# A STUDY ON THE PHYTOSOCIOLOGICAL ASPECTS OF SELECTED FLORA AND CARBON SEQUESTRATION ABILITY OF TREE SPECIES IN THE HILL PALACE ARCHEOLOGICAL MUSEUM CAMPUS - KOCHI

**BY**

**AQUILINEANS K.**

**REG NO: SMP20BOT002**


**DEPARTMENT OF BOTANY AND CENTRE FOR RESEARCH**

**ST. TERESA'S COLLEGE (AUTONOMOUS)**

**ERNAKULAM**

A DISSERTATION IN PARTIAL FULFILLMENT OF THE REQUIREMENTS

FOR THE AWARD OF THE DEGREE OF

**"MASTER OF PHILOSOPHY IN BOTANY"**

SUBMITTED TO

**MAHATMA GANDHI UNIVERSITY**

PRIYADHRASHINI HILLS

ATHIRAMPUZHA P.O

KOTTAYAM

**JULY 2022**

# MAHATMA GANDHI UNIVERSITY

## CERTIFICATE ON PLAGIARISM CHECK

| | | |
|---|---|---|
| 1. | Name of the Research Scholar | **AQUILINEANS K** |
| 2. | Title of the Thesis/Dissertation | A Study on the Phytosociological aspects of selected Flora and Carbon Sequestration ability of tree species in the Hill Palace Archeological Museum Campus – Kochi |
| 3. | Name of the Supervisor(s) | Dr. Liza Jacob |
| 4. | Department/Institution/ Research Centre | Department of Botany<br>St. Teresa's College (Autonomous) Ernakulam |
| 5. | Similar Content (%) identified | **0% (Zero)** |
| 6. | Acceptable Maximum Limit | 25% |
| 7. | Software Used | Ouriginal |
| 8. | Date of Verification | 29-06-2022 |

**Report on plagiarism check, items with % of similarity is attached*

Checked by (with Name, Designation & Signature)

29/06/22

SEBASTIAN JOSEPH
Asst. Librarian
Mahatma Gandhi University
P.O
Kottayam

Name & Signature of the Researcher : Aquilineans K

29/06/22

Name & Signature of the Supervisor(s) : Dr. Liza Jacob

Name & Signature of the HoD/ HoI (Chairperson of the Doctoral Committee) :

Dr. Stephen Sequeira M.Sc.,Ph.D
Assistant Professor
Post Graduate Dept. of Botany
Maharaja's College
Ernakulam - 682011

Curiginal

## Document Information

| | |
|---|---|
| Analyzed document | AQUILINEANS K-A STUDY ON THE PHYTOSOCIOLOGICAL ASPECTS OF SELECTED FLORA AND CARBON SEQUESTRATION ABILITY OF TREE SPECIES IN THE HILL PALACE ARCHEOLOGICAL MUSEUM CAMPUS - KOCHI.docx (D141430479) |
| Submitted | 2022-06-29 06:42:00 |
| Submitted by | Smt. Letha Aravind |
| Submitter email | library@mgu.ac.in |
| Similarity | 0% |
| Analysis address | library.mgu@analysis.urkund.com |

## Sources included in the report

**W**

URL: https://en.wikipedia.org/wiki/Evolvulus_alsinoides
Fetched: 2020-08-13 13:13:44
1

**W**

URL: https://innovareacademics.in/journals/index.php/ijpps/article/view/41907
Fetched: 2021-11-07 05:33:46

DL
29/06/22

SEBASTIAN JOSEPH
Asst. Librarian
Mahatma Gandhi University
P.D. Hills P.O
Kottayam

## DECLARATION

I hereby declare that the dissertation entitled **"A Study on the Phytosociological aspects of selected Flora and Carbon Sequestration ability of tree species in the Hill Palace Archeological Museum Campus – Kochi"** is an authentic record of the research work carried out by myself under the guidance of **Dr. Liza Jacob**, Associate Professor, Department of Botany, St. Teresa's College (Autonomous), Ernakulam.

Place: Ernakulam

Date: AQUILINEANS K.

## CERTIFICATE

This is to certify that the investigatory project entitled **A Study on the Phytosociological aspects of selected Flora and Carbon Sequestration ability of tree species in the Hill Palace Archeological Museum Campus – Kochi** submitted in partial fulfillment of the requirements for the award of Degree of Master of Philosophy in Botany, is an authentic record of the research work carried out by **AQUILINEANS K. (SMP20BOT002)** under the supervision and guidance of **Dr. Liza Jacob**, Associate Professor, Department of Botany, St. Teresa's College (Autonomous), Ernakulam. I further certify that no part of the work embodied in the project has been submitted for the award of any other degree or diploma.

Dr. Liza Jacob
Head
Department of Botany
St. Teresa's College (Autonomous)
Ernakulam

Dr. Liza Jacob
Associate Professor
Department of Botany
St. Teresa's College (Autonomous)
Ernakulam

St. Teresa's College (Auto.) Department of Botany Ernakulam

13/9/2024

## ACKNOWLEDGEMENT

*At the outset I offer my gratitude to the Almighty for all the blessings given to me and for the successful completion of my work.*

*It is my privilege to express my deep sense of gratitude, respect and admiration towards Dr. Liza Jacob - my supervising teacher and Head of the Department for suggesting this topic, selfless assistance, and motivation throughout the course of my dissertation work. Without her sincere help and moral support this work would have not been a success.*

*It's my great pleasure to express my gratitude towards Dr. Alphonsa Vijaya Joseph Dr. Arya P Mohan, and I.K Nishita, for her support during my work and also to my all-beloved teachers for their encouragement and support.*

*I am very much thankful to the non-teaching staff, department of botany and friends for their help co-operation and encouragement*

*I hereby express my gratitude to the authorities of Hill Palace Museum campus. Specially to Mr Jigish, (Hticulturist) and to Mrs. Remya Jose in the Hill Palace Museum for spending their valuable time during field work.*

*I express my special thanks to Dr. Giby Kuriakose, Dr. Priya Rani M. and Mrs. Ratna for extending helping hands towards me. I would like to express my special thanks to my colleagues for their kind hearted co - operation. I gratefully acknowledge Department of Collegiate Education (DCE), Government of Kerala for granting Aspire Scholarship to carry out this work.*

*I am very much thankful to my friends Mrs. Aji Mathew, Mrs. Anooja , Miss. Asha, Mrs. Janis Jose, Mrs. Minnu Earnest, Mrs. Soumya Mary and Mrs. Uma Devi for their kind hearted co – operation, valuable moral support, motivation and care towards me. I am also great full to my classmates and cousins.*

*I wish to record my deep sense of gratitude towards my dear Husband Mr. Joseph Thomas for motivation and moral support. I am also grateful to my beloved Parents, Late Mr. K. A. Antony and Mrs. Philomina Antony for their blessings throughout my course. without which this work would not have been completed successfully.*

Place: Ernakulam

Date: AQUILINEANS K.

## CONTENTS


| SL NO: | CHAPTER | PAGE NO: |
|---|---|---|
| 1. | INTRODUCTION | 1-7 |
| 2. | OBJECTIVES OF THE STUDY | 7 |
| 3. | REVIEW OF LITERATURE | 8-14 |
| 4. | MATERIALS AND METHODS | 15-19 |
| 5. | OBSERVATION AND RESLTS | 20-57 |
| 6. | DISCUSSION | 58-63 |
| 7. | SUMMARY AND CONCLUSION | 64-65 |
| 8. | REFERENCES | 66-77 |

## ABBREVIATIONS

| | |
|---|---|
| **AGB** | Above Ground Biomass |
| **A** | Abundance |
| **BGB** | Below Ground Biomass |
| **D** | Density |
| **DBH** | Diameter at Brest Height |
| **F** | Frequency |
| **IVI** | Importance Value Index |
| **kg** | Kilogram |
| **$m^2$** | Meter square |
| **RDO** | Relative Dominance |
| **RF** | Relative Frequency |
| **TC** | Total Carbon |
| **TB** | Total Biomass |

## LIST OF TABLES


**Table 1** Herbs identified

**Table 2** Trees identified

**Table 3** Phytosociological attributes of study Area

**Table 4** Medicinal properties of the herbs identified

**Table 5** DBH, Height, Density, AGB, BGB and TC of 100- 150-year-old trees

**Table 6** DBH, Height, Density, AGB, BGB and TC of 75 -100-year-old trees

**Table 7** DBH, Height, Density, AGB, BGB and TC of 50-75-year-old trees

**Table 8** DBH, Height, Density, AGB, BGB and TC of newly planted (15 years old) trees

## LIST OF FIGURES


**Figure 1** Comparative account of Importance Value Index of species in the months of February, March and April.

**Figure 2** Comparative account on Frequency of species in the months of February, March and April

**Figure 3** Comparative account on the Density of species in the months of February, March & April

**Figure 4** Comparative account on the Abundance of species in the months of February, March and April.

**Figure 5** Relationship between diameter and carbon sequestration of 100-150-year-old trees

**Figure 6** Relationship between diameter and carbon sequestration of 75-100-year-old trees

**Figure 7** Relationship between diameter and carbon sequestration of 50- 75-year-old trees

**Figure 8** Relationship between diameter and carbon sequestration of 15-year-old trees

## LIST OF PLATES


| | |
|---|---|
| **PLATE 1** | Map showing the Ernakulam district, Irumpanam and google map showing the Hill Palace Museum |
| **PLATE 2** | Study area |
| **PLATE 3** | *Aerva lanata*, Juss.<br>*Alternanthera sessilis*, R.Br.<br>*Boerhaavia diffusa*, L.<br>*Calycopteris floribunda*, Lam.<br>*Centrosema mole*, Benth.<br>*Chasalia curviflora*, Thw. |
| **PLATE 4** | *Cleome viscosa*, L.<br>*Cyclea peltate*, Hk.f.&T.<br>*Desmodium triflorum* W & A.<br>*Emilia sonchifolia*, DC.<br>*Eupatorium odoratum*, L.<br>*Euphorbia hirta*, L. |
| **PLATE 5** | *Evolvulus alsinoides*, L.<br>*Hewittia bicolor*, W&A.<br>*Ichnocarpus frutescens*, R. Br.<br>*Mimosa pudica* , L.<br>*Mukia leiosperma*, W.<br>*Mullugo pentaphylla*, L. |
| **PLATE 6** | *Naregamia alata*, W.&A.<br>*Oldenlandia alata*, Koen.<br>*Oxalis corniculata*, L.<br>*Pennisetum pedicellatum*, Trin.<br>*Peperomia pellucida*, H.B.K.<br>*Phyllanthus niruri*, L. |
| **PLATE 7** | *Pothos scandens*, L.<br>*Scoparia dulcis*, L.<br>*Sebastiana*, Spr. *Chamaelea*, M. Arg.<br>*Synedrella nodiflora*, Gaertn.<br>*Tridax procumbens*,L<br>*Wedelia biflora*, DC. |

**PLATE 8** Measuring the DBH and height

**PLATE 9**

*Achras sapota,* L.
*Adenanthera pavonina,* L.
*Aegle Marmelos,* Corr
*Alstonia scholaris* R. Br.
*Anacardium occidentale,* L.
*Artocarpus heterophyllous,* L.

**PLATE 10**

*Artocarpus hirsuta,* Lam.
*Azadirachta indica,* A Juss.
*Borassus flabellifer,* L.
*Cassia Fistula,* L.
*Casuarina equisetifolia,* Forst.
*Chrysophyllum cainito,* L

**PLATE 11**

*Couroupita guianensis,* Aublet
*Delonix regia,* Raf
*Diospyros*, L. *Ebenum.* Koen
*Erythrina*, L. *Indica,* Lam
*Ficus bengalensis,* L.
*Ficus macrocarpa,* L. f.

**PLATE 12**

*Ficus recemosa*, L.
*Ficus religiosa,* L.
*Filicium decipiens,* Thw.
*Gmelina arborea,* Roxb.
*Lagerstroemia indica,* L.
*Litichi chinensis,* Sonn.

**PLATE 13**

*Macaranga peltata,* M.Arg.
*Mangifera indica*, L.
*Mellotus philippensis*, Lam.
*Michelia champaca,* L.
*Mimusops Elengi ,* L.
*Neolamarckia cadamba,* Roxb.

**PLATE 14**

*Parkia biglobosa* (Jacq.) R.Bx.ex.
*Polyalthia longifolia* Hk.f.&T.
*Pterocarpus indicus, Roxb*.
*Samanea saman* (Jacq.) Merr.
*Saraca indica,* L.
*Tabebuia berteroi,* L.

**PLATE 15**

*Tectona grandis*, L.f.
*Tamarindus indica,* L.
*Terminalia bellerica,* Roxb.
*Terminalia catappa,* L.
*Vetteria indica*, Vet.
*Zanthoxylum,* L. Rhetsa, DC.

## Abstract

Hill palace is an archaeological museum and palace spreading across 54 acres, located in Tripunithura of Ernakulam district in Kerala. The museum campus has a wealth of flora including shrubs, herbs, and trees. The present study was conducted to analysis the phytosociological aspects of herbs and carbon sequestration ability of trees in the museum campus. Quadrate method was used to study the phytosociological aspect. A total of 30 types of herbs belonging to 19 families were encountered in this study. Based on Importance Value Index, *Oxalis corniculata*, L was the most dominant followed by *Tridax procumbens*,L. The diversity of herbs unevenly dispersed in the study area. Different herbs with different families were recorded but very few in number. All these are medicinally important. In order to study the carbon sequestration, the trees were grouped into four on the basis of year of planting. The first group consists of trees, with an approximate age of 100-150-year-old. Among them *Ficus bengalensis* L. is found as the highest carbon sequestration (34.9668kg). In the second group the highest carbon sequestration of 3.0635 kg was found in *Mangifera indica, L*. This group consists of 12 trees of 70–100-year-old. 12 trees were identified in the 3rd group, the plants were 50-75 years old. In this category the highest sequestration was found in *Polyalthia longifolia* Hk.F.&T. (0.6 161) The plants belonging to this group belongs to 50- 75-year-old. The last category consists of plants which are 15 years old. In this category the highest carbon sequestration was found in *Ficus macrocarpa*, L.f. followed by *Ficus recemosa*, L. These results clearly showed Ficus species were good in sequestrating the carbon.



Keywords

Importance Value Index, *Oxalis corniculata*, L, *Tridax procumbens*,L. Carbon sequestration, *Ficus bengalensis* L, *Mangifera indica, L*.

# INTRODUCTION

The world, 500 million years ago observed very different to today. The land was plain, with only bacteria, fungi and algae able to survive on it. But once plants moved onto land, they transformed almost everything on Earth's surface. The life containing and life supporting environment of the world is restricted to a very irregular layer around the globe. The covering of living material on the earth is called ecosphere or biosphere. Plants are the significant of life forms that includes familiar organisms such as trees, herbs, bushes, grasses, vines, ferns and mosses.

The plants generate soils, rivers and the oxygen-rich atmosphere, which eventually allowed animals to live a life out of water. The variety of all life on earth that range from bacteria to baboons, plants to people described as biodiversity. So, the biodiversity means the variety of living species on Earth, which includes animals, plants, bacteria and fungi. We are blessed with a rich biodiversity, that many species have yet to be discovered. Each of these species and organisms work together in ecosystems, like a complex web, to maintain balance and support life. We need food, clean water, shelter, medicine etc to survive our biodiversity provides everything that support our life. Biodiversity acts an important role in maintaining ecological balance.

The variability of life on earth results in the formation of biodiversity. The variabilities can be observed within species, and among the species of plants and animals. It also includes variability of genes and population in different ecosystems. The climate plays a crucial role in the biodiversity which shows variation and not uniformity.

Studies shows that over 50 million of plants, animals and microorganisms exist in this world. Among them only about 2 million organisms have been identified and studied till now. Studies have shown that various life forms that exist on earth have immense potentials of survival and adaptation. David Mc Donald a professor at Oxford University says that, "Without biodiversity, there is no future for humanity,"

This biodiversity includes countless interactions which have occurred over millions of years of evolution. Scientists exploring more about these interactions in the ecosystem. This includes the water we drink, the food we eat, the air we breathe. All of which relay on these interactions. There are only advantages that can be seen because of the richness of biodiversity. Among the human benefits are medicines that are harvested from nature which are able to even fight cancer. Animals and plants also help to enrich the soil against the risk of drought or salt. It is because of plants that we have oxygen and because of bees that there is pollination which results in fruits. If the interactions in the biodiversity are damaged our planet system would entirely be unbalanced. In order to have a healthy sustainable planet we need to maintain the ecosystem in its balanced and healthy state.

Research shows that our life and requirements depend mainly on these biological resources says. Biological diversity, a term that was coined in 1985 by contracting biological diversity, is however at risk lately. However, in the recent times global biodiversity is going through a crisis that is seems specifically in the climate change across the world.

The plants in an exceedingly community sometimes live along and influence each other. Within the forest there are several plant communities, like trees, shrubs, herbs, mosses and lichens. These communities blend with each other and regulate in line with environmental conditions. Trees give shadow on several shade smitten plants that grow around or below them. The microorganisms like microorganism, algae, fungi, and viruses influences the lifetime of plants in some ways. The decomposition of dead components of plant bodies adds organic compounds and humus to soil. During this means, vegetation modifies the habitats to a substantial extent.

This vast ecosystem is however difficult to handle and thus for convenience we generally study nature by making its artificial subdivisions into units of smaller ecosystems of different sizes. The common method is to divide it into two main segments the living (biotic) and the non-living (a biotic) (Ambashat and Ambashat, 2004). The abiotic and abiotic components make the world suitable for all. The objects like rivers, mountains, volcanoes and water-bodies are the abiotic components. The biotic means the world of flora and fauna. The word

“flora” is used to label plant life. Fauna is all of the animal life. Healthy native flora provides benefits to the planet in many ways. They help to maintain balance between carbon dioxide and oxygen in the environment. Native flora provides food, shelter and warmth for humans, animals who live in the area. It fertilizing soil and filtering water for drinking. Many plants contain healing compounds too.

The plant ecology consists of facts and interpretations of these facts. Natural laws and principles are playing an important role in order to justify these facts. The vegetation which is present today is the result of environmental conditions that exist in the past. Thus, environmental conditions modified the vegetation and their character is developed due to this environmental influence. The study of vegetation from an ecological point of view embodies fact that subsist on the ground, facts about vegetation, about habitat etc.

Man has been interested in ecology in a practical sort of way since early in his history (Odum 1979) perhaps first great phenomenon to interest plant ecologist was that the vegetation of different parts of the earth looked different. There were rain forests, and tundra. Geographical drew maps showing the aerial extant of each of these formations and their maps seemed to say that the world was neatly parcelled out between different formations of plant (Paul, 1930).

It is very difficult to see the plant or animal lives as isolated individual. They live in groups or colonies. Plant community is the area dominated by plants. Plant community may be an assortment or association of plant species among a delegated geographical unit, that forms a comparatively uniform patch, distinguishable from neighbouring patches of various vegetation sorts. In several cases we can identify many soils with in a given plant community. Plant communities studied well by ecologists, thanks to providing data on the consequences of spreading, tolerance to environmental conditions, and response to disturbance of a range of plant species, data valuable to the comprehension of varied plant community dynamics. The study of sets of species of plant that are usually seen together is called as Phytosociology, it is also known as phytocoenology or plant sociology.

The study of structure and composition of plant communities has been developed largely in Europe and Zurich – Montpether School of Vegetation analysis led by J. Braun – Blanquet suggested several methods grouping them into phytosociology. Qualitative and quantitative methods are commonly used to study about plant community. The qualitative structure of plant community based on visual observations. Quantitative aspects of study describe the manner in which the plants occupy the ground. It tells about detailed information including the area, number of plant species etc. Phytosociology deals with plant communities and gives emphasis on the classification of plants.

According to Braun Blanquet (1932) analytical characteristics are those features of community which can be observed or measured directly in each stand. They include kinds and numbers of individuals, height of plants, areas volume, growth rate and periodicity, etc. The vegetational analysis consists of two aspects of namely quantitative characters and qualitative characters. in which the quantitative characters can be measured more readily than the others.

It is difficult to get a complete structure of a plant community from a single habitat. In order to get the sociological order in a plant community we should observe the plant at different places or in a sample area, or to be precise, in a habitat. Ecologists suggest several methods for doing these studies. One of the commonly used methods is a quadrate method.

Quadrate is a square sample plot method. A single sample plot or several subplots can be used in this method. The size of a quadrate varies on the basis of the area. E.g., quadrates of one fifth acre are used for the forest community, while quadrates of smaller size are enough for shrubs and grass. The quadrates of one square meter size or 50x50cm size is used for grassland and low herbaceous community. Shapes of the quadrates can be square, rectangle and circle. Among these the square shape is commonly preferred and frequently used.

Quantitative structure of a community helps to identify the coexistence and competitions. So, in a community the individuals are affected by the above phenomenon. The numerical constants help to characterize the community. These constants are called parameters, for instance, the mean value of individuals of a

species per plot. So, by analyzing the frequency, density, abundance and importance value index, we get a clear structure of a community.

Density is the numerical strength of a species in a unit space. In a community the individual species are not distributed evenly. In order to find the frequency, the presence of individual species in each sample plot is noted. If the species is present in all the sample plots, we can say the frequency of that particular species in that zone is high. Abundance refers to the total number of individuals of the species in all quadrates to the total number of quadrated in which the species occurred. Importance value index helps us to measure the dominant species. Relative Frequency, Relative Density and Relative Dominance are the values expressed as percentage its value ranges from 0 to 300.

The environment influences growth of the plants. The geographic distribution of plants is also the result of environment in which it grows. We cannot imagine the world without plants. These plants support our surroundings in many ways. Plants are the major source of food and medicine. The chemical constituents present in the herbs exhibit therapeutic properties. Each herb has specific qualities. Herbal medicine has lots of advantages than chemical drugs. Plants are safe to use without any side effects. The presence of active principle in herbs have got pharmaceutical value. The people around the world uses herbal medicine because most of the herbs are locally available. According to WHO around 85% of the people uses herbs as herbal remedies.

Natural cooling effect and air quality is improved by the green plants. If planted in polluted places it would enable safer breathing. Plants are rich in carbon, and form the carbon pool of earth. Plants are able to store carbon through the process called photosynthesis which regulates the carbon cycle. In the global carbon cycle, the forest ecosystem plays an important role, it sequestrated a considerable amount of $CO_2$ from the atmosphere (Maslekar and Jugal 1981) This is why the forest ecosystem leads to be an important source of carbon.

Oceans, fossil fuel deposits, terrestrial ecosystem are the natural stocks of carbon in the environment. Rocks, sediments, wetlands and forest and soils are the places where the carbon sequestration is seen. Plants store atmospheric carbon

dioxide in the form of carbon as long as they live, it is called live biomass. When plants die, they become the part of the food chain which finally enters to soil. The burning of biomass allows carbon to be released into the atmosphere to enter the carbon cycle.

It is essential to understand the importance of the role of forests in carbon sequestration. It provides the greatest near-term potential for human management. Plants and most crops, are having short lifespan they release the carbon at the end of each season, but the case of forest is different the biomass accumulates carbon over decades and centuries. The carbon accumulation power of forest trees is large. They can sequestrate significant amounts of additional carbon in relatively short periods – decades.

We depend on forest for timber, wildlife or recreation. It is important to protect forests to sequester carbon. Such an emphasis on biomass accumulation provides a rich biodiversity. The forests that are managed for carbon sequestration are permitted to establish and persist unharvested, for a long-term we will get an enhanced biodiversity.

The biomass is the terrestrial carbon storage by trees. Other important source of carbon are the vegetation and the soil. It is a proven fact that carbon is removed from the atmosphere and store in the biosphere. By the process of photosynthesis, the $CO_2$ is converted into biomass, the plant tissue is stored this biomass. Finally leads to the overall development and growth of plants.

Due to diversity trees are the major component of landscape. Their importance in ecosystem dynamics is prominent. However, it is paradoxical that vegetation has undergone destruction and degradation in modern times due to industrial and technological advancements achieved by human society. This advancement has resulted in the extravagant emission of carbon in to the ecosystem. There for it is important to address environmental problems associated with them. Global warming or the heating of the earth's surface due to various human activities is one of the most discussed topics around the world. From the world stage to classrooms, to protest marches to political campaigns, global warming has captured an individual's imagination around the globe.

The most important sinks for atmospheric carbon are trees. It is well known that 50% of their standing biomass is carbon. (Ravindranath *et al.,* 1997). There is clear documentation of importance of forested areas in carbon sequestration. We should study the importance of trees in carbon sequestration from urban areas. Tree-dominated areas in cities are known as 'green pockets' which include institutions, avenues and public gardens these are considered as the non-forested areas.

The area selected for the present work is Hill Palace Museum. It is an archeological museum and palace spreading across 54 acres, located in Tripunithura of Ernakulam district in Kerala. It was the residence of the Cochin Maharaja. Based on historical evidence the oldest building was built on 1853 by Ravi Varma. The palace complex consists of 49 buildings. From 1981 onwards this palace complex and the surrounding property was acquired by the Department of Archaeology. The museum complex is home to many trees which enhances the beauty of the place.

The study constitutes an assessment of phytosociological aspect of selected flora and carbon sequestration potential of tree flora in and around the hill palace museum campus.

The objectives of the present work as the following

1. To find out the Frequency and relative frequency of selected flora.
2. To find out the Density and Relative Density of selected flora.
3. To find out the Abundance of selected flora.
4. To find out the Importance Value Index of selected flora.
5. To find out the weight of carbon sequestrated by selected species.

# REVIEW OF LITERATURE

The present study deals with the phytosociological aspects of selected flora and carbon sequestration potential of trees on the hill place museum campus. Many studies have been carried out in the areas of phytosociology and carbon sequestration.

The herbaceous flora of Hill Palace Museum has analyzed phytosociologically and their medicinal properties were collected from the literature.

## PHYTOSOCIOLOGY

Curtis and McIntosh (1950) conducted a study on the analytic and synthetic phytosociological characters of plant community. Phytosociological studies on *Polygala chinensis* L, were studied by Merlee and Avita (1989). Denisa (1993) conducted a study on phytosociology of grassland vegetation ( North Korea).

Smiliar studied were carried out on *Eleutheranthera ruderalis* (SW) SCH. Bip., by Sheela and Hema (2003). Prasad (2005) conducted the studies on the phytosociology revealed the presence of Asteraceae, Cyperaceae, Fabaceae, Lamiaceae and Euphorbiaceae. Yunxiang and Toru (2006) studied the steppe vegetation in Ukraine.

Sheela and Asha (2007) studied the phytosociological aspects of the medicinally important plants of the family Compositae. They took 3 plants for the study. *Eclipta alba Emilia sonchifolia* and *Vernonia cinerea* were the plants selected for the study. Sheela and Girija (2008) studied the phytosociology of *Synedrella nodiflora* Gaertn.

Ray and Jojo (2009) phytosociological method were carried out to identify the degree of tolerance of species. They identified 85 species belonging to 27 families

Khan *et al.,* (2012) conducted a study on phytosociological aspects of forest and non-forest vegetation. It was a comparative analysis. They took 36 sites for field work. Nazir *et al.,* (2012) studied the diversity and regeneration status of community forest in Garhwal Himalaya. Total 52 plant species were studied. Which included 12 trees, 18 shrubs and 22 herb species.

Sasikala *et al.,* (2014) conducted a study on the phytosociological aspects of sacred groves in Mahe. 19 sacred groves were present in this region. out of that they selected two major grooved for the study.

Asma *et al*., (2014) conducted the phytosociological study on the Herbaceous plant community. 41 herb species were observed. which is belonging to 20 different families.

Barin and Debabrata (2015) studied the phytosociological aspects of medicinal Plants of forests at Buxa Tiger Reserve (BTR) and Gorumara National Park. It is a conserved area.

Plant Biodiversity and Phytosociological Studies on tree Species diversity was studied by Srinivasa *et al.,* (2015). They recorded 110 species belongs to 40 different families Varghese and Menon conducted a study on M*yristica* swamp forests of southern western ghats in Kerala. They analyzed floristic composition and diversity.

Many workers done the phytosociological studies to understand the pattern of vegetation, Shilpa and Anitha (2016) did a study on phytosociological studies of the selected sacred grove in Kannur district.

Herbaceous flora of sacred grooves in Pattambi was carried out by Nishitha and Joby (2016). Amaranthaceae and Asteraceae were the dominant species.

Deepa *et al.,* (2017) studied the phytosociological studies on Chithalikavu it is a sacred grove. Groves were rich with natural vegetation. They also studied the taxonomic aspects too.

Sukumaran *et al.,* (2018) conducted a study on phytosociological aspects of sacred grove of Kanyakumari district in India. Akash *et al*., (2018) conducted a work on phytosociological studies, biodiversity conservation in a sub-tropical forest. it is a moist deciduous forest situated at Rajaji Tiger reserve.

Konatowska, and Rutkowski (2019) studied the importance of phytosociology. According to them it is a tool for the assessment of human impacts on forest ecosystem.

Vishnu et al., (2020) studied the phytosociological aspects of three terrestrial ecosystems of Wayanad in Kerala. Vegetation was quantified with the help of 85 quadrats (10 x 10 m).

Phytosociology and biodiversity of roadside herbs was carried out by Abu *et al.,* (2021) in a salinity-affected coastal area of Bangladesh.

Phytosociological study on medicinal plants were studied by Alice *et al*., (2022). They also studied the importance of medicinal plants in the present scenario. Because there were lots of pharmaceutical companies required raw materials.

## MEDICINAL PROPERTIES OF HERBS IDENTIFIED

Amritpal Singh (2008) conducted a review work on the ethnomedicinal uses and pharmacology of E*volvulus alsinoides* linn.

Ravindra (2010) conducted a review work on *Cleome viscosa* based on phytochemistry, and pharmacology.

A review work was conducted by Meena *et al.,* (2011) on the importance of *Wedelia biflora* DC. Hullatti *et al*., (2011) studied the diuretic activity of the leaf extract of the medicinal plant *Cyclea peltate*, cooke. Memfin *et al*., (2011) studied the antimicrobial and wound healing activities of *Centrosema genus.*

Mahesh *et al.,* (2012) conducted a review work on *Boerhaavia diffusa* . Studies stated that it is having a good medicinal property.

Ethnobotanical and pharmacological properties of *Mukia leiosperma* W. was carried out by Petrus (2013). A study on the pharmacology and traditional uses of *Mimosa pudica* was conducted by Baby *et al.,* (2013)

Ajeesh Krishna *et al*., (2014) studied the Physico-chemical evaluation of crude drug powder of *Chassalia curviflora*. Thomas *et al., (2014) studied the importance of Alternanthera sessilis* R.Br. the result revealed that it has anti-microbial, antipyretic activity,and anti-oxidant activities . It also helps in wound healing.

Dash *et al.,* (2015) studied the, phytochemical, pharmacological aspects of *Emilia sonchifolia* DC. They also studied the traditional and uses of *Emilia sonchifolia* DC. Reena *et al*., (2015) studied the antimicrobial properties of *Sebastian,* spr. *Chamaelea* M. arg.

*Icnocarpus frutescens*, R. Br was a medicinal plant. Kumarappan, *et al*., (2015) studied the valuable medicinal properties of this plant. Nittya and Suresh (2015) studied a revies work on Ethno medicinal uses of *Vernonia cinerea*, Less.

Ethnopharmacological studies on *Desmodium gangeticum* (l.) Dc, *Desmodium triflorum* linn and *Desmodium triquetrum* L. was carried out by Vedpal *et al.,* (2016). Hakim and Obydul (2016) carried out a review on phytochemical and pharmacological properties of *Phyllanthus niruri* L. Mandal and Swati Madan (2016) studied the pharmacological importance of *Aerva lanata*

Patric *et al*., (2017) studied the neuropharmacological effect of the whole plant extract of *Synedrella nodiflora*, gaertn

Medicinal effects of *Mullugo* genus were studied by Aglin (2018). Wound healing properties of *Pennisetum pedicellatum* was carried out by Ukwuani *et al*., (2018). Raghavendra and Prashith (2018) studied the importance of phytochemistry and pharmacological activities of Peperomia *pellucida* H.B.k. A review of medicinal uses of *Tridax procumbens* L was carried out by Samantha *et al*., (2018)

Babar *et al*., (2019) carried out a review work on medicinal properties of *Calycopteris floribunda* Lam. The parts of plant being used medicinally in the treatment of vomiting, dysentery, ulcers etc. Shaktijit *et al.,* (2019) studied on the phytochemical and pharmacological importance of *Oldenlandia corymbose* koen

Pranabesh *et al*., (2019) conducted a review work on the phytochemical constituents and pharmacological properties of *Euphorbia Hirta* L

*Scoparia dulsis* L **is u**sed to cure jaundice, stomach problems, reproductory issues, skin disease, fever, and kidney stones. it has, antioxidant, anti-microbial, and anti-inflammatory property. Ahana (2020)

Prashasti *et al.,* (2020) analysed the medicinal properties of *Naregamia alata*, W.&A. A review work on the therapeutic potentials of *Oxalis corniculate*, L was carried out by Anika *et al.,* (2020). Niral and Rabinarayan (2020) studied the ethanobotanical importance of *Pothos scandens* L. Nur *et al.,* (2020) studied the Pharmacological Properties and Medicinal Potential of *Chromolaena odorata*

Timothy *et al.,* (2021) did a review on medicinal plants used as snake venom antidotes in east African community. *Hewittia Bicolor* W&A can be used as antidotes.

## CARBON SEQUESTRATION

Ravindranath and Ostwald M (2008) studied the methods for estimating above-ground biomass. Jana *et al*., (2009) observed the sequestration rate of four young tree species of *Shorea robusta Albizzia lebbek, Tectona grandis* and *Artocarpus integrifolia.* They also studied on the aboveground biomass carbon potential.

Meenakshi *et al.,* (2010) studied on the carbon storage and sequestration potential of the tree species in India. They took selected species for study they are *Eucalyptus tereticornis* Sm., *Populus Deltoides* Marsh, and *Tectona Grandis* Linn.

The carbon sequestration on roadsides by urban trees studied by Sandhya and Shah (2011) they conclude that the tree planting on roadside have the ability to store CO2 from human sources.

A study on the Carbon Sequestration potential of tree species in Somjaichi Rai (Sacred grove) at Maharashtra in India was conducted by Hangarge *et al.,* (2012). The used nondestructive methods for analysis. The dominant species were the *Terminalia bellirica* it sequestrated 327.78 tonnes of carbon

David *et al*., (2013) studied the carbon storage and sequestration by trees in urban and community areas of the United States. The study deals with the magnitude of carbon storage by trees and the role of urban forest in climate change. The field work was conducted and data were collected from 28 cities and 6 states. Indu *et al*., (2013) studied the carbon Sequestration Potential. The agroforestry Systems in India was subjected for the study.

Ishan *et al.,* (2013) analysed 25 trees for their carbon sequestration ability. Mangroves were the important part of vegetation. The carbon sequestration by mangroves was studied by Pandey and Pandey (2013). The second largest mangrove cover is seen in Gujarat. They estimated 8.116-million-ton carbon.

Suryawanshi *et al.,* (2014) conducted a work on the carbon sequestration potential of tree species in the environment of North Maharashtra University Campus in Jalgaon. They studied 10 tree species. Pilania *et al.,* (2014) conducted a study on the carbon sequestration by different tree species. The study area was tropical dry deciduous forest of Gujarat in India. They studied 28 species belonging to 20 families. the study reveals the relationship among carbon sequestration. The girth, height, biomass, native place and economic importance of species influences the carbon sequestration

Shrestha LJ, *et al.,* (2016) conducted a study on the carbon sequestration on the trees of sacred groves.

Onkar *et al.,* (2018) did a review work on the aboveground biomass and carbon stocks of Indian forest ecosystems. Researchers founded six major forest types In India with weird characteristics. Tree inventories data, species-specific biomass estimation, destructive, nondestructive, and remote sensing are the Procedures used by researchers for carbon stock/ biomass estimation. Nondestructive allometric equation approach was the common and frequently used method. Jithila and Prasadan (2018) studied on the carbon sequestration of the trees at wayanad.they studied 610 trees.

In large universities there was a prominent space for green vegetation. Amity University campus in Noida is such place which spread across 60 acres. Non-destructive sampling method is used in order to measure above- and below-ground biomasses of 45 tree species. Richa *et al.,* (2020). Dharmendra *et al.,* (2020) studied the carbon sequestration potential of trees planted along roadsides of Bhopal city in India. Using nondestructive method, they assessed the biomass and carbon stock of woody vegetation.

Carbon sequestration potential of trees was conducted by Chandan *et al.,* (2020). It was carried at Sambalpuri town in Eastern India. The present study is a comparative analysis of trees in polluted and non- polluted areas of Sambalpur town. In this work above ground and below ground biomass of tree species were estimated. David *et al.,* (2020) studied the importance of large trees in carbon storage.

Studies conducted by Anil and Krishna (2020) revealed the importance of tree species suitable for roadside in Bilaspur, India. *Delonix regia, Tamarindus indica , Ficus religiosa, Samanea saman, Peltophorum pterocarpum, Albizia lebbeck, Terminalia catappa,Azadirachta indica, Ficus benghalensis* and *Terminalia arjuna*. Among this *Delonix regia* found to the largest amounts of CO2 stocks.

Uttam *et al.,* (2021) studied the quantifying tree diversity, Carbon Stocks, and Sequestration Potential for Diverse Land Uses in Northeast India. Estimation of the biomass and carbon storage potential trees were studied for the first time from thus area.

# MATERIALS AND METHODS

The present work deals with the phytosociological aspects of selected flora and carbon sequestration ability of tree species in the Hill Palace Museum campus.

## 1. STUDY AREA

Hill Palace Museum is the area selected for the present study. This archaeological museum and palace spreading across 54 acres, located at Irumpanam of Ernakulam district in Kerala. The museum lies between $9^0$ 57' 5.69" N latitude and $76^0$ 21' 30.59" E longitude. The estimate terrain elevation above sea level is 31 meters. It was the residence of the Cochin Maharaja. The museum complex is home to many trees which enhances the beauty of the place.

## 2. DATA COLLECTION AND ANALYSIS

Plants were identified with the help of flora and herbarium. The horticulturist in the museum assisted during the work. Photographs were taken. The phytosociological aspects of selected herbs were studied using quadrate method. In order to precure information on medicinal property, a literature search was carried out. The medicinal importance of species was tabulated. Carbon sequestration ability of tree species were done by measuring the height and diameter at breast height.

## 3. PHYTOSOCIOLOGY

The phytosociological studies were conducted from February to April using quadrate method. Vegetation was analysed by taking 10 quadrates. 1m x 1m size quadrates were laid for the present study as described by Misra and Puri (1954). The quantitative data for frequency, density, abundance and basal area were gathered as per the method given by Braun and Blanquet (1932). From the basal area dominance is

calculated. The importance value index provides more information of the species than any other single attribute alone and reflects the realistic ecological importance of the species in a stand" (Brown and Curtis 1952). So, the relative values of frequency, density and dominance were summed to determine importance value index in a particular stand.

## 3.1 DENSITY

Density is the numerical strength of a species in a unit space. The proportion of density of a species to that of whole is referred as relative density.

$$Density = \frac{Total\ number\ of\ individuals\ of\ a\ species}{Total\ number\ of\ quadrats\ studied} \times 100$$

$$Relative\ density = \frac{Number\ of\ individuals\ of\ a\ species}{Total\ number\ of\ all\ individuals} \times 100$$

## 3.2 FREQUENCY

In order to find the frequency, the presence of individual species in each sample plot is noted. The dispersion of species in relation to that of all the species is known as relative frequency.

$$Frequency = \frac{Number\ of\ quadrats\ of\ \ occurrence\ of\ a\ species}{Total\ number\ of\ quadrats\ studied} \times\ 100$$

$$Relative\ Frequency = \frac{Frequency\ of\ a\ species}{Sum\ frequencies\ of\ all\ species} \times\ 100$$

## 3.3 ABUNDANCE

Abundance refers to the total number of individuals of the species in all quadrates to the total number of quadrated in which the species occurred.

$$Abundance = \frac{Number\ of\ individuals\ of\ a\ species}{Number\ of\ quadrats\ of\ occurrences\ of\ the\ species}$$

### 3.5 RELATIVE DOMINANCE

Relative dominance is the proportion of the basal area of a species to the sum of the basal area of all the species in the area.

$$Relative\ dominance = \frac{Total\ basal\ area\ of\ the\ species\ in\ all\ the\ quadrats}{Total\ basal\ area\ of\ all\ species\ in\ all\ the\ quadrats} \times 100$$

### 3.6 IMPORTANCE VALUE INDEX

Importance value index helps us to measure the dominant species. By adding the values of Relative Density, Relative Frequency and Relative Dominance we will get Importance Value Index.

$$IVI = Relative\ Density + Relative\ Frequency + Relative\ Dominance$$

## 4. CARBON SEQUESTRATION

The estimation of the carbon sequestration rates for the selected trees species were carried out. Indirect method was chosen for the present study as it is ethical and ecological. Indirect method is also known as non-destructive method. Measurable parameters like tree height, diameter and density were used to estimate sequestration rate. (de Gier, 2003)

### 4.1 MEASUREMENT OF DBH AND HEIGHT.

Diameter and height were the parameters measured for estimating the carbon sequestration. The diameter is measured at breast height from the ground level using a tape height is measured with the help of a laser distance meter. (PLATE 2)

## 4.2 CALCULATION OF BIOVOLUME

Biovolume was calculated using the parameters such as diameter and height. The following equations were used to find out the biovolume. (Pandya *et al*., 2013)

$$Basal\ area(\mathrm{m}^2) = \frac{(DBH)^2}{4\pi}$$

$$Biovolume(\mathrm{m}^2) = Basal\ area\ \times\ Height\ of\ the\ tree$$

## 4.3 CALCULATION OF ABOVE GROUND BIOMASS (AGB)

Above ground biomass means all the living biomass above the soil. Inorder to calculate the biovolume multiply the volume of biomass into wood density as described by Kumar and Nandini (2013) The wood density value for the species obtained from web.

$$AGB(kg) = Biovolume \times wood\ density$$

## 4.4 CALCULATION OF BELOW GROUND BIOMASS (BGB)

The below ground biomass means biomass of live roots excluding fine roots having< 2 mm diameter (Chavan & Rasal, 2011). The equation to estimate the biomass for tree roots are comparatively uncommon in the literature. The BGB has been calculated by multiplying AGB to 0.26. Where 0.26 as the root shoot ratio. (Chavan and Rasal 2011: Hangarge *et al.*, 2012)

$$BGB\ (kg) =\ 0.26 \times AGB$$

## 4.5 ESTIMATION OF TOTAL BIOMASS

The total biomass is the sum of the above ground biomass and below ground biomass (Sheikh *et al*., 2011)

$$Total\ biomass\ (Kg) = AGB + BGB$$

## 4.6 TOTAL CARBON

According to Pearson *et al.*, (2005), the carbon content for any plant species was taken as 50% of its biomass

$$Total\ carbon\ storage\ (Kg) = \frac{Biomass}{2}$$

# OBSERVATION AND RESULTS

## 1. STUDY AREA

Hill Palace Museum is the area selected for the present study. It is situated at Tripunithura of Ernakulam district. That is within the state of Kerala in India. (Plate 1)

## 2. DATA COLLECTION AND ANALYSIS

Herbs and trees were selected to study the phytosociological aspects (Plate 2) and carbon sequestration ability (Plate 8) respectively. 30 Herbs (Plate 3-7).) and 42 trees were identified (Plate 9-15) using the flora and they were tabulated (Table 1 & 2). Medicinal properties of herbs were also taken from literature.

| Sl no | Name | Family |
|---|---|---|
| 1 | *Aerva lanata* Juss. | Amaranthaceae |
| 2 | *Alternanthera sessilis* R.Br. | Amaranthaceae |
| 3 | *Boerhaavia diffusa* L. | Nyctaginaceae |
| 4 | *Calycopteris floribunda* Lam. | Combretaceae |
| 5 | *Centrosema mole* Benth. | Leguminosae |
| 6 | *Chasalia curviflora* Thw. | Rubiaceae |
| 7 | *Cleome viscosa* L. | Capparidaceae |
| 8 | *Cyclea peltate* Hk.f.&T. | Menispermaceae |
| 9 | *Desmodium triflorum* W & A. | Leguminosae |
| 10 | *Emilia sonchifolia* DC. | Asteraceae |
| 11 | *Eupatorium odoratum* L. | Asteraceae |
| 12 | *Euphorbia hirta* L. | Euphorbiaceae |
| 13 | *Evolvulus alsinoides* L. | Convolvulaceae |
| 14 | *Hewittia bicolor* W&A. | Convolvulaceae |
| 15 | *Ichnocarpus frutescens* R. Br. | Apocynaceae |
| 16 | *Mimosa pudica* L. | Leguminosae |
| 17 | *Mukia leiosperma* W. | Cucurbitaceae |
| 18 | *Mullugo pentaphylla* L. | Aizoaceae |
| 19 | *Naregamia alata* W.&A. | Meliaceae |
| 20 | *Oldenlandia alata* Koen. | Rubiaceae |
| 21 | *Oxalis corniculata* L. | Oxalidaceae |
| 22 | *Pennisetum pedicellatum* Trin. | Poaceae |
| 23 | *Peperomia pellucida* H.B.K. | Piperaceae |
| 24 | *Phyllanthus niruri* L. | Euphorbiaceae |
| 25 | *Pothos scandens* L. | Araceae |
| 26 | *Scoparia dulcis* L. | Plantaginaceae |
| 27 | *Sebastiana* Spr. *Chamaelea* M. Arg. | Euphorbiaceae |
| 28 | *Synedrella nodiflora* Gaertn. | Asteraceae |
| 29 | *Tridax procumbens* L | Asteraceae |
| 30 | *Wedelia biflora* DC. | Asteraceae |

**Table 1: Herbs identified**

| Sl no | Name | Family |
|---|---|---|
| 1 | *Achras sapota* L. | Sapotaceae |
| 2 | *Adenanthera pavonina* L. | Fabaceae |
| 3 | *Aegle Marmelos* Corr | Rutaceae |
| 4 | *Alstonia scholaris* R. Br. | Apocynaceae |
| 5 | *Anacardium occidentale* L. | Anacardiaceae |
| 6 | *Artocarpus heterophyllous* L. | Moraceae |
| 7 | *Artocarpus hirsuta* Lam. | Moraceae |
| 8 | *Azadirachta indica* A Juss. | Meliaceae |
| 9 | *Borassus flabellifer* L. | Arecaceae |
| 10 | *Cassia Fistula* L. | Fabaceae |
| 11 | *Casuarina equisetifolia* Forst. | Casuarinaceae |
| 12 | *Chrysophyllum cainito* L | Sapotaceae |
| 13 | *Couroupita guianensis* Aublet | Lecythidaceae |
| 14 | *Delonix regia* Raf | Fabaceae |
| 15 | *Diospyros* L. *Ebenum* Koen | Ebenaceae |
| 16 | *Erythrina* L. *Indica* Lam | Fabaceae |
| 17 | *Ficus bengalensis* L. | Moraceae |
| 18 | *Ficus macrocarpa* L. f. | Moraceae |
| 19 | *Ficus recemosa* L. | Moraceae |
| 20 | *Ficus religiosa* L. | Moraceae |
| 21 | *Filicium decipiens* Thw. | Sapindaceae |
| 22 | *Gmelina arborea* Roxb. | Lamiaceae |
| 23 | *Lagerstroemia indica* L. | Lythraceae |
| 24 | *Litichi chinensis* Sonn. | Sapindaceae |
| 25 | *Macaranga peltata* M.Arg. | Euphorbiaceae |
| 26 | *Mangifera indica* L. | Anacardiaceae |
| 27 | *Mellotus philippensis* Lam. | Euphorbiaceae |
| 28 | *Michelia champaca* L. | Magnoliaceae |
| 29 | *Mimusops Elengi* L. | Sapotaceae |
| 30 | *Neolamarckia cadamba* Roxb. | Rubiaceae |
| 31 | *Parkia biglobosa* (Jacq.) R.Bx.ex. | Fabaceae |
| 32 | *Polyalthia longifolia* Hk.f.&T. | Annonaceae |
| 33 | *Pterocarpus indicus Roxb*. | Fabaceae |
| 34 | *Samanea saman* (Jacq.) Merr. | Fabaceae |
| 35 | *Saraca indica* L. | Fabaceae |
| 36 | *Tabebuia berteroi* L. | Bignoniaceae |
| 37 | *Tectona grandis* L.f. | Lamiaceae |
| 38 | *Tamarindus indica* L. | Fabaceae |
| 39 | *Terminalia bellerica* Roxb. | Combretaceae |
| 40 | *Terminalia catappa* L. | Combretaceae |
| 41 | *Vetteria indica* Vet. | Dipterocarpaceae |
| 42 | *Zanthoxylum* L. Rhetsa DC. | Rutaceae |

**Table 2: Trees identified**

## 3. PHYTOSOCIOLOGICAL ASPECTS OF HERBS

The phytosociological relationship of herbs was carried out for three consecutive months, from February to April (Plate 4). The collected data were used to measure the relative density, relative frequency, abundance and relative dominance. The sum of relative density, relative frequency, and relative dominance were known as Importance Value Index. It is the most important parameter to understand the structure of a plant community. The research findings were presented in table 3.

The herbaceous flora consists of 30 species belonging to 19 different families. The dominant family is Asteraceae with 5 genera. They were *Emilia sonchifolia* DC, *Eupatorium odoratum* L., *Synedrella nodiflora* Gaertn., *Tridax procumbens* L, and *Wedelia biflora* DC. Asteraceae is followed by Leguminosae and Euphorbiaceae with three genera. *Centrosema mole* Benth., *Desmodium triflorum* W & A & *Mimosa pudica* L were the species recorded from the family Leguminosae. *Euphorbia hirta* L, Phyllanthus niruri L and *Sebastiana* spr. *Chamaelea* M. arg were recorded from the of family Euphorbiaceae.

Amaranthaceae, Rubiaceae, and Convolvulaceae with two genera each. *Aerva lanata* Juss & *Alternanthera sessilis* R.Br. were identified in the family Amaranthaceae. *Chasalia curviflora* Thw & *Oldenlandia alata* Koen were the species identified from Rubiaceae. *Evolvulus alsinoides* L. and *Hewittia bicolor* W&A were the genus found in Convolvulaceae.

The remaining 15 families were represented by single genus only., *Boerhaavia diffusa* L (Nyctaginaceae), *Calycopteris floribunda* Lam (Combretaceae), *Cleome viscosa* L. (Capparidaceae), *Cyclea peltate* Hk.f.&T. (Menispermaceae), *Ichnocarpus frutescens* R. Br (Apocynaceae), *Mukia leiosperma* W (Cucurbitaceae), *Mullugo pentaphylla* L. (Aizoaceae), *Naregamia alata* W.&A (Meliaceae) *Oxalis corniculata* L. (Oxalidaceae), *Pennisetum pedicellatum* Trin (Poaceae), *Peperomia pellucida* H.B.K (Piperaceae), *Pothos scandens* L (Araceae) & *Scoparia dulcis* L (Plantaginaceae).

The studies revealed that the *Oxalis corniculata L*. was the dominant herb having highest value for IVI. It was 20.72, 20.39 & 20.34 respectively in the month of February,

March and April. The lowest values of 4.15, 3.77, & 3.65 was shown by *Scoparia dulcis*, L in the months of February, March and April. The IVI was highest in the month of February for *Oxalis corniculata L*. Followed by *Tridax procumbens* L. (18.37, 18.33 & 18.02).(Fig:1)

In the month of February, the highest values of frequency (30%) were recorded by 11 species. They were *Ichnocarpus frutescens* R. Br, *Oxalis corniculata* L, Phyllanthus niruri L *Mimosa pudica* L, *Boerhaavia diffusa* L, *Tridax procumbens* L, *Desmodium triflorum* Linn, *Cleome viscosa* L, *Alternanthera sessilis* R.Br., *Evolvulus alsinoides* L. and *Eupatorium odoratum* L. In the month of March, the frequency of *Ichnocarpus frutescens* R. Br and *Eupatorium odoratum* L. were dropped down from 30% to 20%. In April only the *Phyllanthus niruri* L, *Desmodium triflorum* Linn, *Cleome viscosa* L, *Alternanthera sessilis* R.Br., and *Eupatorium odoratum* L. were displayed 30% of frequency. In February 11 species were found with highest frequency of 30%, By March and April the number is reduced to 9 and 5 respectively. (Fig;2)

The highest value for density was shown by *Oxalis corniculata* L. It was 3.2, 3.2, and 2.7 respectively in the months of February, March and April. The lowest value (0.3) for density was recorded by the species of *Scoparia dulcis* L, *Pothos scandens* L, *Euphorbia hirta* L and *Centrosema mole* Benth., in the month of February. In March lowest density of 0.2 was recorded by *Scoparia dulcis*, L. By April, *Euphorbia hirta* L & *Pothos scandens* L showed the lowest density of 0.2.(Fig:3)

The highest value for abundance was shown by *Oxalis corniculata* L in all three months. And it was 10.6, 10.7 and 9. In the month of February, the lowest value of 1.5 was recorded from 3 species, *Pothos scandens* L, *Euphorbia hirta* L and *Centrosema mole* Benth. The lowest value of 1 was recorded from the *Pothos scandens* L during March and April. (Fig:4)

| Sl. No. | Name of the plant | FEBRUARY | | | | | MARCH | | | | | APRIL | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | F / RF | D/RD | A | RDO | IVI | F / RF | D/RD | A | RDO | IVI | F / RF | D/RD | A | RDO | IVI |
| 1 | *Aerva lanata*, Juss. | 20/2.98 | 1.3/4.29 | 6.5 | 7.65 | 14.92 | 20/3.22 | 1.3/4.60 | 6.5 | 6.8 | 14.62 | 20/3.63 | 1.0/4.27 | 5.0 | 6.55 | 14.45 |
| 2 | *Alternanthera sessilis*, R.Br. | 30/4.48 | 1.5/4.95 | 5.0 | 4.18 | 13.61 | 30/4.83 | 1.3/4.60 | 4.3 | 4.06 | 13.49 | 20/3.63 | 0.7/2.99 | 3.5 | 3.14 | 9.76 |
| 3 | *Boerhavia diffusa*, L. | 30/4.48 | 1.3/4.29 | 4.3 | 8.37 | 17.14 | 30/4.83 | 1.2/4.25 | 4.0 | 5.96 | 15.04 | 30/5.45 | 1.2/5.12 | 4.0 | 4.46 | 15.03 |
| 4 | *Calyceteris floribunda*, Lam. | 20/2.98 | 0.6/1.98 | 3.0 | 4.26 | 9.22 | 20/3.22 | 0.6/2.13 | 3.0 | 3.1 | 8.45 | 10/1.81 | 0.5/2.13 | 5.0 | 4.48 | 8.42 |
| 5 | *Centrosema mole*, Benth. | 20/2.98 | 0.3/0.99 | 1.5 | 2.95 | 6.92 | 20/3.22 | 0.3/1.06 | 1.5 | 2.59 | 6.87 | 20/3.63 | 0.3/1.28 | 1.5 | 0.98 | 5.89 |
| 6 | *Chasalia curviflora*, Thw. | 20/2.98 | 0.6/1.98 | 3.0 | 3.85 | 8.81 | 20/3.22 | 0.4/1.41 | 2.0 | 2.99 | 7.62 | 20/3.63 | 0.6/2.56 | 3.0 | 2.39 | 8.58 |
| 7 | *Cleome viscosa*, L. | 30/4.48 | 0.8/2.64 | 2.6 | 4.52 | 11.64 | 30/4.83 | 0.8/2.83 | 2.6 | 4.24 | 11.9 | 20/3.63 | 0.8/3.41 | 4.0 | 3.89 | 10.93 |
| 8 | *Cyclea peltate*, Hk.f.&T. | 20/2.98 | 0.8/2.64 | 7.0 | 5.54 | 11.16 | 10/1.63 | 0.7/2.48 | 4.0 | 6.56 | 10.67 | 10/1.81 | 0.6/2.56 | 6.0 | 5.68 | 10.05 |
| 9 | *Desmodium triflorum* W & A. | 30/4.48 | 1.8/5.94 | 6.0 | 6.97 | 17.39 | 30/4.83 | 1.8/6.38 | 6.0 | 5.7 | 16.91 | 20/3.63 | 0.7/2.99 | 3.5 | 4.13 | 10.75 |
| 10 | *Emilia sonchifolia*, DC. | 20/2.98 | 1.1/3.63 | 5.5 | 1.92 | 8.53 | 20/3.22 | 0.8/2.83 | 4.0 | 1.78 | 7.83 | 20/3.63 | 0.5/2.13 | 2.5 | 1.12 | 6.88 |
| 11 | *Eupatorium odoratum*, L. | 30/4.48 | 0.7/2.31 | 3.5 | 4.26 | 11.05 | 10/1.61 | 0.4/1.42 | 4.0 | 4.13 | 7.16 | 10/1.81 | 0.4/1.70 | 4.0 | 3.61 | 7.12 |
| 12 | *Euphorbia hirta*, L. | 20/2.98 | 0.3/0.99 | 1.5 | 1.59 | 5.56 | 20/3.22 | 0.3/1.06 | 1.5 | 1.2 | 5.48 | 10/1.81 | 0.2/0.85 | 2.0 | 1.45 | 4.11 |
| 13 | *Evolvulus alsinoides*, L. | 30/4.48 | 1.2/3.96 | 4.0 | 2.86 | 11.3 | 30/4.83 | 1.2/4.25 | 4.0 | 1.86 | 10.94 | 30/5.45 | 1.0/4.27 | 3.3 | 1.07 | 10.79 |
| 14 | *Hewittia bicolar*, W&A. | 10/1.49 | 0.4/1.32 | 4.0 | 1.81 | 4.62 | 10/1.61 | 0.4/1.42 | 4.0 | 1.63 | 4.66 | 10/1.81 | 0.4/1.70 | 4.0 | 1.06 | 4.57 |
| 15 | *Ichnocarpus frutescens*, R. Br. | 30/4.48 | 1.4/4.62 | 4.6 | 7.69 | 16.79 | 20/3.22 | 1.3/4.60 | 6.5 | 6.78 | 14.6 | 20/3.63 | 1.3/5.55 | 6.5 | 5.37 | 14.55 |
| 16 | *Mimosa pudica*, L. | 30/4.48 | 1.0/3.30 | 3.3 | 5.93 | 13.71 | 30/4.83 | 0.9/3.19 | 3.0 | 5.64 | 13.66 | 30/5.45 | 0.9/3.84 | 3.0 | 4.36 | 13.65 |
| 17 | *Mukia leiosperma*, W. | 10/1.49 | 0.4/1.32 | 4.0 | 1.8 | 4.61 | 10/1.61 | 0.3/1.06 | 3.0 | 1.69 | 4.36 | 10/1.81 | 0.4/1.70 | 4.0 | 0.83 | 4.34 |
| 18 | *Mullugo pentaphylla*, L. | 20/2.98 | 0.9/2.97 | 4.5 | 2.93 | 8.88 | 20/3.22 | 0.9/3.19 | 4.5 | 2.29 | 8.7 | 20/3.63 | 0.8/3.41 | 4.0 | 1.39 | 8.43 |
| 19 | *Naregamia alata*, W.&A. | 20/2.98 | 1.6/5.28 | 8.0 | 5.01 | 13.27 | 20/3.22 | 1.5/5.31 | 7.5 | 4.31 | 12.84 | 20/3.63 | 1.2/5.12 | 6.0 | 4.03 | 12.78 |
| 20 | *Oldenlandia alata*, Koen. | 20/2.98 | 0.9/2.97 | 6.0 | 1.35 | 7.3 | 20/3.22 | 0.9/3.19 | 4.5 | 0.82 | 7.23 | 10/1.81 | 0.6/2.56 | 4.5 | 1.12 | 5.49 |
| 21 | *Oxalis corniculata*, L | 30/4.48 | 3.2/10.56 | 10.6 | 5.68 | 20.72 | 30/4.83 | 3.2/11.35 | 10.7 | 4.21 | 20.39 | 30/5.45 | 2.7/11.53 | 9.0 | 3.36 | 20.34 |
| 22 | *Pennisetum pedicellatum*, Trin. | 20/2.98 | 1.7/5.61 | 8.5 | 5.48 | 14.07 | 20/3.22 | 1.7/6.02 | 8.5 | 4.38 | 13.62 | 20/3.63 | 1.4/5.98 | 7.0 | 3.84 | 13.45 |
| 23 | *Peperomia pellucida*, H.B.K. | 20/2.98 | 0.8/2.64 | 4.0 | 3.09 | 8.71 | 20/3.22 | 0.7/2.48 | 3.5 | 2.98 | 8.68 | 10/1.81 | 0.3/1.28 | 3.0 | 2.01 | 5.1 |
| 24 | *Phyllanthus niruri*, L. | 30/4.48 | 1.8/5.94 | 6.0 | 4.63 | 15.05 | 30/4.83 | 1.8/6.38 | 6.0 | 3.55 | 14.76 | 20/3.63 | 1.4/5.98 | 5.0 | 4.88 | 14.49 |
| 25 | *Pothos scandens*, L. | 20/2.98 | 0.3/0.99 | 1.5 | 1.86 | 5.83 | 10/1.61 | 0.3/1.06 | 1.0 | 1.25 | 3.92 | 20/3.63 | 0.2/0.85 | 1.0 | 0.19 | 4.67 |
| 26 | *Scoparia dulcis*, L. | 10/1.49 | 0.3/0.99 | 3.0 | 1.67 | 4.15 | 10/1.61 | 0.2/0.71 | 3.0 | 1.45 | 3.77 | 10/1.81 | 0.3/1.28 | 3.0 | 0.56 | 3.65 |
| 27 | *Sebastiana*, Spr. *Chamaelea*, M. Arg. | 20/2.98 | 0.7/2.31 | 3.5 | 2.15 | 7.44 | 10/1.61 | 0.6/2.13 | 6.0 | 2.03 | 5.77 | 10/1.81 | 0.6/2.56 | 6.0 | 2.21 | 6.58 |
| 28 | *Synedrella nodiflora*, Gaertn. | 20/2.98 | 0.4/1.32 | 2.0 | 2.5 | 6.8 | 20/3.22 | 0.4/1.42 | 2.0 | 2.4 | 7.04 | 20/3.63 | 0.3/1.28 | 1.5 | 1.54 | 6.45 |
| 29 | *Tridax procumbens* L. | 30/4.48 | 1.6/5.28 | 5.3 | 8.61 | 18.37 | 30/4.83 | 1.5/5.32 | 5.0 | 8.18 | 18.33 | 30/5.45 | 1.3/5.55 | 4.3 | 7.02 | 18.02 |
| 30 | *Wedelia biflora*, DC. | 20/2.98 | 0.7/2.31 | 3.5 | 4.45 | 9.74 | 20/3.22 | 0.5/1.77 | 2.5 | 4.17 | 9.16 | 20/3.63 | 0.7/2.99 | 3.5 | 2.39 | 9.01 |

F – Frequency D- Density A- Abundance RF- Relative Frequency RDO- Relative Dominance IVI-Importance Value Index.

Table 3: Phytosociological attributes of study Area

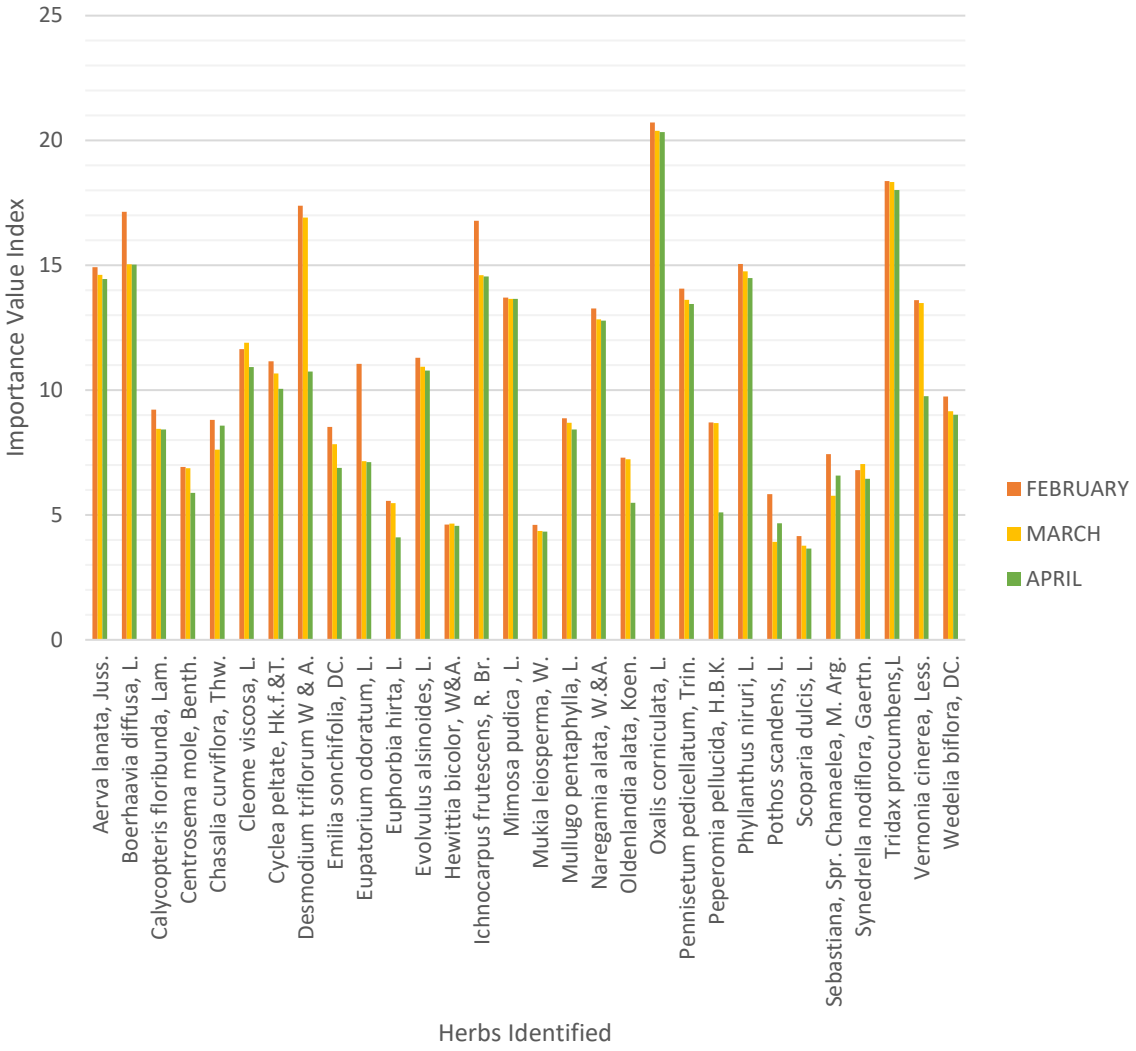



**Figure 1**

Comparative account of Importance Value Index of species in the months of February, March and April.

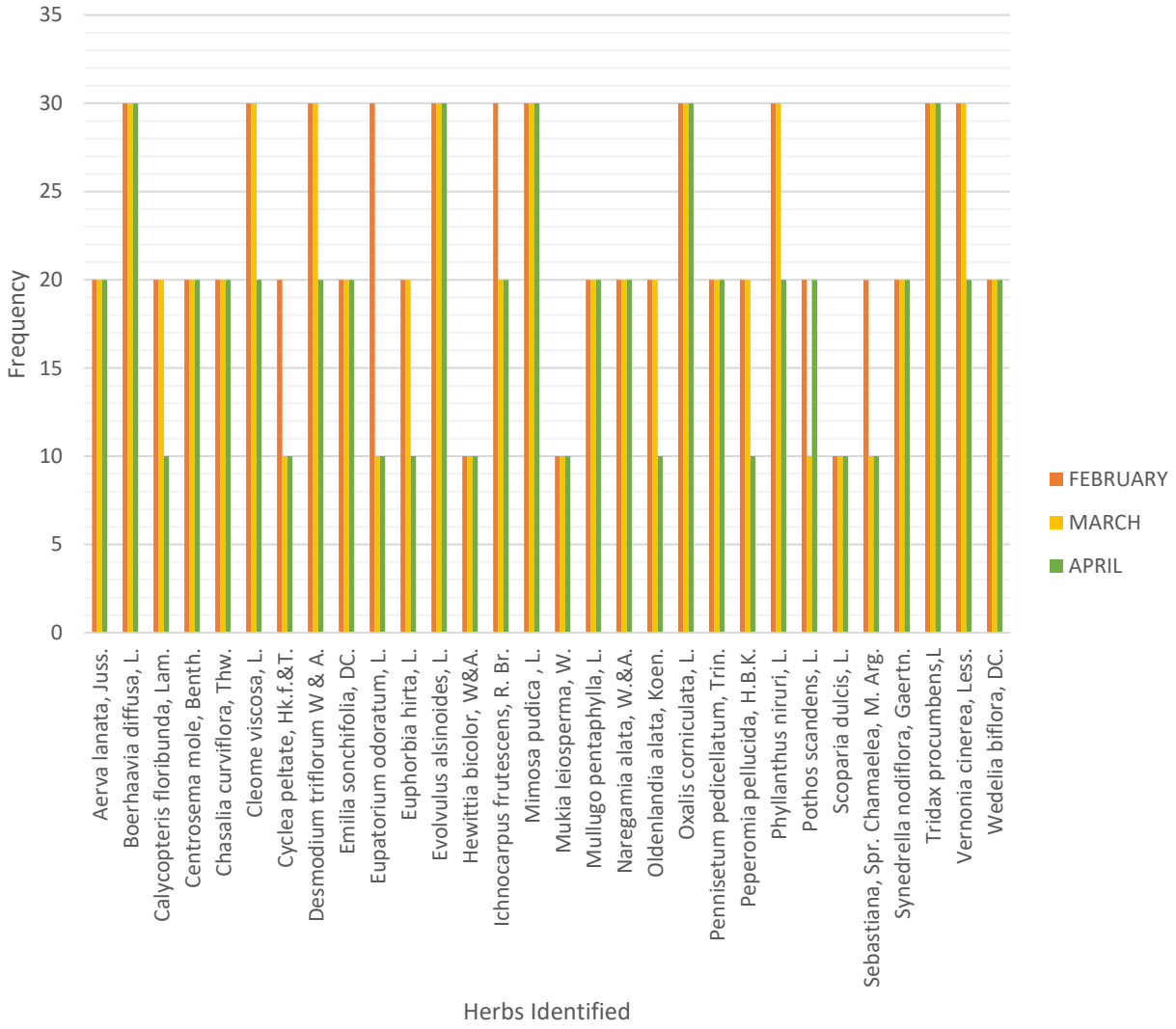



**Figure 2**

Comparative account on the Frequency of species in the months of February, March and April.

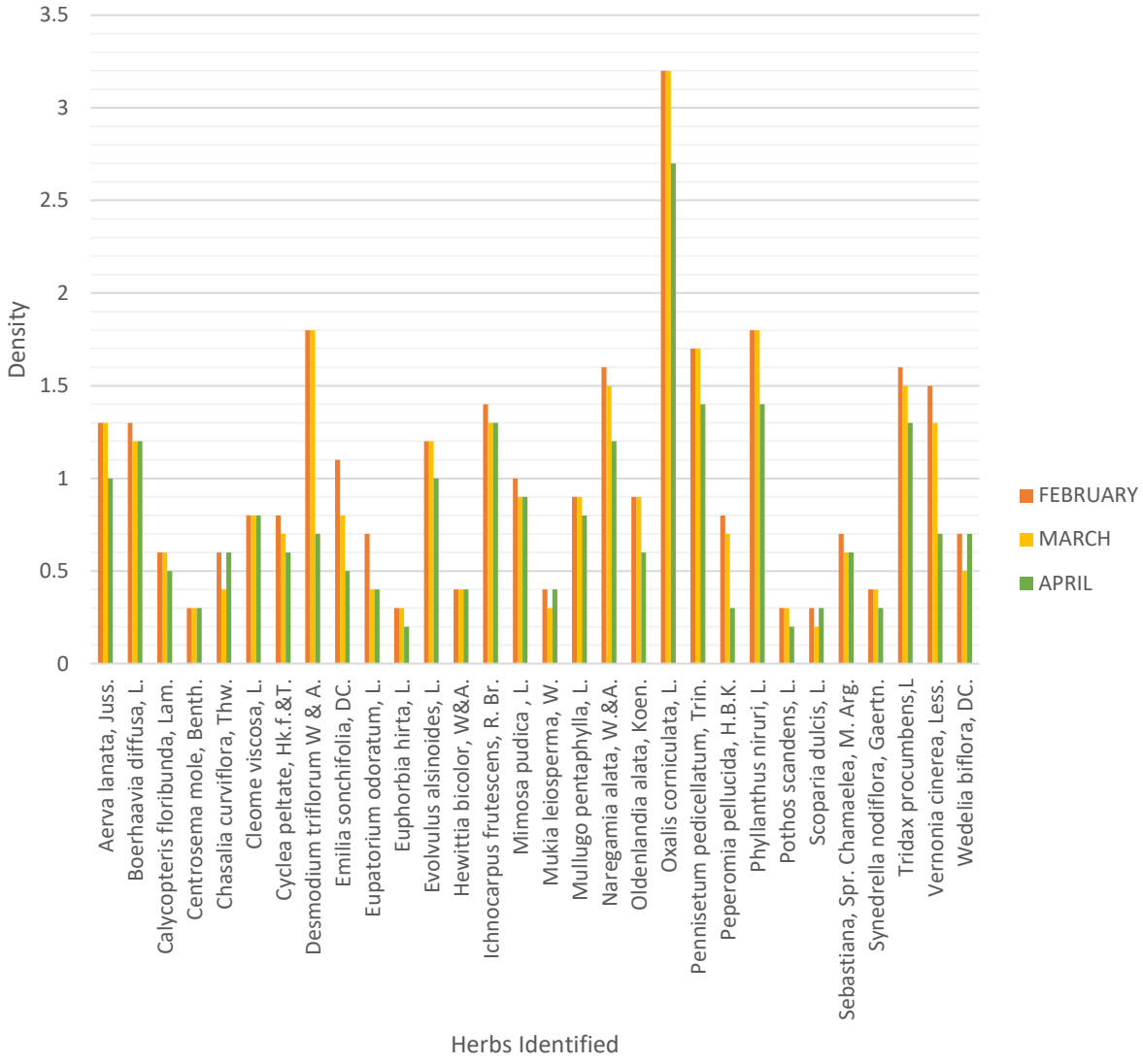



**Figure 3**

Comparative account on the Density of species in the months of February, March and April

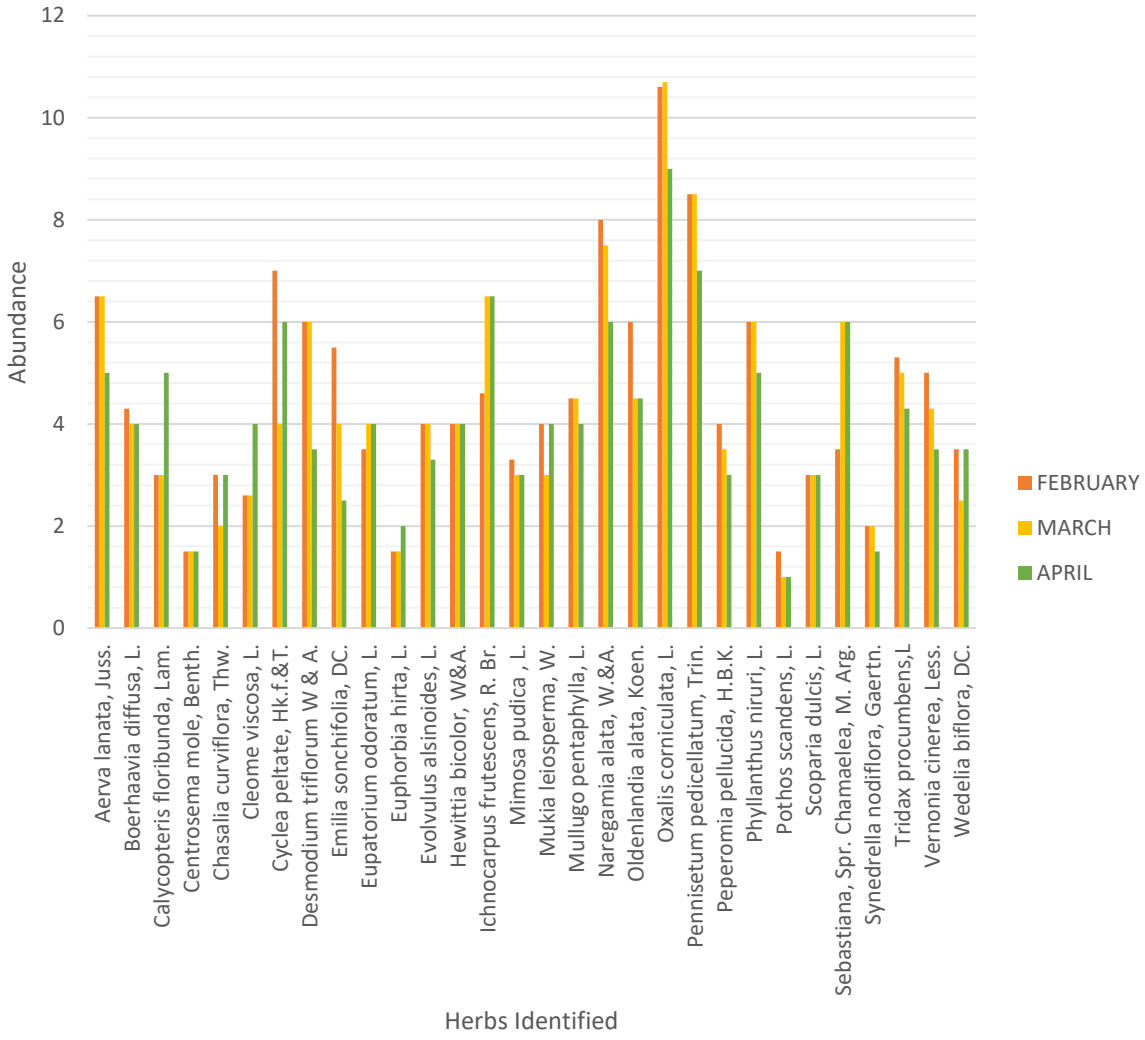



**Figure 4:**

Comparative account on the Abundance of species in the months of February, March and April.

## 4. MEDICINAL PROPERTIES AND USES

| Sl no | Name | Medicinal properties and uses |
|---|---|---|
| 1 | *Aerva lanata* Juss. | It bears diuretic, hepatoprotective, anticancer, antioxidant, antimicrobial, and numerous other pharmacological activities. (Mandal and Swati, 2015) |
| 2 | *Alternanthera sessilis* R.Br. | *It shows Alternanthera sessilis*, R.Br. the result revealed that it has anti-microbial, antipyretic activity, and anti-oxidant activities. It also helps in wound healing. (Thomas *et al., 2014)* |
| 3 | *Boerhaavia diffusa* L. | The plant shows anti-bacterial, anti-inflammatory and anti-convulsant activities. Used to treat, dyspepsia, abdominal pain, inflammation, and jaundice. (Mahesh *et al.,* 2012) |
| 4 | *Calycopteris floribunda* Lam. | Anthelmintic, antibacterial and antiviral property. Used to cure vomiting, jaundice skin diseases, intestinal worms, leprosy, malarial fever, dysentery, ulcers etc. (Baber *et al.,* 2019) |
| 5 | *Centrosema mole* Benth. | Antibacterial and antifungal activity. (Memfin *et al.,* 2011) |
| 6 | *Chasalia curviflora* Thw. | Used to treat typhoid and it also act as an insect repellent. (Ajeesh *et al.,* 2014) |

| | | |
|---|---|---|
| 7 | *Cleome viscosa* L. | It possess the activities such as antimicrobial, analgesic, antiinflammatory, antidiarrheal, and hepatoprotective activities: (Ravindra *et al.*, 2010) |
| 8 | *Cyclea peltate* Hk.f.&T. | Leaves possessed diuretic activity. (Hullatti *et al.*, 2011) |
| 9 | *Desmodium triflorum* W & A. | Used to cure dysentery, wounds, cough, malaria and hepatitis (Vedpal *et al.*,2016) |
| 10 | *Emilia sonchifolia* DC. | Used to treat night blindness, epilepsy, fever, malaria, asthma, liver diseases, eye inflammation and influenza, (Dash *et al.*, 2015) |
| 11 | *Eupatorium odoratum* L. | The plant possesses antibacterial anti-inflammatory, antioxidant and analgesic activity. (Nur *et al.*, 2020) |
| 12 | *Euphorbia hirta* L. | The plant possesses antimicrobial, anti-diabetic, anti-cancer, anti-tumor, wound healing, sedative, and diuretic properties. (Pranabesh *et al.*, 2019) |
| 13 | *Evolvulus alsinoides* L. | Used to treat fever, cough and cold. (Amritpal *et al.*, 2008) |
| 14 | *Hewittia bicolor* W&A. | The leaves are rubbed into wounds. (Timothy *et al.*, 2021) |
| 15 | *Ichnocarpus frutescens* R. Br. | Used against headaches, fevers, and purification of blood. skin troubles. (Kumarappan *et al.*, 2015) |

| | | |
|---|---|---|
| 16 | *Mimosa pudica* L. | It is used in the treatment of leprosy, dysentery, inflammations, burning sensation, asthma, leucoderma, fatigue and blood diseases. (Joseph *et al.,* 2013) |
| 17 | *Mukia leiosperma* W. | The plant is used to cure hypertension, diabetes, and rheumatoid arthritis. (Petrus, 2013) |
| 18 | *Mullugo pentaphylla* L. | The plant shows antimicrobial, anti-inflammatory and antioxidant activity. Fever, stomach ache, jaundice, gout and rheumatism. (Aglin, 2018) |
| 19 | *Naregamia alata* W.&A. | It is having antibacterial property. Used to cure scabies, jaundice, anaemia, asthama, bronchitis and arthritis. (Prashasti *et al.,* 2020) |
| 20 | *Oldenlandia alata* Koen. | It has hepatoprotective, cytotoxic, anti-oxidant and anti-microbial properties. Used to cure infections ulcers, cold, cough and bronchitis. (Shaktijit *et al.,*2019) |
| 21 | *Oxalis corniculata* L. | It is having anti-inflammatory, anti-epileptic, anti-fungal, anti-ulcer, anti-cancer, anti-diabetic, hepatoprotective, anti-microbial and wound healing property. (Anika *et al*., 2020) |
| 22 | *Pennisetum pedicellatum* Trin. | Used to treat wounds, and parasitic infections. (Ukwuani *et al.,* 2018) |
| 23 | *Peperomia pellucida* H.B.K. | The plant possesses antiulcer, anticancer and antimicrobial property. (Raghavendra & Prashith, 2018) |
| 24 | *Phyllanthus niruri* L. | The plant shows antimicrobial, antiviral, anticancer, anti-inflammatory and diuretic properties. It can be used to treat jaundice, ulcers, skin diseases, diabetes, |

| | | |
|---|---|---|
| | | chest pain and urinary complications. (Hakim *et al.*, 2016) |
| 25 | *Pothos scandens* L. | The plant shows anti-inflammatory, anticancer, antioxidant, wound healing activities. (Niral & Rabinarayan, 2020) |
| 26 | *Scoparia dulcis* L. | Used to cure jaundice, stomach problems, reproductory issues, skin disease, fever, and kidney stones. it has, antioxidant, anti-microbial, and anti-inflammatory property. (Ahana *et al.*, 2020) |
| 27 | *Sebastiana* Spr. *Chamaelea* M. Arg. | Antimicrobial property. (Reena *et al.*, 2015) |
| 28 | *Synedrella nodiflora* Gaertn. | Used to treat epilepsy. (Patric *et al.*, 2012) |
| 29 | *Tridax procumbens* L | It shows anti-inflammatory, anti-diabetic and anesthetic properties. (Samantha *et al.*, 2018) |
| 30 | *Wedelia biflora* DC. | It is having antioxidant, anti-inflammatory, and antimicrobial property. It also has anticancer activity. (Meena *et al.*, 2011) |

Table 4: Medicinal properties of the herbs identified.

## 5. CARBON SEQUESTRATION

Inorder to study the rate of carbon sequestration 42 plants belonging to 28 families were studied. Their collective carbon sequestration was 129.3419 kg. Among them the biggest tree is *Ficus bengalensis* L. The highest carbon sequestration of 34.9668 kg/tree was found in this 150-year-old tree. In contrast the *Saraca indica* L was fairly newly having been planted in the campus only 15 years ago. This tree had the lowest concentration with only $C$ =0.0289 kg/tree. Rate of carbon sequestration increases with increase in diameter

Considering the time of planting the approximate age was assigned. These data were collected from the authorities of Hill Place Museum. Earlier works suggested that carbon sequestration was increases with increase in diameter. (Chandan *et al.,* 2020., Dharmendra *et al.,* 2020., Pilania *et al.,* 2014., Ishan *et al.,* 2013., Jithila and Prasadan. 2018).

Out of nearly 42 trees studied 10 would fall into the category of oldest tree, they were 100- 150 years old, their total carbon content was 105.3116 kg. The highest carbon sequestration (34.9668) was found in *Ficus bengalensis* L. Its diameter was 7.3m. which is the highest diameter found in this age group. The lowest sequestration of 4.2957 kg carbon was shown by *Tamarindus indica* L *(table 5).*

Next group belongs to 12 trees they were 70-100 years old. (Table 6) Their total carbon content was 18.3368 kg. The highest carbon sequestration was found in *Mangifera indica,* L (3.0635) The lowest sequestration was found in *Borassus flabellifer,* L (0.0923).12 trees include in the age group ranges from 50-75 years (table 7). In this *Polyalthia longifolia* Hk.F.&T (0.6 161) *and Chrysophyllum caimito* L (0.0793*)* were the plants having highest and lowest sequestration respectively.

They were 8 newly planted trees of 15-year-old (table 8). In this Ficus macrocarpa found to sequestrate more carbon. The Ficus species were good in sequestrating carbon. *Saraca indica* L. sequestrate only a negligible amount of carbon. Tree species had different carbon stocks, It is due their varying growth rate. Generally maximum amount of storage was recorded during the stage of wood formation. (Anil, 2020., Shrestha *et al.*, 2016)

The maximum carbon was stored in *Ficus bengalensis* L, *Mangifera indica* L, *Polyalthia longifolia* Hk.F.&T and *Ficus macrocarpa* L.f. . Ficus species were the most efficient in sequestrating high amounts of carbon and were therefore suitable for plantation.

| Sl.no | Name of the plant | DBH | Height | Density | AGB | BGB | TC |
|---|---|---|---|---|---|---|---|
| 1. | *Ficus bengalensis* L | 7.3 | 26.681 | 0.4903 | 55.5029 | 14.4307 | 34.9668 |
| 2. | *Samanea saman* (Jacq.)Merr. | 6.2 | 19.702 | 0.5238 | 31.5870 | 8.2118 | 19.8979 |
| 3. | *Ficus religiosa* L | 5.5 | 24.526 | 0.4430 | 26.1673 | 6.8034 | 16.4853 |
| 4. | *Artocarpus heterophyllous* L | 4.3 | 24.283 | 0.5359 | 19.1568 | 4.9807 | 12.0687 |
| 5. | *Casuarina equisetifolia* Forst | 3.3 | 21.689 | 0.9186 | 17.2761 | 4.4917 | 10.8839 |
| 6. | *Couroupita guianensis Aubl* | 4.6 | 13.613 | 0.4340 | 9.9525 | 2.5876 | 6.2700 |
| 7. | *Artocarpus hirsute* lam | 3 | 27.812 | 0.4867 | 9.6985 | 2.4436 | 6.0710 |
| 8. | *Terminalia bellerica* Roxb | 2.9 | 19.569 | 0.6975 | 9.1382 | 2.3759 | 5.7570 |
| 9. | *Delonix regia* Hook | 2.2 | 29.53 | 0.6729 | 7.6561 | 1.9905 | 4.8233 |
| 10 | *Tamarindus indica* L | 2.1 | 19.613 | 0.9902 | 6.8186 | 1.7728 | 4.2957 |

Table 5: DBH, Height, Density, AGB, BGB and TC of 100- 150-year-old trees.

(TC=105.3116 kg.)

| Sl.no | Name of the plant | DBH | Height | Density | AGB | BGB | TC |
|---|---|---|---|---|---|---|---|
| 1 | *Mangifera indica* L | 3 | 11.130 | 0.5977 | 4.8628 | 1.2643 | 3.0635 |
| 2 | *Alstonia scholaris* R.Br | 2.3 | 23.89 | 0.3973 | 4.1732 | 1.0850 | 2.6291 |
| 3 | *Adenanthera pavonine*L | 2 | 14.692 | 0.7237 | 3.3853 | 0.8797 | 2.1325 |
| 4 | *Diospyros ebenum* Koen | 2.4 | 8.529 | 0.8600 | 3.3626 | 0.8742 | 2.1184 |
| 5 | *Parkia biglobosa* (Jacq.)R.Bx.ex | 1.8 | 21.511 | 0.5295 | 2.8677 | 0.8316 | 1.8946 |
| 6 | *Magnolia champaca* L | 3 | 7.233 | 0.5350 | 2.7725 | 0.7208 | 1.7466 |
| 7 | *Tabebuia berteroi* L | 1.4 | 18.182 | 0.7306 | 2.0722 | 0.5387 | 1.3054 |
| 8 | *Erythrina indica* Lam | 1.8 | 24.246 | 0.2908 | 1.8183 | 0.4727 | 1.1455 |
| 9 | *Tectona grandis* L.f. | 1.6 | 14.327 | 0.6127 | 1.7889 | 0.4830 | 1.1359 |
| 10 | *Cassia fistula* L | 1.21 | 12.67 | 0.8293 | 1.0118 | 0.2630 | 0.6374 |
| 11 | *Aegle marmelos* Corr | 1.3 | 6.570 | 0.7827 | 0.6915 | 0.1797 | 0.4356 |
| 12 | *Borassus flabellifer* L | 0.45 | 9.343 | 0.9750 | 0.1466 | 0.0381 | 0.0923 |

Table 6: DBH, Height, Density, AGB, BGB and TC of 75 -100-year-old trees.

(TC=18.3368 kg.)

| Sl.no | Name of the plant | DBH | Height | Density | AGB | BGB | TC |
|---|---|---|---|---|---|---|---|
| 1 | *Polyalthia longifolia* Hk.F.&T | 1.2 | 15.146 | 0.5635 | 1.7357 | 0.9780 | 0.6 161 |
| 2 | *Azadirachta indica* A Juss. | 0.85 | 22.157 | 0.7275 | 0.9268 | 0.2409 | 0.5838 |
| 3 | *Litichi chinensis* Sonn. | 1.2 | 7.41 | 0.8674 | 0.7365 | 0.1914 | 0.4639 |
| 4 | *Neolamarckia cadamba* Roxb | 1.3 | 8.621 | 0.4800 | 0.5565 | 0.1446 | 0.3505 |
| 5 | *Zanthoxylum rhetsa* DC | 0.9 | 14.672 | 0.3917 | 0.3700 | 0.1073 | 0.2386 |
| 6 | *Anacardium occidentale* L. | 0.9 | 11.529 | 0.50 | 0.3712 | 0.0965 | 0.2338 |
| 7 | *Lagerstromia indica* L | 0.8 | 9.314 | 0.6325 | 0.2998 | 0.0779 | 0.1888 |
| 8 | *Terminalia catappa* L | 0.5 | 24.326 | 0.5404 | 0.2615 | 0.0679 | 0.1647 |
| 9 | *Achras sapota* L | 0.9 | 5.216 | 0.9100 | 0.2415 | 0.0627 | 0.1521 |
| 10 | *Mellotus philippensis* (Lam) | 0.6 | 7.231 | 0.6836 | 0.1413 | 0.0367 | 0.089 |
| 11 | *Mimusops elengi* L | 0.45 | 9.233 | 0.8829 | 0.1311 | 0.0340 | 0.0825 |
| 12 | *Chrysophyllum caimito* L | 0.5 | 9.449 | 0.6700 | 0.1259 | 0.0327 | 0.0793 |

Table 7: DBH, Height, Density, AGB, BGB and TC of 50-75-year-old trees

(TC = 2.627 kg.)

| Sl.no | Name of the plant | DBH | Height | Density | AGB | BGB | TC |
|---|---|---|---|---|---|---|---|
| 1. | *Ficus macrocarpa* L.f. | 1.2 | 16.274 | 0.4474 | 2.0925 | 0.5440 | 1.3182 |
| 2. | *Ficus recemosa* L | 1.2 | 14.142 | 0.4410 | 0.7146 | 0.1857 | 0.4501 |
| 3. | *Vetteria indica* L | 1 | 8.671 | 0.4354 | 0.4719 | 0.1226 | 0.2972 |
| 4. | *Macaranga peltate* M.Arg | 0.7 | 10.26 | 0.6720 | 0.2688 | 0.0698 | 0.1693 |
| 5. | *Pterocarpus indicus* Roxb | 0.6 | 6.57 | 0.7426 | 0.1404 | 0.0365 | 0.0884 |
| 6. | *Filicium decipiens* Thw | 0.45 | 6.172 | 0.9600 | 0.0955 | 0.0278 | 0.0605 |
| 7. | *Gmelina arborea* Roxb | 0.45 | 8.516 | 0.4389 | 0.0601 | 0.0156 | 0.0378 |
| 8. | *Saraca indica* L | 0.4 | 6.214 | 0.5832 | 0.0460 | 0.0119 | 0.0289 |

Table 8: DBH, Height, Density, AGB, BGB and TC of newly planted (15 years old) trees

(TC= 2.4504)

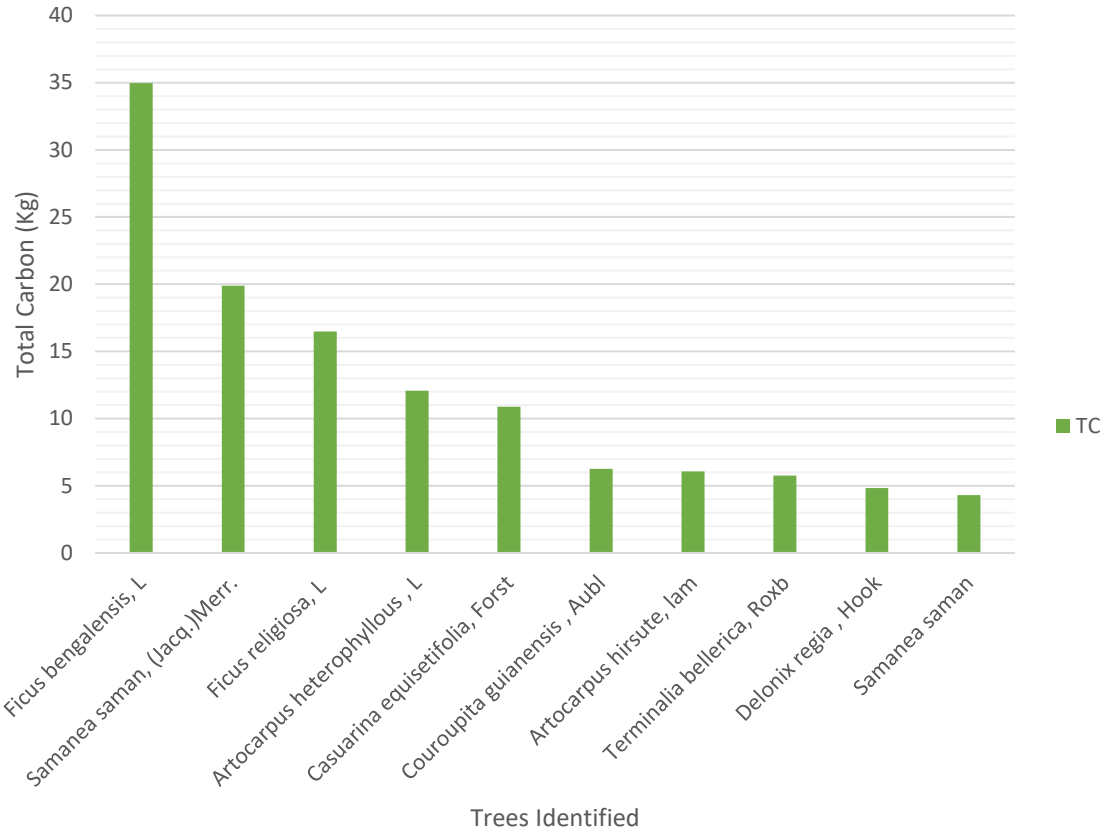



**Figure 5**

Graph showing the Total carbon sequestration of 100-150-year-old trees.

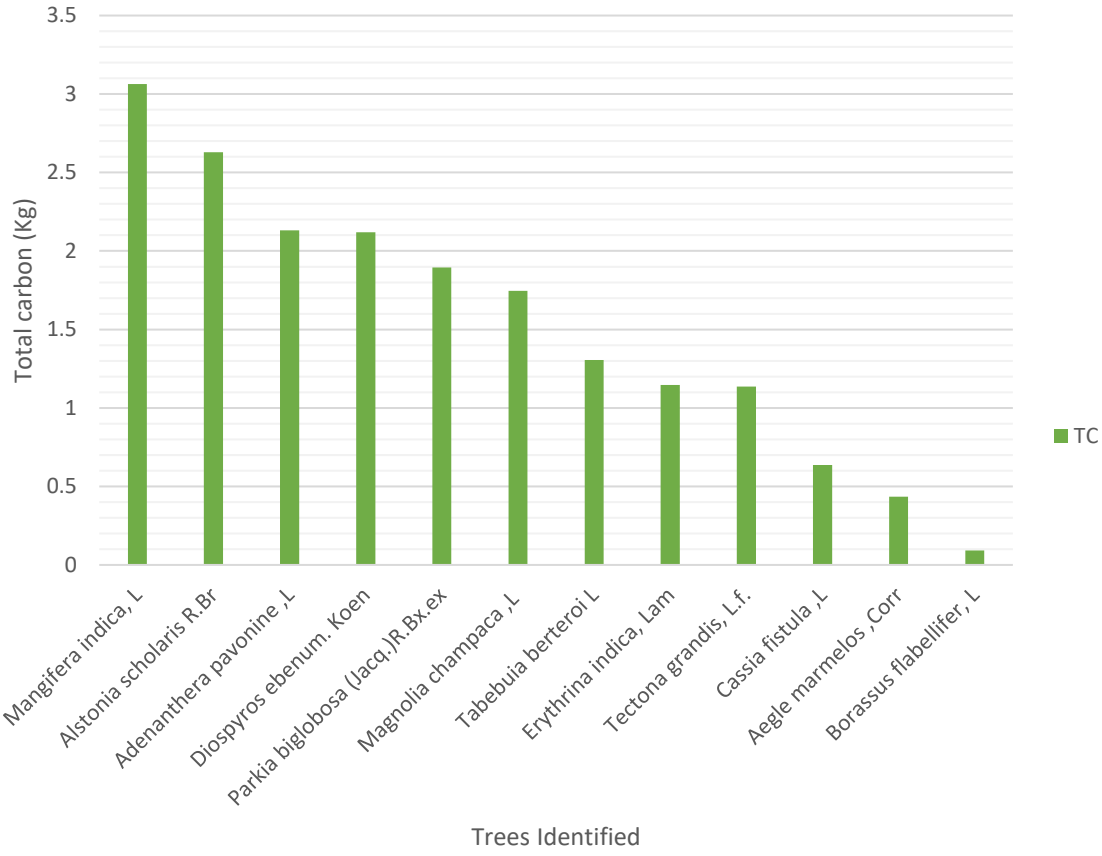



**Figure 6**

Graph showing the Total carbon sequestration of 75-100-year-old trees

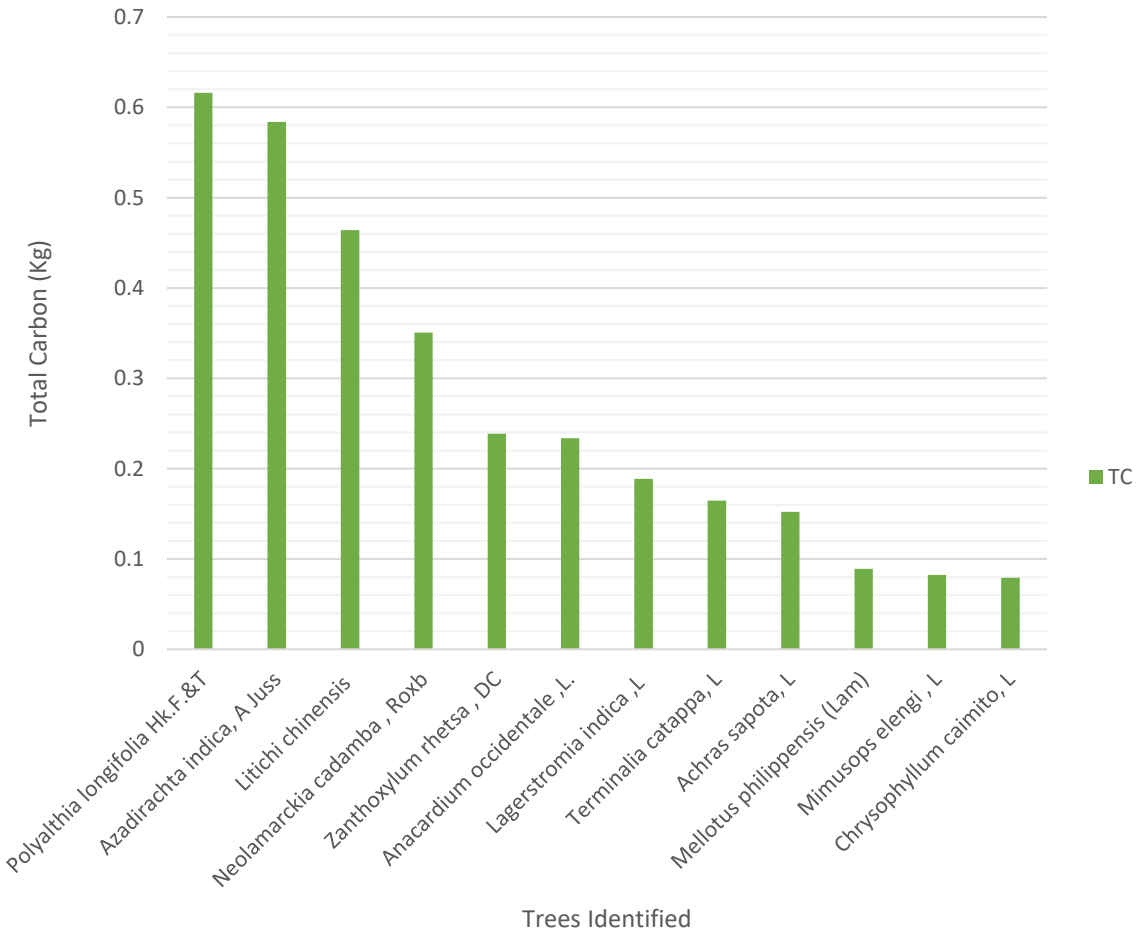



**Figure 7**

Graph showing the Total carbon sequestration of 50- 75-year-old trees

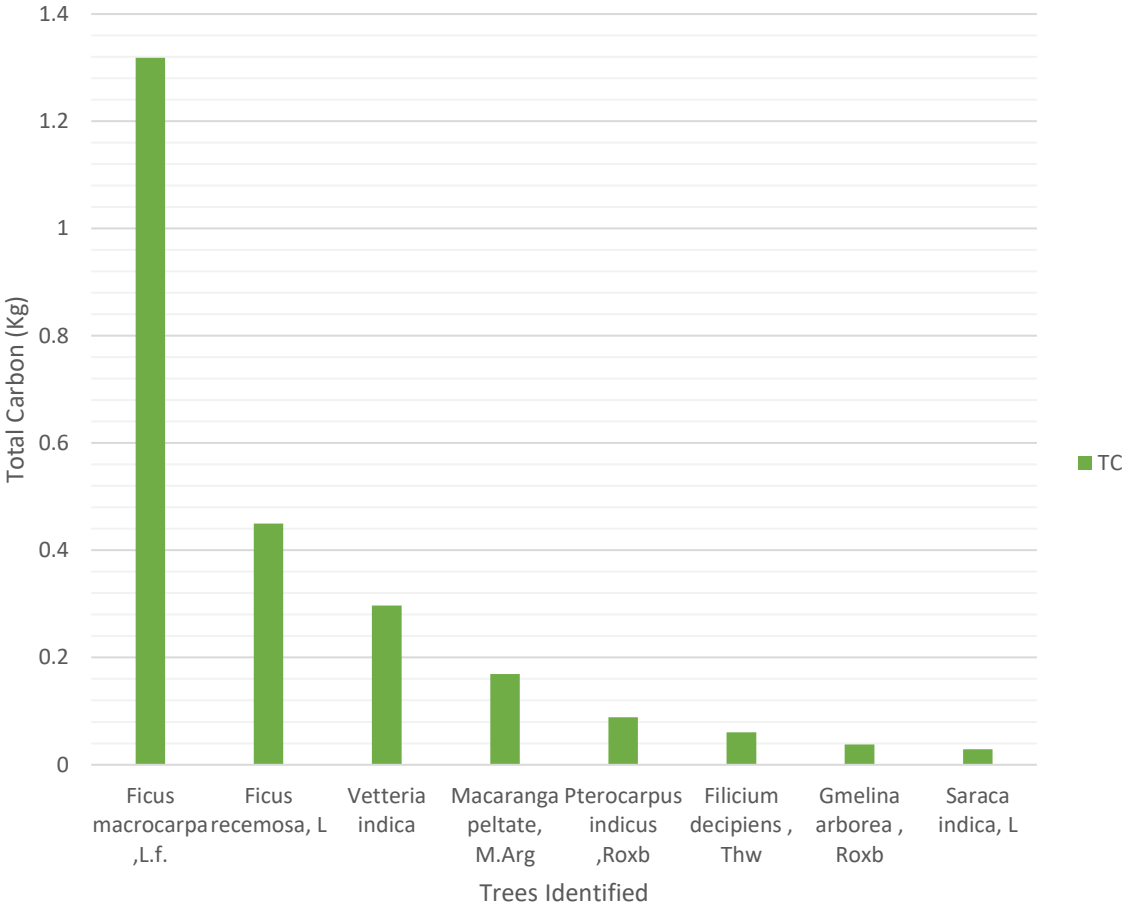
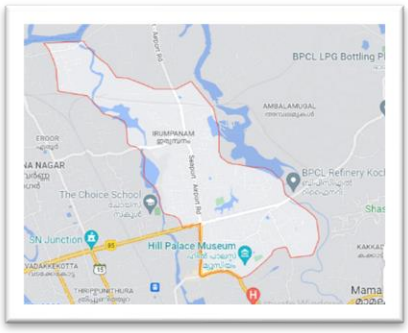



**Figure 8**

Graph showing the Total carbon sequestration of 15-year-old trees


Map showing Ernakulam district in Kerala.




Map Showing Irumpanam of Ernakulam district

Google map showing the Hill Palace Museum (Enclosed with in the polygon)

PLATE 1

Study area

PLATE 2

*Aerva lanata* Juss.

*Alternanthera sessilis* R.Br.

*Boerhaavia diffusa* L.

*Calycopteris floribunda* Lam.

.

*Centrosema mole* Benth.

*Chasalia curviflora* Thw.

PLATE 3

*Cleome viscosa* L.

*Cyclea peltate* Hk.f.&T.

*Desmodium triflorum* W & A.

*Emilia sonchifolia* DC.

*Eupatorium odoratum* L.

*Euphorbia hirta* L.

PLATE 4

*Evolvulus alsinoides* L.

*Hewittia bicolor* W&A.

*Ichnocarpus frutescens* R. Br.

*Mimosa pudica* L.

*Mukia leiosperma* W.

*Mullugo pentaphylla* L.

PLATE 5

*Naregamia alata* W.&A.

*Oldenlandia alata* Koen.

*Oxalis corniculata* L

*Pennisetum pedicellatum* Trin

*Peperomia pellucida* H.B.K

*Phyllanthus niruri* L.

PLATE 6

*Pothos scandens* L.

*Scoparia dulcis* L.

*Sebastiana* Spr. *Chamaelea* M. Arg.

*Synedrella nodiflora* Gaertn.

*Tridax procumbens* L

*Wedelia biflora* DC.

PLATE 7


Measurment of Diameter using Tape


Measurment of height using Laser Distance meter

PLATE 8

*Achras sapota* L.

*Adenanthera pavonina* L.

*Aegle Marmelos* Corr.

*Alstonia scholaris* R. Br.

*Anacardium occidentale* L.

*Artocarpus heterophyllous* L.

PLATE 9

*Artocarpus hirsuta* Lam.

*Azadirachta indica* A Juss.

*Borassus flabellifer* L.

*Cassia Fistula* L.

*Casuarina equisetifolia* Forst.

*Chrysophyllum cainito* L.

PLATE 10

*Couroupita guianensis* Aublet.

*Delonix regia* Raf.

*Diospyros* L. *Ebenum* Koen.

*Erythrina* L. *Indica* Lam.

*Ficus bengalensis* L.

*Ficus macrocarpa* L. f.

PLATE 11

*Ficus recemosa* L.

*Ficus religiosa* L

*Filicium decipiens* Thw.

*Gmelina arborea* Roxb

*Lagerstroemia indica* L.

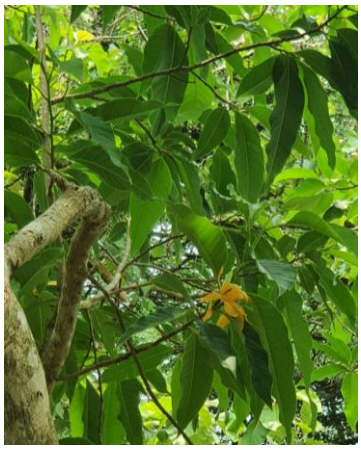
*Litichi chinensis* Sonn.

PLATE 12

*Macaranga peltata* M.Arg.

*Mangifera indica* L.

*Mellotus philippensis* Lam.



*Michelia champaca* L.

*Mimusops Elengi* L.

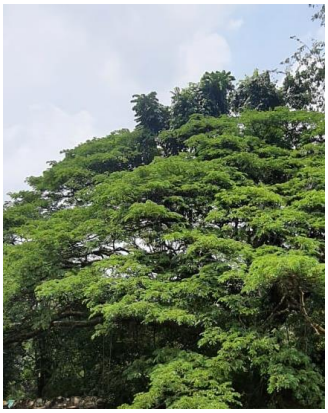
*Neolamarckia cadamba* Roxb.

PLATE 13

*Parkia biglobosa* (Jacq.) R.Bx.ex.

*Polyalthia longifolia* Hk.f.&T.

*Pterocarpus indicus* Roxb.



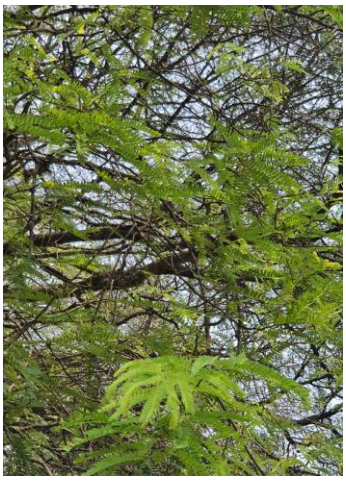
*Samanea saman* (Jacq.) Merr.

*Saraca indica* L.

*Tabebuia berteroi* L.

PLATE 14

*Tectona grandis* L.f.



*Tamarindus indica* L.

*Terminalia bellerica* Roxb.

*Terminalia catappa* L.

*Vetteria indica* Vet.

*Zanthoxylum* L. *Rhetsa* DC.

PLATE 15

# DISCUSSION

## 1. PHYTOSOCIOLGY.

The branch of Botany which deals with the study of plant communities is known as phytosociology. It gives the distribution pattern of plants in a community. The plants were distributed randomly. The structure and diversity of species were varying with community. The present research was an attempt to analysed the diversity of herbaceous species. The plant community were quantitively analysed for abundance, density and frequency (Curtis *et al*., 1950). IVI was also calculated by adding the relative values of density frequency and dominance.

The report revealed the presence of 30 herbs from the study sites, belonging to 20 families. Asteraceae was represented by the maximum of species. Followed by Leguminosae and Euphorbiaceae. Similar families were identified by Prasad (2005). In his study the families like Poaceae, Asteraceae, Cyperaceae, Fabaceae, Lamiaceae and Euphorbiaceae were dominant. The studies done by Deepa *et al.,* (2017) recorded Euphorbiaceous as the dominant family followed by Fabaceae.

30 types of herbs were reported during February to April. These 30 types were there in the site from February to April but their frequency, abundance, density and IVI were seeming to be changed during this period. It is due to the change in climate and anthropogenic activities. The studies done by Shashikala (2014) were also reported that the anthropogenic activity may cause harmful effect on vegetation. The Hill Palace Musicum and Palace is the area selected for the present study. The Palace is the main attraction. So the authorities won't put enough care to herbs.

*Oxalis corniculate* L was the dominant herb having the IVI values of 20.72, 20.39 & 20.34 respectively in the months of February, March and April. It is followed by *Tridax procumbens* L. IVI indicate the importance of that species in community. *Oxalis corniculate* L and *Tridax procumbens* L were the two important medicinal plants. *Oxalis corniculata* L is having anti-inflammatory, anti-epileptic, anti-fungal, anti-ulcer, anti-cancer, anti-diabetic, anti-microbial and wound healing property. Anika *et al*., (2020).

*Tridax procumbens* L is a herb , which shows anti-inflammatory, anti-diabetic and anesthetic properties. Samantha (2018).

The next herbs with an *IVI* value of 15.74, 15.31 and 15.01 was *Boerhaavia diffusa* L., Ichnocarpus *frutescens* R. Br. and *Desmodium triflorum* W & A., *Boerhaavia diffusa* L exhibit anti-bacterial, anti-inflammatory and anti-convulsant activities. This is used to treat, dyspepsia, abdominal pain, inflammation, and jaundice. Mahesh (2012). *Ichnocarpus frutescens* R. Br Br can be used against headaches, fevers, and purification of blood. Kumarappan (2015). *Desmodium triflorum* W & A.is a widely grown herb it is used to cure dysentery, wounds, cough, malaria and hepatitis Vedpal (2016).

*Phyllanthus niruri* L. shows an average IVI of 14.76. An average IVI values 14.66 were obtained for *Wedelia biflora* DC. and *Aerva lanata* Juss. *Phyllanthus niruri L* shows antimicrobial, antiviral, anti-inflammatory and diuretic properties. It can be used in the treatment of jaundice, ulcers, skin diseases, diabetes, chest pain and urinary complications. Hakim (2016). *Wedelia Biflora* DC is having antioxidant, anti-inflammatory, and antimicrobial property. Meena (2011) Mandal & Swati (2015) studied the importance of *Aerva lanata* Juss.. According to them it bears diuretic, hepatoprotective, , antimicrobial, anticancer, antioxidant, and numerous other pharmacological activities.

An average IVI value of 13.71 and 13.67 obtained respectively from *Pennisetum pedicellatum* Trin. and *Mimosa pudica* L. According to Ukwuani *et al.,* (2018) *Pennisetum pedicellatum* Trin can be used in the to treatment of wounds, and parasitic infections. Nur *et al.,* (2020). *Mimosa pudica* L is a good medicinal plant It is used in the treatment of leprosy, asthma, leucoderma, fatigue , dysentery, inflammations, burning sensation, and blood diseases. Joseph *et al.,* (2013).

*Naregamia alata* W.&A. and *Alternanthera sessilis* R. Br. got an average IVI value of 12.96 and 12.28. *Naregamia alata W.&*A is having antibacterial property. We can use this plant to cure scabies, jaundice, anaemia, asthama, bronchitis and arthritis. Prashasti *et al.,* (2020). *Alternanthera sessilis* R.Br. has wound healing property. Thomas *et al., (2014)*

*Cleome viscosa* L., *Evolvulus alsinoides* L., and *Cyclea peltate* Hk.f. & T. were got an IVI value of 11.49, 11.01 and 10.63 respectively. *Cleome viscosa* L having the properties like antimicrobial, analgesic, anti-inflammatory, antidiarrheal, and hepatoprotective activities. Ravindra (2010). *Evolvulus alsinoides* is a herb and it can be used to treat fever, cough and cold. Amritpal (2008). *Cyclea peltate* Hk.f.&T possessed diuretic activity. The leaves showed medicinal property.

*Calycopteris floribunda* Lam (8.69), *Mullugo pentaphylla* L. (8.67), *Eupatorium odoratum* L *(*8.44*) Chasalia curviflora* Thw. (8.33), *Emilia sonchifolia* DC. (*7.75*), *Peperomia pellucida* H.B.K. (7.49), *Synedrella nodiflora* Gaertn. (6.76), *Oldenlandia alata* Koen. (6.67), *Sebastiana* Spr. *Chamaelea* M. Arg. (6.59), *Centrosema mole* Benth. (6.56), *Euphorbia hirta* L. (5.05), *Pothos scandens* L. (4.80), *Hewittia bicolor* W&A. (4.61) and *Mukia leiosperma* W. (4.43) were the plants with an average IVI of below 10.

*Calycopteris floribunda* Lam.Lam is a herb with, antibacterial and antiviral property .it can be used to cure vomiting, jaundice skin diseases, intestinal worms, leprosy, malarial fever, dysentery, ulcers etc. (Baber *et al.,* 2019). *Mullugo pentaphylla* shows antimicrobial, anti-inflammatory and antioxidant activity. It can be used to treat Fever, stomach ache, jaundice, gout and rheumatism. Aglin (2018). Lots of work were done to reveal the medicinal importance of these plants *Eupatorium odoratum* L. is having antibacterial anti-inflammatory, antioxidant and analgesic activity. Nur *et al.,* (2020). *Chasalia curviflora* Thw. It is used to treat typhoid. studies also revealed its insect repellent property. Ajeesh (2014).

*Emilia sonchifolia* DC can be used to treat night blindness, fever, malaria, epilepsy, asthma, eye inflammation liver diseases and influenza, Dash *et al.,* (2015). *Peperomia pellucida* H.B.K possess antiulcer, anticancer and antimicrobial property. Raghavendra & Prashith (2018).

According to Patric *et al.,* (2012) *Synedrella nodiflora* Gaertn can be used to treat epilepsy *Oldenlandia alata* Koen acts as hepatoprotective, cytotoxic, anti-oxidant and anti-microbial properties. Used to treat infections ulcers, cold, cough and bronchitis. (Shaktijit *et al.,* 2019). *Sebastiana* spr. *Chamaelea* M. arg is a herb with antimicrobial

property. Reena *et al.,* (2015). *Centrosema mole* Benth. is an herb showed the antibacterial and antifungal activity. Memfin *et al.,* (2011).

Pranabesh (2019) described the antimicrobial, anti-diabetic, anti-cancer, anti-tumour, wound healing, sedative, and diuretic properties of *Euphorbia hirta* L.

*Pothos scandens L is t*he plant with anti-inflammatory, anticancer, antioxidant, wound healing properties. Niral & Rabinarayan (2020). Timothy *et al.,* (2021) did a study on *Hewittia Bicolor* W&A. the leaves were used to treat wounds. According to Petrus (2013) the *Mukia leiosperma* W. helped to relieve hypertension, diabetes, and rheumatoid arthritis.

The lowest IVI value of shrubby species were observed in case of scoparia. (3.86) *Scoparia dulsis* L is commonly utilized by local people. It has the ability to cure jaundice, stomach problems, reproductory issues, skin disease, and kidney stones. Ahana (2020). But it is very few in number. They were seen near the foot path. So, the existing plants are likely to perish in future.

The maximum values for frequency were recorded by 11 species in the month of February. By March and April, the number of species with 30% frequency were dropped down to 9 and 5 species respectively. The plants that shows the highest frequency were *Ichnocarpus frutescens* R. Br, *Oxalis corniculata* L., *Phyllanthus niruri* L., *Mimosa pudica* L, *Boerhaavia diffusa* L, *Tridax procumbens* L, *Desmodium triflorum* Linn, *Cleome viscosa* L, *Alternanthera sessilis* R.Br., *Evolvulus alsinoides* L. and *Eupatorium odoratum* L.

The highest value for density was shown by *Oxalis corniculata* L. in the months of February, March and April. 0.3 is the lowest value for density recorded by 4 species (*Scoparia dulcis* L, *Pothos scandens* L, *Euphorbia hirta* L and *Centrosema mole* Benth.), in the month of February. The density of *Scoparia dulcis,* L. was decreased to 0.2 in the month of March. By April, the density of *Euphorbia hirta* L was decreased (0.2) along with *Pothos scandens* L.

The highest value for abundance was shown by *Oxalis corniculata* L. it was 10.6, 10.7 and 9. In the month of March, the lowest value of abundance 1.5 was recorded from 3 species, (*Pothos scandens* L, *Euphorbia hirta* L and *Centrosema mole* Benth.,) The lowest value of 1 was recorded from the, *Pothos scandens* L during March and April.

The other herbs identified Aerva *lanata* Juss., *Chasalia curviflora* Thw, *Cyclea peltate* . *Emilia sonchifolia* DC, *Hewittia Bicolor* W&A, *Mukia leiosperma* W, *Mullugo pentaphylla Naregamia alata W.&*A, *Oldenlandia alata* koen, *Pennisetum pedicellatum* Trin, *Peperomia pellucida* H.B.K, *Sebastiana* spr. *Chamaelea* M. arg, *Synedrella nodiflora,* gaertn & *Wedelia Biflora* DC.

## 2. CARBON SEQUESTRATION

Storing carbon using plants involves living biomass, deadwood, litter and soil. During photosynthesis, carbon dioxide is pulled from the atmosphere, bounded as sugar (glucose) and oxygen is returned. All the sugar is spent to build wood, branches and trees. Unlike species of the animal kingdom, perennial trees were huge and can capture carbon in their trunk. Its lifespan can range from thousands of years compared to mammals which can at best live a few centuries, restricted by their physical size.

Field measurement method is used to find out the carbon sequestration rate. This can be done by either destructive method or non-destructive method. Non-destructive method is chosen and it is implemented by using the measurable parameters like height, diameter and density. (Ravindranath and Ostwald 2008). Diameter at breast height and height were the parameters used to find the biovolume. The equation was taken from the studies done by Pandya *et al.,* (2013). Above ground biomass was calculated by multiplying the volume of biomass into wood density as described by Kumar and Nandini (2013) The wood density value for the species obtained from the wood density database. The BGB has been calculated as per the method developed by Chavan and Rasal 2011 and Hangarge *et al*., 2012. The total biomass and carbon content was taken from the methods describes by Sheikh *et al.,* 2011 and Pearson *et al.,* (2005).

Based on the time of planting trees were grouped into four. The first group consists of 10 trees, they were100-150-year-old. *Ficus bengalensis* L is the oldest tree, it

sequestrates 34.9668kg. of carbon. It is the largest tree in the campus. There were 8 newly planted trees. It had been planted 15 years ago. In this category the highest carbon sequestration was found in *Ficus macrocarpa* L.f. followed by *Ficus recemosa* L. These results clearly showed the ability of Ficus in sequestrating the carbon. This result supports the finding of following authors.

Anil and Krishna (2020) studied the trees species suitable for road side plantations. He concluded that *Delonix regia, Tamarindus indica, Ficus religiosa, Samanea saman, Ficus benghalensis* and *Terminalia arjuna*. were good in carbon sequestration.

Hangarge *et al*., (2012) reported *Terminalia bellirica* species sequestrated 327.78 tons of carbon, followed by *Ficus amplissima.* He also found that the other major carbon sequestrating species were *Mangifera indica, Dalbergia lanceolaria, Ficus racemosa* and *Lagerstoemia microcarpa*. Dharmendra *et al.,* (2020) studied the carbon sequestration potential of trees. He recorded Ficus religiosa as good carbon sequester.

The second group consists of 12 trees they were 70–100-year-old. In this group *Mangifera indica, L* found to sequestrate 3.0635 kg carbon, it is followed by *Alstonia scholaris* R. Br *(*2.6291). according to Richa *et al.,* (2021) the *Alstonia scholaris* R. Br had the ability to survive in hardy nature, it can tolerate air pollution. The 3rd group consists of 12 plants. The highest sequestration was found in *Polyalthia longifolia* Hk.F.&T. The plants belonging to this group belongs to 50- 75-year-old.

In the present work it is found that the trees with maximum diameter and height sequestrate more carbon. Chandan *et al*., (2020) reports that the large trees with high DBH store more carbon. Pilania *et al*., (2014) studied the carbon sequestration of tree species. The studies revealed that the trees with high DBH store more carbon., Ishan *et al.,* (2013) conducted quantitative analysis on carbon storage. They found that as diameter of species increases its carbon storage capacity increase. According to Jithila and Prasadan (2018) the trees with maximum DBH store heigh carbon. The studies done by Anil and Krishna (2020) states that larger tress accumulate more carbon.

# SUMMARY AND CONCLUSION

Hill palace was an archeological museum situated at Irumpanam of Ernakulam district. The main attraction was the palace. The musicum has huge amount of floral wealth. But no one knows much about the valuable flora in the museum campus. The present study was carried out to analysis the importance of flora in the hill palace museum campus. It deals with phytosociological aspects of herbs and carbon sequestration ability of trees in the campus.

A total of 30 types of herbs belonging to 19 families were encountered in this study. Based on Importance Value Index, *Oxalis corniculata* L was the most dominant followed by *Tridax procumbens* L. The diversity of herbs unevenly dispersed in the study area. Different herbs with different families were recorded but very few in number. All these are medicinally important.

It was very essential to protect the herbaceous flora we can protect it by artificial means like gardening. Available plots can be used to create herbal garden. Medicinal plants were an integral part of pharmaceutical industry so if they are cultivated commercially, it will generate income and this will become a good place for field work too. Students can make use of this to learn concepts and develop research.

The world that we see today is the result of urbanization and industrialization. These adversely affect the climate conditions of the world. It is well known that the tree is the largest sink of carbon dioxide. So, the next part of this work focuses on the importance of trees in sequestrating carbon from the atmosphere.

Hill palace was situated at Irumpanam. It was an urban area, The trees that were close to roadside were most vulnerable to vehicular emission. These trees were important element in reducing air pollution from such emission. The tree cover stored and sequestrated carbon along with the reduction in the air pollutant. So, it is must that we should protect the flora in and around the museum campus. The green cover in the hill

place museum was playing a major role to reduce the frequency of pollution and moderate the adverse effects of climate change.

"The large-diameter trees have the potential to determining global atmospheric carbon stocks. The exciting trees should conserved and proper care should give to those that will soon reach large diameters" (Lindenmayer *et al*., 2014; Lutz *et al*., 2018; Moomaw *et al.*, 2019)

In the present study the *Ficus bengalensis* L. were found as good in carbon sequestration. It was the largest and oldest tree in the campus. *Ficus macrocarpa* L.f. and *Ficus recemosa* L. were also found as good in carbon sequestration but these were smaller when compared to the other Ficus species. The larger trees with larger DBH of were found to sequestrate more carbon when compared to smaller trees with relatively less DBH. The old tree sequestrates more carbon than the newly planted trees. It is found that the sequestration rate is not uniform. The increase in the rate of photosynthetic activity in the younger tress helps to sequester carbon at a faster rate. The carbon sequestration potential in smaller trees were not high. Nevertheless, they have relevant potential for growth in future.

Carbon that is put into the atmosphere is far more than that is sequestered by nature. We should boost the $CO_2$ sequestration by planting more trees. This help to slow down global warming. The present study focused on the carbon sequestration potential of trees to measure the contribution of plants in scrubbing carbon dioxide from the atmosphere in an urban area.

# REFERENCES


Abu, S., Ehsanul, B., Hasibur, R., & Mohammad, M. R. (2021). Phytosociology and biodiversity of roadside herbs in a salinity-affected coastal area of Bangladesh, *Heliyon*, 7, 1-8.

Aglin, A.A. (2018). Medicinal Effects of Mollugo cerviana - A Review, *International Journal of Scientific Research in Multidisciplinary Studies*, 4(9),34-37.

Ahana, S., Pranabesh, G., Susmita, P., Tanusree, S., Suradipa, C., & Sirshendu, C. (2020). Phytochemical, botanical and Ethnopharmacological study of *Scoparia dulcis* Linn. (Scrophulariaceae): A concise review, *The Pharma Innovation Journal*, 9(7), 30-35.

Ajayi, S., & Obi, R. L. (2015). Tree Species Composition, Structure and Importance Value Index (IVI) of Okwangwo Division, Cross River National Park, Nigeria, *International Journal of Science and Research*, 5(12), 85-93.

Ajeesh, K., Adarsh, K., Kumuthakallavalli, R., Sanyo, R., Sanis, J., Shobha, R., Darsana U., Suresh, N. N., & Reghu, R. (2014). Physico-chemical evaluation and biochemical quantification of crude drug powder of *Chassalia curviflora* Wall. ex Kurz - A folk medicinal plant, *Journal of Pharmacognosy and Phytochemistry*, 3 (3), 184-187.

Akash., Navneet., & Bhandari, B.S. (2018). Phytosociological studies, biodiversity conservation in a sub-tropical moist deciduous forest of Rajaji Tiger reserve; Uttarakhand- India, *International Journal of Research and Analytical Reviews* ,5(3),39-51.

Ambashat, A.S., & N.K.Ambashat. (2004). *A text book of plant ecology*. CBS publishers and distributors, New Delhi:16

Amritpal, S. (2008). Review of Ethnomedicinal Uses and Pharmacology of *Evolvulus alsinoides* Linn., *Ethnobotanical Leaflets,* 12, 734-740.

Anika, A. K., Fatema, S., Shifat, S. K., Upoma., Timothy., & Pritesh, R. D. (2020). Therapeutic potentials of oxalis corniculata linn. As a medicinal plant: a review, *International Journal of Pharmacognosy,* 7(4), 87-95.

Anil, R., & Krishna, K. C. (2020). Tree species suitable for roadside afforestation and carbon sequestration in Bilaspur- India, *Carbon Management,* 11:4, 369-380.

Asma, A.B., Rouf, A. B., & Ashok, K. P. (2014). Phytosociological Study of Herbaceous Plant Community in Yusmarg Forest: A Developing Hill Resort in Kashmir Valley, *International Journal of Environment and Bioenergy,* 9(3): 217-235.

Babar, V. B., Karajgi, S.R., & Sudarshan, N. (2019). Medicinal profile of *Calycopteris floribunda* Lam: A review, *Journal of Medicinal Plants Studies* ,7(3), 130-133.

Baby, J., Jency, G., & Jeevitha, M. (2013). Pharmacology and Traditional Uses of *Mimosa pudica*, *International Journal of Pharmaceutical Sciences and Drug Research*, 5(2), 41-44.

Barin, K. P., & Debabrata, D. (2015). Preliminary Phytosociological Study of Medicinal Plants Conservation Area (MPCA) At Forests of Buxa Tiger Reserve (BTR) and Gorumara National Park, Journal of Environmental Science, Toxicology and Food Technology , 9(4), PP 64-77.

Bipal, K. J., Soumyajit, B., Mrinmoy, M., Pankaj, K.R., & Asis, M. (2009). Carbon sequestration rate and aboveground biomass carbon potential of four young species, *Journal of Ecology and Natural Environment*, 1(2), 15-24.

Braun-Blanquet J. (1932). Plant sociology: the study of plant communities, McGraw-Hill, New York.

Brown, R.J., and Curtis, J.J. (1952). The upland conifer-hardwood communities of southern Wisconsin. *Ecological Monographs* 22: 217-234.

Chandan, S., Hemendra, N. N., & Sanjat, K. S. (2020). Carbon sequestration potential of trees in an urban area: a case study of Sambalpuri town in eastern India, *Fresenius Environmental Bulletin*, 29(10), 8757-8766.

Curtis, J.T., & McIntosh, R.P. (1950). The interrelations of certain analytic and synthetic phytosociological characters, *Ecology*, 31: 434−455

Dash, G. K., Abdullah, M. S., & Yahaya, R. (2015). Traditional uses, phytochemical and pharmacological aspects of *Emilia sonchifolia* Dc, *Int. J. Res. Ayurveda Pharm*, 6(4), 551-556.

David, J. M., Logan, T. B., Beverly E. L., Richard, A. B., & William, R. M. (2020). Large Trees Dominate Carbon Storage in forests east of cascade crest in the United states Pacific Northwest , *Frontiers in Forests and Global Change* ,3, 1-15.

David, J. N., Eric J. G., Robert, E. H., & Elizabeth, L. (2013). Carbon storage and sequestration by trees in urban and community areas of the United States, *Environmental Pollution*, 178, 229 – 236.

Deepa, M. R., Udayan, P.S., & Anilkumar, K. A. (2017) Taxonomical and phytosociological studies on Chithalikavu- A sacred grove -Thrissur district -Kerala, *Tropical plant research*, 4(1), 20–30.

Denisa, B. (1993). Phytosociological study of grass land vegetation in North Korea, *Folia Geobotanica*, 28 (3), 247-260.

Dharmendra, D., Srirag, S., Ankit, K. P., Ankita, P., Deependra, D. S., Krishna, D., Nidhi, S., Shivani, V., Shourya, N., Shruti, G., & Pradeep, C., (2019). Carbon sequestration potential of trees planted along roadsides: a case from Bhopal city- India, *International Journal f Environment*, 9(2), 104-119.

Emanuela, A. L., Manuela, G., & Cerasela, E.G. (2022). The Initiation of a Phytosociological Study on Certain Types of Medicinal Plants, *Agriculture*, 12, 1-28.

Gier, A. (2003.) A new approach to woody biomass assessment in wood lands and shrub lands, *Geoinformatics for tropical ecosystems*, 161–198.

Hakim, M. D., Kamruzzaman., & Obydul, H.M. (2016). A review on ethnomedicinal, phytochemical and pharmacological properties of *Phyllanthus niruri*, *Journal of Medicinal Plants Studies*, 4(6), 173-180.

Hangarge, L.M., Kulkarni, D. K., Gaikwad, V.B., Mahajan, D.M., & Chaudhari, N., (2012). Carbon Sequestration potential of tree species in SomjaichiRai (Sacred grove) at Nandghur village, in Bhor region of Pune District, Maharashtra State, India, *Annals of Biological Research*, 3(7):3426-3429.

*Hull, J.C. (2008). Plant ecology- Encyclopedia of Ecology, Oxford: Academic Press, 2818–2824.*

Hullatti, K. K., Gopikrishna, U. V., & Kuppast, I. J. (2011). Phytochemical investigation and diuretic activity of Cyclea peltate leaf extracts, *Journal of Advanced Pharamaceutical Technology and research*, 2(4), 241–244.

Indu, K. M., Mohini, G., Sonam, T., Madhushree, M., Rakesh, T., Hegde, G.T., & Ravindranath, N. H.(2013). Carbon Sequestration Potential of Agroforestry Systems in India, *Earth Science Climate Change*, 4(1), 2-7.

Ishan, Y. P., harshad, S., Omprakash, C., & Nilesh, V. (2013). Quantitative analysis on carbon storage of 25 valuable tree species of Gujarat, incredible India, *Indian j.sci.res,* 4(1), 137-141.

Jithila, P.J., & Prasadan, P.K. (2018). Carbon Sequestration by Trees-A Study in the Western Ghats, Wayanad Region, *Indian Journal of Ecology*, 45(3): 42-59.

*Keddy & Paul . (2017). Plant Ecology: Origins, Processes, Consequences. Cambridge University* Press, *90.*

Konatowska, M., & Rutkowski, P. (2019). Phytosociology—A Useful Tool for the Assessment of Past and Future Human Impacts on Plants and Forest Ecosystems, *Journal of Biosciences and Medicines*, **7**, 154-163.

Kumarappan, C., Srinivasan, R., Jeevathayaparan, S., Rajinikanth, R.I., Naveen, K., Senthilrajan, S., & Subhash, C.M. (2015). *Ichnocarpus frutescens*: a valuable medicinal plant, *Pharmacology online*.30.

Kumar, M. and Nandini, N. (2013). Importance of assessing carbon sequestration potential in forest and urban areas, *Life Sciences Leaflets,* 5, 78 – 88.

Lindenmayer, D. B., Laurance, W. F., Franklin, J. F., Likens, G. E., Banks, S. C., Blanchard, W., et al. (2014). New policies for old trees: averting a global crisis in a keystone ecological structure. Conserv. Lett. 7, 61–69.

Lutz, J. A., Furniss, T. J., Johnson, D. J., Davies, S. J., Allen, D., Alonso, A., et al. (2018). Global importance of large-diameter trees. Glob. Ecol. Biogeogr. 27, 849–864.

Meena, A.K., Rao, M.M., Meena P.R., and Panda P. (2011). Pharmacological and phytochemical Evidences for the plants of Wedelia Genus – A Review, *Asian Journal of Pharmaceutical Reseach* , 1, 7-12.

Mahesh, A.R., Harish, K., Ranganath, M.K., & Raviraj, A. D. (2012). Detail Study on *Boerhaavia Diffusa* Plant for its Medicinal Importance- A Review, *Research Journal of Pharmaceutical Sciences*, 1(1), 28-36.

Mandal, B., & Swati, M. (2016). *Aerva lanata*: A blessing of Mother Nature, *Journal of Pharmacognosy and Phytochemistry*, 5(1), 92-101.

Meenakshi, K., & Mohren, G. M., &. Dadhwal, V. K. (2010). Carbon storage and sequestration potential of selected tree species in India, *Mitig Adapt Strateg Glob Change*, 15, 489–510.

Merlee., & Avita (1989). Autecological studies on Indian senega (*Polygala chinensis*, L)- A medicinal plant. *Feddes Repertorium*, 100(3-4), 157 – 165.

Memfin, E., Herbert, M., Clement, J., & Mary, E. (2011). Antimicrobial and wound healing activities of *Centrosema pubescens* ( leguminosae), 2(1), 12-24.

Misra, R., & Puri, G.S. (1954). Indian manual of plant ecology, Dehra Dun, 143.

Moomaw, W. R., Masino, S. A., and Faison, E. K. (2019). Intact forests in the United States: proforestation mitigates climate change and serves the greatest good. Front. For. Glob. Change 2:27.

Nasrullah, K., Moinuddin, A., Muhammad, F.S., Sadia, B., & Irshad, A. (2012). A phytosociological study of forest and non-forest vegetation of district chitral, hindukush range of Pakistan, *Fuuast J. Biol*, 2(1), 91-101

Nazir, A. P., Negi, A. K., Yogesh, G., Jahangeer, A. B., & Todaria, N.P. (2012). Diversity and regeneration status of Sarkot Van Panchyat in Garhwal Himalaya, India, *Journal of Forestry Research*, 23(3) 399−404.

Niral, H. S., & Rabinarayan, A. (2020). A Review on Ethnomedicinal Claims and Spread of *Pothos scandens* L, *European Journal of Medicinal Plants*, 31(5), 22-28.

Nishitha, P., & Joby, P. (2016). Herbaceous flora of sacred grooves in Perumudiyoor, Muthuthala gramapanchayath - Pattambi, *South Indian Journal of Biological Sciences*, 2(1), 145-151.

Nittya, K. D., Suresh, K. (2015). A review on ethno- medicinal uses and pharmacology of Vernonia cinrea less, *Natural* product research, 29(12), 1102-17.

Nur A. A., Mashani, M., Hannis, F. M., Nurul, A. M., Hazalin, N., & Khuriah, A. H. (2020). The Pharmacological Properties and Medicinal Potential of *Chromolaena odorata*: A Review, *International Journal of Pharmaceuticals, Nutraceuticals and Cosmetic Science*, 2, 30-41.

Odum, E. P. (1979). *Fundamentals of ecology*, W.B Sunders company, USA: 15.

Onkar, S., Khare, P. K., Richa, K., & Khan, M. L. (2018). A systematic review on the aboveground biomass and carbon stocks of Indian forest ecosystems, *Ecological Processes*, 7(17), 1-12.

Pandey, C. N., & Pandey, R. (2013). Carbon Sequestration by Mangroves of Gujarat-India, *International Journal of Botany and Research*, 3(2), 57-70

Pandya, I.Y., Salvi, H., Chahar, O., & Vaghela, N. (2013). Quantitative Analysis on Carbon Storage of 25 Valuable Tree Species of Gujarat, Incredible *Indian J.Sci.Res*, 4(1):137-141.

Patrick, A., Samuel, A., Dorcas, O., Kennedy, K., Thomas, K., & Samuel B. (2017). Extract of *Synedrella nodiflora* (L) Gaertn. exhibits antipsychotic properties in murine models of psychosis, *Complementary and alternative medicine*, 17, 14-16.

Paul, C. V.1930. *Introduction to ecology*, John Wiley and sons, New Yoek: 7-8.

Petrus, A.J. (2013). Ethnobotanical and pharmacological profile with propagation strategies of Mukia maderaspatana L M. Roem- A concise overview, *Indian Journal of Natural Products and Resources*, 4 (1), 9-26.

Pilania, P.K., Gujar, R.V., & Panchal, N.S. (2014). Carbon sequestration by different tree species in tropical dry deciduous forest of Panchmahal District (Gujarat) in India, *Environment Conservation Journal*,15(3), 101-107.

Pranabesh, G., Chandreyi, G., Shaktijit, D., Chandrima, D., Suprodip, M., & Sirshendu, C. (2019). Botanical Description, Phytochemical Constituents and Pharmacological Properties of *Euphorbia hirta* Linn: A Review, International Journal of Health Sciences & Research, 9(3), 273- 286.

Prasad, M.N. (2005). Nickelophilous plants and their significance in phytotechnologies. *Braz. J. Plant Physiol.* 17 (1), 113-128.

Prashasti, T., Anupam, T., Vinita, B., & Shalini, P. (2020). *Naregamia alata:* An endanger medicinal plant, *The Pharma Innovation Journal*, 9(8), 293-297.

Raghavendra, H. L., Prashith, T. R. (2018). Ethnobotanical uses, phytochemistry and pharmacological activities of peperomia pellucida (L.) Kunth (piperaceae)-a review, *Int J Pharm Pharm Sci*, 10(2), 1-8.

Ravindra, G. M. (2010). *Cleome viscosa* (wild mustard): A review on ethnobotany, phytochemistry, and pharmacology, *Pharmaceutical Biology*; 48(1), 105–112.

Ravindranath, N.H., Ostwald, M. (2008). Carbon inventory methods: handbook for greenhouse gas inventory, carbon mitigation and round wood production projects. Springer Science + Business Media B.V, Dordrecht, 113–114.

Ravindranath, N.H., Somashekhar, B.S. (1995). Potential and economics of forestry options for carbon sequestration in India. Biomass and Bioenergy, 8(5) ,323-336.

Ravindranath, N.H., Somashekhar, B.S., & Gadgil, M. (1997). Carbon flow in Indian forests, Submitted to the Ministry of Environment and Forest

Ray, J.G., & Jojo, G. (2009). Phytosociology of roadside communities to identify ecological potentials of tolerant species, *Journal of Ecology and the Natural Environment*, 1(5), 184-190.

Reena, G., Kamalanathan, D., & Natarajan, D. (2015). Chemical constituents and antimicrobial activity of Sebastiana Chamaelea, *Chemistry of natural compounds*, **51**, 1178–1180.

Richa, S., Lolita, P., Maya, K., & Prodyut, B. (2021). Assessment of Carbon Sequestration Potential of Tree Species in Amity University Campus Noida, *Environmental Science Proceedings*, 3, 52.

Robert, O., & Phyllis, M.F. (2003). Introduction to California Plant Life, University of California Press, Ltd., 69.

Sahu, C., and Sahu, S.K. (2015). Air pollution tolerance index (APTI), anticipated performance index (API), carbon sequestration and dust collection potential of Indian tree species – A review, *International Journal of Emerging Research in Management and Technology*, 4(11), 37 – 40.

Samantha, B., Heather, M., Toma, T., Esli-Armando & Olga, R. K. (2018). A Review of Medicinal Uses and Pharmacological Activities of Tridax Procumbens (L.), *Journal of Plant Studies*, 7(1), 19-30.

Sandhya, G. K., & Shah, K. (2011). Carbon sequestration by urban trees on roadsides of Vadodara city, International Journal of Engineering Science and Technology, 3(4), 3066 – 3070.

Sasikala, K., Harilal, C.C., & Pradeepkumar, G. (2014). Phytosociological Studies of two sacred groves in Mahe, U.T. of Puducherry - India, *Bioscience Discovery*, 5(2),154-159.

Shaktijit, D., Nasim, M., Somdutta, M., Pranabesh, G., Chandreyi, G., Chandrima, Das., & Sirshendu, C. (2019). Botanical features, phytochemical and pharmacological overviews of *Oldenlandia corymbosa* Linn. A brief review, *The Pharma Innovation Journal*, 8(2), 464-468.

Sheela, D., & Asha, G. (2007). Ecological studies on three medicinally important plants of the family Compositae, *Nature Environment and Pollution Technology*, 6(3), 515-520.

Sheela, D., & Girija, D. K. (2008). Phytosociolgical studies on *Syndrrella nodiflora*, Gaertn. *Indian Journal Environment and ecoplane*, 15(1), 439-44.

Sheela, D., & Hema, S. (2003). Phytosociological studies on *Eleutheranthera ruderalis* (Sw) Sch. Bip, an exotic weed in Kerala, *Geobios*, 30, 271-273.

Sheikh, M.A., Kumar, M. B., & Wand, T.N. (2011). Carbon Balance and Management, *Life Sciences Leaflets*, 1186-1750.

Shilpa, S.V., & Anitha, T. (2016). Floristic diversity and phytosociological studies of the selected sacred grove in Kannur district- Kerala, *International Journal of Advanced Science and Research*, 1(4), 21-24.

Shrestha, L.J., Devkota, M.P., & Sharma, B.K. (2016). Are sacred groves of Kathmandu valley efficient in sequestering carbon, *J Botany*, 4 (1), 25-37.

Srinivasa, D. R., Prayaga, P.M., & Aniel, O.K. (2015). Plant Biodiversity and Phytosociological Studies on Tree Species diversity of Khammam District, Telangana State, *India Journal of Pharmaceutical*. Science & Research, 7(8), 518-522.

Sukumaran, S., Pepsi1, A., SivaPradesh, D.S., & Jeeva, S. (2018). Phytosociological studies of the sacred grove of Kanyakumari district, Tamilnadu, India, *Tropical plant research*, 5(1), 29–40.

Suryawanshi, M. N., Patel, A.R., Kale, T. S., & Patil, P. R. (2014). Carbon sequestration potential of tree species in the environment of North Maharashtra University Campus - Jalgaon (MS) India, *Bioscience Discovery*, 5(2), 175-179.

Timothy, O., Caroline, K. N., Rania, A. N., Florence, A. O., Sadia, B. O., Merab, L.N., Immaculate, M., Winfred, N., Papias, N., Sarah, K., Augastine, O., & Edmond, E. (2021). Medicinal Plants Used as Snake Venom Antidotes in East African Community: Review and Assessment of Scientific Evidences, *Journal of Medicinal and Chemical Sciences*, 4(2), 107-144.

Ukwuani, A. N., Dalhatu, R., Senchi, T.J., & Nuhu, U. D. (2018). Analgesic and Wound Healing Effect of Methanolic Leaves Extract of Pennisetum Pedicellatum in Wistar Albino Rat, International *Journal of Medicinal Plants and Natural Products* ,4(1), 13-18.

Uttam, K. S., Prakash, T., Arun, J. N., Sourabh, D., Dhruba, J. D., Asha, G., Bijayalaxmi, D., Shivashankar, C., Soibam, L.S., Amit, K., & Brajesh, K. T. (2021). Quantifying Tree Diversity, Carbon Stocks, and Sequestration Potential for Diverse Land Uses in Northeast India, *Frontiers in Environmental Science,* 9, 1-14.

Vishnu, M., Gopakumar, S., & Anoopa, M. (2020). Comparative phytosociological assessment of three terrestrial ecosystems of Wayanad Wildlife Sanctuary, Kerala, India, *Journal of Threatened Taxa*, 22(5), 67 -78.

Vedpal., Dhanabal, S. P., Dhamodaran, P., Chaitnya, M. V., Duraiswamy, B., Unni, J., & Neha, S. (2016). Ethnopharmacological and Phytochemical profile of three potent *Desmodium* species, *Journal of Chemical and Pharmaceutical Research*, 8(7), 91-97.

Yunxiang, C., & Toru, N. (2006). Phytosocilogical study of steppe vegetation, *Grass Land Science*, 52(2), 61-67.