests problems can be controlled by the application of pesticides such

as furadon and carbofuran.

Perspectives for the future

The *Azolla-Anabena* association is an excellent biofertilizer for rice cultivation. It produces a large quantity of biomass rich in nutrients. *Azolla* can be used as composting material. Over and above that, it has an excellent Carbon/Nitrogen ratio and thus, its integration as compost and its efficacy in the reclamation of degraded agricultural waste lands also need to be addressed. There have been no systematic studies on the exact phytochemical composition of these plants despite its importance as a source of food for cattle and human beings. The exact chemical composition and biological activity has not been explored.

5. CONCLUSION

Azolla-Anabena association is a very good biofertilizer for lowland rice cultivation. It produces a massive quantity of biomass rich in nutrients. Its incorporation to the field has been reported to rapid growth and also increases the soil microbial activity. *Azolla* has an excellent Carbon/Nitrogen ratio and therefore, its addition as compost and its efficacy in the reclamation of degraded agricultural waste lands also need to be addressed. Further, it is an important source for cattle food as rich in protein and amino acids.

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A Student Study Project on

Vegan milk: An alternate to cow's milk for sustainable health

PROJECT REPORT

Done by

B.Sc. Life Sciences students- 2022-2023

Submitted to

The Commissioner of Collegiate Education
Government of Telangana
Hyderabad

M.K.R. GOVERNMENT DEGREE COLLEGE,

DEVARAKONDA, NALGONDA, 508242.

Reaccredited by NAAC with B^{++}

CERTIFICATE

This is to certify that this project report entitled, **"Vegan milk: An alternate to cow's milk for sustainable health "** is the bonafied work of B. Sc. Life Sciences Second year students during the academic year 2019-20 under the supervision of Dr. Ch. Rama Raju, Assistant Professor of Botany.

Signature of the Principal

PRINCIPAL (FAC)
M.K.R. Government Degree College,
Devarakonda, Nalgonda. Dt. 508

DECLARATION

We the students of B.Sc. Life Sciences, Second year, declare that this study has been originally carried out by us under the supervision of Dr. Ch. Ramu Naik, Assistant Professor of Botany, M.K.R. Government Degree College, Devarakonda, Nalgonga and this has not been submitted to any other institution/ university.

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K. Ashwini	2204402644510l6	Ashwini
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ACKNOWLEDGEMENTS

The production of this project has been made easier through the efforts of many people, to whom we indebted.

This project would not have been possible without the kind support, the probing questions, and the remarkable patience of our Supervisor Dr. **Ch.RamaRaju.** Assistant Professor of Botany, and Principal (FAC), M.K.R. Government Degree College, Devarakonda, Nalgonda. We would like to thank him for all his guidance and encouragement throughout this work.

We extend our thanks to **S. Sharada Devi** Assistant professor of Commerce & Jignasa Coordinator for the initiation, progress and completion of the study project.

We would like to thank our batch mates of B.SC, B.Z.C. for their support.

Vegan milk: An alternate to cow's milk for sustainable health.

ABSTRACT

Vegan milk made from soybeans, oats, and almonds, could be a good substitute for animal origin milk. To overcome the gritty texture of vegan milk, add sugar and thickeners to make their products smoother and more palatable. Thermal treatment has long been used as a processing method to extend the shelf life of plant milk. In general, it is 1 cup of basic ingredient to 3 cups of water. Unsweetened vegan milk can be consumed whole or strained to remove the pulp for a more homogenized consistency. Add some flavor of interest with sweeteners preferably honey.

Key words: Plant-based milk alternatives, beverage, honey

INTRODUCTION

Vegan milk has long been a popular beverage as well as a flavorful element in sweet and savory foods, such as curries made with coconut milk. The consumption of vegan milk has been increased due to absence of cholesterol and lactose. Plant milks have been extensively utilized in various recipes from ages. People due to various reasons such as allergies, lactose intolerance or vegetarianism, are not capable of absorbing milk. Vegan milk made from soybeans, oats, and almonds, could be a good substitute for animal origin milk. To overcome the grity texture of vegan milk, add sugar and thickeners to make their products smoother and more palatable.

In plant-based milks, three factors namely, size of the particle, formation of an emulsion and solubility of proteins governs the stability. Vegan milks beverages with a creamy mouth feel that can be substituted for dairy milk. For commerce, vegan milks are typically packaged in containers similar and competitive to those used for dairy milk however it cannot be labelled as "milk".

AIM & OBJECTIVES

1. Plant based vegan milks are alternative to cow's milk.

2. Homemade vegan milks are cheaper to commercial products

MATERIAL AND METHODS

- Food processor or blender
- muslin cloth
- Measuring jug
- Bowl
- Glass bottle or jar for storage

Plant-based milk alternatives are prepared by disintegration of plant material, which makes the particle composition and size as non-uniform. A simple blend of a nut / seed/ grain/ fruit (coconut) with filtered water is the first step. The ratio of the base food to water varies depending on the base ingredient. In general, it is 1 cup of basic ingredient to 3 cups of water. Unsweetened vegan milk can be consumed whole or strained to remove the pulp for a more homogenized consistency. Add some flavor of interest with sweeteners preferably honey.

Plant-Based Milk Base Recipe

A general classification of the plant based/vegetable milk alternatives into four categories, which is as follows:

(a) Cereal based: Oat milk, Rice milk, Corn milk.

(b) Legume based: Soy milk, Peanut milk, Cowpea milk.

(c) Nut based: Almond milk, Coconut milk, Walnut milk.

(d) Seed based: Sesame milk, Flax milk, Hemp milk, Sunflower milk.

Unsweetened Milk:

- 1 cup nut, seed, grain
- 3 cups filtered water

  - Measure out the nut/ seed/ grain and soak according to the need.
  - Drain and rinse thoroughly. Transfer the drained ingredient to the blender.
  - Add the clean filtered water and any flavor enhancers-spice.
  - Blend on high for 30 to 60 seconds until the ingredients are liquefied.
  - Add the flavor enhancers to taste and blend again.
  - To strain, place a filter bag over a large jug or bowl, pour the milk into the bag, twist the filter bag closed, and gently squeeze it to pass the liquid through.
  - Transfer the strained vegan milk to a container and chill the fridge.

The benefits of homemade plant-based milk

1. are fresh
2. taste better
3. free from additives and preservatives

And, complete control over the integrity of the vegan milk. This can determine the:

1. flavor
2. texture
3. sweetness

Milks that do not need straining:

1. cashews
2. coconut

These nuts yield vegan milks that are incredibly smooth when made in a high- speed blender.

Milks that need straining:

1. almonds
2. flax seeds
3. rice
4. oats

These foods yield vegan milks with some texture. One *can* drink the milk like this.

1. Vegan milks in recipes 2. For Smoothies:

For Coffee and Tea:

Homemade vegan milks can curdle and separate when heated. The best way to make a coffee is on low flame. The best vegan milks for hot coffee and tea are:

1. *oat milk*
2. *almond milk*
3. *cashew milk*

4. coconut milk

Almond Milk

Take 100g of almonds (*Prunus amygdalus*) soaked overnight, with 1 litre of water. Blend in cinnamon/cardamon, a large date and a little lemon.

Almond milk has a mild, nutty flavor that makes it ideal for use in sweet recipes. The mild flavor makes almond milk to go-to with any other ingredients.

Homemade almond milk is low in saturated fats and carbohydrates, and is lactose and cholesterol free. Whole, unstrained almond milk contains all of the nutrients of the whole raw almond, and is packed with protein; heart-healthy monounsaturated fats; omega fatty acids; Vitamins B, D and E; and magnesium, potassium and copper.

Coconut Milk

Coconut *(Cocos nucifera L.)* milk is rich, creamy, and is fantastic for use in sweet and savory recipes. Fresh coconut milk is widely used as a cooking base in cuisines all over India with spectacular results in dishes such as curries, soups, drinks, and fragrant desserts. Traditionally, coconut milk is made by squeezing grated coconut milk through cheese cloths. Make homemade coconut milk by blending fresh raw coconut meat and raw coconut water.

Oat Milk

Soak 50g of whole oats (*Avena sativa* L.) overnight. For this recipe need blend with 1 litre of hot water at about 80°. This is really important to avoid a slimy texture. Blend for 1 minute with 1/2 a liter of water and your favorite complimentary ingredients like root ginger, green cardamom, cinnamon or vanilla. Finally add the rest of the water and blend again for a few seconds.

Rice milk

Take 100g of brown rice (*Oryza sativa*) and blend with 1 litre of hot water just off the boil. Blending in a teaspoon of ground cinnamon or nutmeg and little lemon peel is a real classic. Try adding pear for a real treat.

Rice milk is very thin, light, watery vegan milk that is traditionally made by grinding boiled brown rice and filtered water. This grain milk was one of the first vegan milks to hit the market many years ago, and is a great option for people living with food allergies to dairy, nuts, seeds, soy, and coconut. Rice milk is great for use in smoothies. Rice milk can be a little too watery for a lot of recipes. Rice milk is great on it's own or with a handful of hazelnuts for extra flavor and awesomeness.

Soy Milk

100g of organic soya beans *(Glycine max)* soaked for 8 hours per litre of water. Add 3cm of vanilla bean for flavor and 2 teaspoons of honey for sweetness. After blending, heat for 15 minutes on a medium heat.

Soy milk is made by soaking soy beans and grinding them with filtered water. There is no doubt that soy milk is rich and creamy, and is the easiest way to replicate the texture of dairy milk in recipes.

RESULT AND DISCUSSION

Plant-based milk being rich source of nutrients serves an ideal medium for growth of micro-organisms, and therefore, its quality is adversely affected by the rapid growth of micro-organisms. Thermal treatment has long been used as a processing method to extend the shelf life of food products by eliminating or reducing spoilage and pathogenic micro-organisms. Heat treatment has been utilized to increase the shelf life of plant-based milk along with the

objectives of increasing total solids yield and improvement of flavor whereas, excessive heating found to cause detrimental effects on nutrients (vitamins and amino acids),

Fig. 1 Vegan milk products in the market

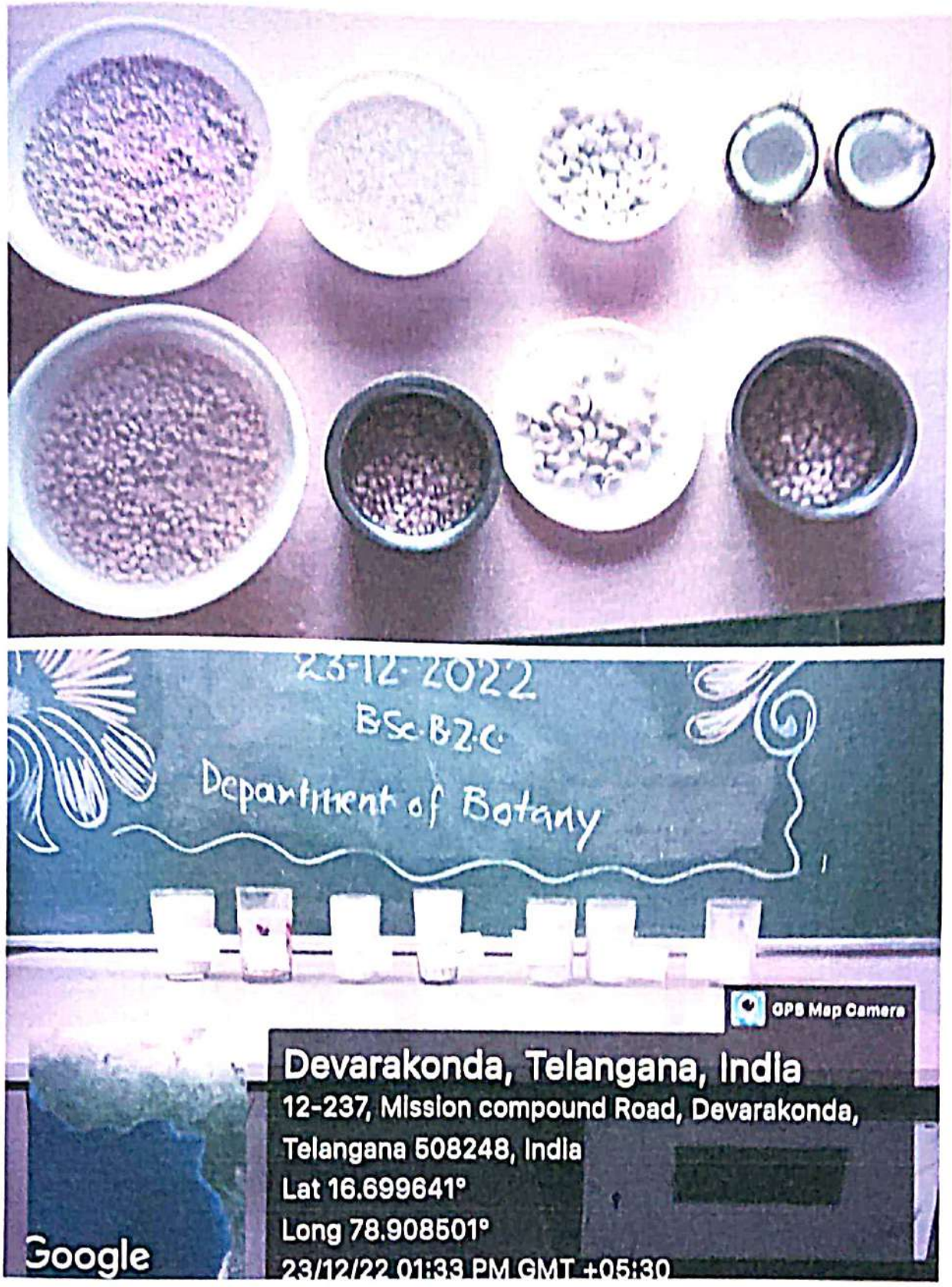

Fig.2 Top: Main ingredient of vegan milk. Bottom: Homemade vegan milks

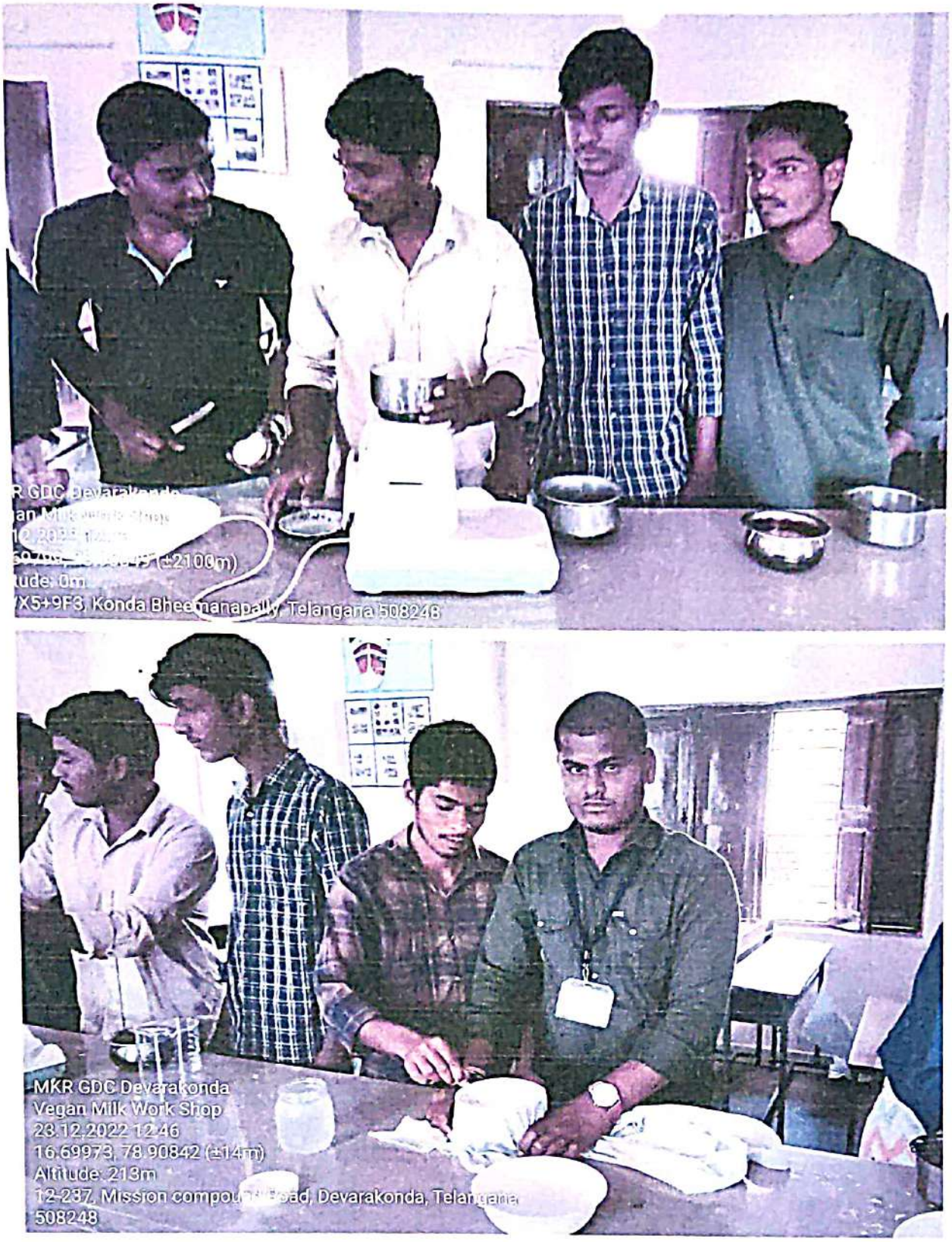

Fig.3 Preparation of vegan milk: Top- Mixing and grinding of ingredient; Bottom-Collection of filtrate

Fig.4 Preparation of vegan milk: Top- Mixing and grinding of ingredient; Bottom-A vegan milk work shop conducted by the students.

The benefits of making homemade vegan milk

There are three significant benefits to making our own plant based alternatives for milk: Price, quality and waste reduction. It's also very satisfying to make your own milk as well.

1. It's a lot cheaper

Firstly it is much cheaper, for example we can make a litre of your own soya milk for around Rs. 50. Nut milks like almond milk are more expensive at about 200 per litre because almonds are quite an expensive nut. This is still better value than industrially processed almond milk considering the raw goodness and the fact that can recycle the pulp.

2. The quality

The second advantage of making own vegetable milk is the quality of the ingredients and the freshness. We control exactly what goes in. We can buy fresh from local stores. Buying organic is especially important in the case of soya beans.

3. Avoid a lot of waste

Finally, we can avoid a lot of waste by buying and storing the ingredients using our own produce bags and containers.

CONCLUSION

Vegan milk alternatives have an enormous expansion prospective for health food market and needs to be widely investigated through the development of advanced processing methods. Fortification of depleted elements, with high overall acceptability is needed. The advanced non-thermal technologies in processing needs to be fully explored and simplified methods to be invented for home made beverages.

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