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NIRMALA
ARTS & SCIENCE COLLEGE
MULANTHURUTHY
Affiliated to MG University, Kottayam

GREEN AUDIT REPORT



GREEN AUDIT REPORT 2021-22

**NIRMALA ARTS & SCIENCE COLLEGE
MULANTHURUTHY**

CONTENTS

Sl.No:		Page No:
1.	Introduction	4
2.	Objectives	5
3.	Study Area	5
4.	Biodiversity	6
	Plant Biodiversity	6
	Invasive Alien Species (IAS)	10
	Nakshathra Vanam	11
	Organic Farming	13
	Animal Biodiversity	13
	Apiary	13
	Threats to biodiversity	13
	Recommendations	14
5.	Water analysis and its management	14
	Analysis of water quality	14
	Turbidity	14
	5.1.2. pH	15
	Alkalinity	15
	Total Dissolved Solids	15
	Total Hardness	16
	Chloride	16
	Sulphates	16
	Iron	17
	Fluoride	17

	5.1.10. Nitrates	17
	5.2. Bacteriological Test	17
	5.3. Recommendations	18
6	Indoor Air Quality	18
	6.1. Recommendations	19
7	Conclusions	19

GREEN AUDIT OF NIRMALA ARTS & SCIENCE COLLEGE, MULANTHURUTHY
(Affiliated to Mahatma Gandhi University, Kottayam)

1. Introduction

Indian education advancement in the field of science and technology has led to rapid change in the lifestyle of people in the country especially in the highly literate State of Kerala. Turning to nature has several effects as nature has answer for any living being on earth for its sustainable existence. In spite of the several imbalances caused by anthropological interventions, nature finds remedy by its inestimable resources. Non Wood Forest Products are many times neglected substances in modern life but it can stand as powerful medicine in adverse conditions when unknown infections try conquering terrestrial habitats with blowing speed. Plants are the storehouses of multifunctional components with nourishing, healing, refreshing, curing and replenishing qualities. Many phytochemicals and their combinations are distributed in various parts of plants. The voracious consumeristic habit among the people of Kerala promotes vast types of industries and this sometimes poses serious threat to environment and its resources.

Public awareness on the issue is least and many times it rests on governmental authorities. Small scale industries many a times focuses on their production and marketing strategies but seldom give thrust on waste management and environmental issues. Sustainable development is a much heard concept, which is the answer for the future. This has to be begun with green campus initiatives in the universities and higher education colleges. Hence the young minds have to be imparted with the idea of sustainable development so that they act as leaders for the future.

Green initiatives in college campus promotes the sustainability by improving human health and environment. In order to study the status of campus biodiversity, the present green audit program is carried out. It also look into water quality in the campus in addition to the ambience and infrastructural facilities given to students. Green audit is a systematic process that includes

identification, quantification, reporting and analysis on natural resources of a given area. Since green audit points out the sources of pollution in an area it serves as an indirect tool for pointing out challenges such as energy consumption monitoring, water quality and quantity monitoring, risk monitoring, stakeholder safety, disaster management and mitigation.

The objectives of the present study includes evaluation of biodiversity in the campus, water quality assessment and management practices. It gives an idea on the organic farming and soil conditions of the campus. The findings and the recommendations from this green audit report are expected to have implemented in the campus for ensuring sound productivity, student and staff health, operational cost and the ecological condition within the campus.

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2. Objectives

To prepare a document on the plant biodiversity within the campus

To study the quality of water and water management

To prepare a document on organic farming initiative and green initiatives in the campus

3. Study Area

Nirmala Arts & Science College is a Science and Arts college affiliated to Mahatma Gandhi university, Kottayam, Kerala. The area lies between $9^{\circ}54.24'N$ and $76^{\circ} 23'.19''E$ and the total are of the campus is 5.1 acres

4. Biodiversity

4.1. Plant Biodiversity

A total of 159 species of flora have been identified and documented from the campus. The floral diversity of the campus is classified into trees, shrubs, herbs, climbers, creepers and aquatic plants belonging to 60 families. The campus consists of angiosperms, gymnosperms, pteridophytes and bryophytes. However, in this report, we focused on angiosperms, gymnosperms and pteridophytes. Fabaceae with 23 species is the dominant family, followed by Apocynaceae with 16 species and other families. It recorded 77 tree species, 22 shrubs and 34 herbs even in the scorching summer. It recorded a total of 23 fruit trees, 23 species of vegetable yielding plants, 8 spice yielding plants, 33 medicinal plants, 45 ornamental plants, 65 avenue trees and 5 species of palms. Table 1, table 2 and table 3 gives the complete details of plants listed in the present study.

Table 1. Herbs and Shrubs enlisted from the campus

Sl.no	Scientific name	Local Name	Common Name	Family	Habit
1	<i>Syngonium sp.</i>	സിംഗോണിയം	Arrowhead Plant	Araceae	Climber
2	<i>Vigna unguiculata</i>	പയർ	Yardlong Bean	Fabaceae	Climber
3	<i>Jasminum officinale</i>	പിച്ചി	Jasmine	Oleaceae	Climber
4	<i>Thunbergia grandiflora</i>	Blue Trumpet Vine	Blue Trumpet Vine	Acanthaceae	Climber
5	<i>Pentalinon luteum</i>	Wild Allamanda	Pentalinon luteum	Apocynaceae	Climber
6	<i>Allamanda cathartica</i>	കോളാമ്പി ചെടി	Golden Trumpet	Apocynaceae	Climber
7	<i>Trichosanthes cucumerina</i>	പടവലം	Snake Gourd	Cucurbitaceae	Climber
8	<i>Mansoa alliacea</i>	വെള്ളുള്ളിചെടി	Garlic Vine	Bignoniaceae	Climber
9	<i>Nymphaea sp.</i>	ആമ്പൽ	Water Lily	Nymphaeaceae	Aquatic herb
10	<i>Tradescantia zebrina</i>	Wandering Jew	Inchplant	Commelinaceae	Creeping

11	<i>Lygodium sp.</i>	Climbing Fern	Climbing Fern	Schizaeaceae	Fern
12	<i>Abelmoschus esculentus</i>	വെണ്ട	Okra	Malvaceae	Herb
13	<i>Elettaria cardamomum</i>	ഏലം	True Cardamom	Zingiberaceae	Herb
14	<i>Mentha x piperita</i>	പുതിന	Peppermint	Lamiaceae	Herb
15	<i>Heliconia sp.</i>	ഹെലിക്കോണിയ	Lobster-claws	Heliconiaceae	Herb
16	<i>Ocimum tenuiflorum</i>	തൂളസി	Holy Basil	Lamiaceae	Herb
17	<i>Coleus scutellarioides</i>	തിരുഹൃദയച്ചെടി	Coleus	Lamiaceae	Herb
18	<i>Curcuma aromatica</i>	കസ്തൂരിമഞ്ഞൾ	Wild Turmeric	Zingiberaceae	Herb
19	<i>Nerium oleander</i>	അരളി	Nerium	Apocynaceae	Herb
20	<i>Dracaena sanderiana</i>	ലക്കി ബാംബൂ	Lucky Bamboo	Asparagaceae	Herb
21	<i>Catharanthus roseus</i>	നിത്യകല്യാണി	Vinca rosea	Apocynaceae	Herb
22	<i>Portulaca grandiflora</i>	പത്തുമണി ചെടി	Moss Rose	Portulacaceae	Herb
23	<i>Strobilanthes alternata</i>	മുറികൂട്ടി	Red Ivy	Acanthaceae	Herb
24	<i>Dracaena trifasciata</i>	മരൽ	Snake Plant	Asparagaceae	Herb
25	<i>Tradescantia spathacea</i>	റിയോ	Oyster Plant	Commelinaceae	Herb
26	<i>Colocasia esculenta</i>	താളി	Taro	Araceae	Herb
27	<i>Chrysopogon zizanioides</i>	രാമച്ചം	Vetiver	Poaceae	Herb
28	<i>Zingiber officinale</i>	ഇഞ്ചി	Ginger	Zingiberaceae	Herb
29	<i>Cymbopogon citratus</i>	ഇഞ്ചിപ്പുല്ല	Lemon Grass	Poaceae	Herb
30	<i>Zamioculcas sp.</i>	ZZ Plant	ZZ Plant	Araceae	Herb
31	<i>Amorphophallus paeoniifolius</i>	ചേന	Elephant Foot Yam	Araceae	Herb
32	<i>Aglaonema sp.</i>	അഗ്ലോനിമ	Aglaonema	Araceae	Herb
33	<i>Cycas revoluta</i>	അലങ്കാരപ്പന	Sago Palm	Cycadaceae	Palm
34	<i>Wodyetia bifurcata</i>	Fox Tail Palm	Fox Tail Palm	Arecaceae	Palm
35	<i>Roystonea regia</i>	Royal palm	Royal Palm	Arecaceae	Palm
36	<i>Cyrtostachys renda</i>	Red palm	Red Palm	Arecaceae	Palm
37	<i>Tabernaemontana divaricata</i>	നന്ത്യാർവട്ടം	Pinwheel Flower	Apocynaceae	Shrub

38	<i>Plumeria rubra</i>	വെള്ളച്ചെമ്പകം	Frangipani	Apocynaceae	Shrub
39	<i>Hydrangea macrophylla</i>	ഹൈഡ്രാഞ്ചിയ	Big Leaf Hydrangea	Hydrangeaceae	Shrub
40	<i>Bauhinia acuminata</i>	വെള്ളമന്ദാരം	White Orchid-Tree	Fabaceae	Shrub
41	<i>Malvaviscus penduliflorus</i>	മുളക് ചെമ്പരത്തി	Turk's Cap Mallow	Malvaceae	Shrub
42	<i>Ixora coccinea</i>	ചെത്തി	Scarlet Jungle Flame	Rubiaceae	Shrub
43	<i>Indigofera tinctoria</i>	നീലയമറി	True Indigo	Fabaceae	Shrub
44	<i>Nyctanthes arbor-tristis</i>	പവിഴമല്ലി	Night-Flowering Jasmine	Oleaceae	Shrub
45	<i>Euphorbia milii</i>	യൂഫോർബിയ	Crown of Thorns	Euphorbiaceae	Shrub
46	<i>Murraya paniculata</i>	മരമുല്ല	Orange Jessamine	Rutaceae	Shrub
47	<i>Syzygium myrtifolium</i>	യൂജീനിയ	Eugenia	Myrtaceae	Shrub
48	<i>Senna tora</i>	വട്ടത്തകര	Sickle Senna	Fabaceae	Shrub
49	<i>Justicia adhatoda</i>	ആടലോടകം	Malabar Nut	Acanthaceae	Shrub
50	<i>Solanum torvum</i>	ആനച്ചുണ്ട	Turkey Berry	Solanaceae	Shrub
51	<i>Manihot esculenta</i>	മരച്ചീനി	Cassava	Euphorbiaceae	Shrub
52	<i>Microcos paniculata</i>	കൊട്ടക്ക	Elm-Leaf Grewia	Malvaceae	Shrub
53	<i>Hibiscus rosa-sinensis</i>	ചെമ്പരത്തി	Chinese Hibiscus	Malvaceae	Shrub
54	<i>Ruta graveolens</i>	അരൂത	Rue	Rutaceae	Shrub
55	<i>Bougainvillea spectabilis</i>	കടലാസ്സു പൂവ്	Bougainvillea	Nyctaginaceae	Shrubby vine
56	<i>Carica papaya</i>	പപ്പായ	Papaya	Caricaceae	Softwood tree
57	<i>Aloe vera</i>	കറ്റാർവാഴ	Aloe	Asphodelaceae	Succulent
58	<i>Tradescantia pallida</i>	Purple heart	Purple heart	Commelinaceae	Succulent
59	<i>Musa × paradisiaca</i>	വാഴ	Bananas	Musaceae	Tree-like herb
60	<i>Passiflora edulis</i>	കൃഷ്ണകമലം	Passion Fruit	Passifloraceae	Woody Climber
61	<i>Dolichandra unguis-cati</i>	Cat's-claw vine	Cat's-Claw Vine	Bignoniaceae	Woody Climber

Table 2. Trees of NCAS

1	<i>Annona reticulata</i>	ആത്ത	Wild Sweetsop	Annonaceae	Tree
4	<i>Alstonia scholaris</i>	ഏഴിലംപാല	Blackboard Tree	Apocynaceae	Tree
3	<i>Cerbera odollam</i>	ഒരളം	Suicide Tree	Apocynaceae	Tree
2	<i>Wrightia tinctoria</i>	ദന്തപ്പാല	Sweet Indrajao Indian	Apocynaceae	Tree
5	<i>Trema orientale</i>	ആമത്താളി	Charcoal Tree	Cannabaceae	Tree
6	<i>Garcinia gummi- gutta</i>	കുടംപുളി	Malabar Tamarind	Clusiaceae	Tree
7	<i>Terminalia arjuna</i>	നീർമരുത്	Arjuna	Combretaceae	Tree
8	<i>Terminalia bellirica</i>	താനി	Baheda	Combretaceae	Tree
9	<i>Terminalia catappa</i>	തല്ലിമരം	Indian- Almond	Combretaceae	Tree
10	<i>Hopea parviflora</i>	തമ്പകം	Malabar Iron- Wood	Dipterocarpaceae	Tree
11	<i>Hevea brasiliensis</i>	റബ്ബർ മരം	Para Rubber Tree	Euphorbiaceae	Tree
23	<i>Acacia mangium</i>	മാഞ്ചിയം	Hickory Wattle	Fabaceae	Tree
15	<i>Albizia lebeck</i>	നെന്മേനിവാക	Siris Tree	Fabaceae	Tree
18	<i>Butea monosperma</i>	പ്ലാശ്	Flame-of-the- Forest	Fabaceae	Tree
20	<i>Cassia fistula</i>	കണിക്കൊന്ന	Golden Shower Tree	Fabaceae	Tree
12	<i>Dalbergia latifolia</i>	ഈട്ടി	Rosewood	Fabaceae	Tree
22	<i>Delonix regia</i>	പൂവാക	Royal Poinciana	Fabaceae	Tree
21	<i>Gliricidia sepium</i>	ശീമ കൊന്ന	Mother of Cocoa	Fabaceae	Tree
19	<i>Libidibia coriaria</i>	ഡിവി ഡിവി	Divi Divi	Fabaceae	Tree
16	<i>Pongamia pinnata</i>	ഉങ്ങ്	Pongame Oil Tree	Fabaceae	Tree
14	<i>Saraca asoca</i>	അശോകം	Ashoka Tree	Fabaceae	Tree
13	<i>Sesbania grandiflora</i>	അകത്തി	Vegetable Humming Bird	Fabaceae	Tree
17	<i>Tamarindus indica</i>	പുളി	Tamarind	Fabaceae	Tree
24	<i>Tectona grandis</i>	തേക്ക്	Teak	Lamiaceae	Tree
25	<i>Cinnamomum verum</i>	കറുവ	True Cinnamon	Lauraceae	Tree

26	<i>Persea americana</i>	വെണ്ണപ്പഴം	Avocado	Lauraceae	Tree
28	<i>Lagerstroemia flos-reginae</i>	പൂമരുത്	Pride of India	Lythraceae	Tree
29	<i>Lawsonia inermis</i>	മൈലാഞ്ചി	Henna	Lythraceae	Tree
27	<i>Punica granatum</i>	മാതളനാരകം	Pomegranate	Lythraceae	Tree
31	<i>Azadirachta indica</i>	ആര്യവേപ്പ്	Neem Tree	Meliaceae	Tree
30	<i>Swietenia macrophylla</i>	മഹാഗണി	Broad-Leafed Mahogany	Meliaceae	Tree
32	<i>Artocarpus hirsutus</i>	ആഞ്ഞിലി	Wild Jack	Moraceae	Tree
33	<i>Ficus racemosa</i>	അത്തി	Cluster Fig	Moraceae	Tree
34	<i>Myristica fragrans</i>	ജാതി	Nutmeg	Myristicaceae	Tree
37	<i>Melaleuca citrina</i>	Bottle Brush	Bottle Brush	Myrtaceae	Tree
35	<i>Pimenta dioica</i>	സർവസുഗന്ധി	Allspice	Myrtaceae	Tree
39	<i>Psidium guajava</i>	പേര	Common Guava	Myrtaceae	Tree
36	<i>Syzygium aqueum</i>	ചാമ്പ	Java Apple	Myrtaceae	Tree
38	<i>Syzygium aromaticum</i>	കരയാമ്പൂ	Clove	Myrtaceae	Tree
40	<i>Averrhoa bilimbi</i>	ഇരുമ്പൻപുളി	Bilimbi	Oxalidaceae	Tree
41	<i>Phyllanthus emblica</i>	നെല്ലി	Indian Gooseberry	Phyllanthaceae	Tree
42	<i>Coffea arabica</i>	കാപ്പി	Arabian Coffee	Rubiaceae	Tree
43	<i>Aegle marmelos</i>	കൂവളം	Indian Bael	Rutaceae	Tree
44	<i>Citrus × aurantiifolia</i>	ചെറുനാരകം	Lime	Rutaceae	Tree
45	<i>Santalum album</i>	ചന്ദനം	Indian Sandalwood	Santalaceae	Tree
46	<i>Nephelium lappaceum</i>	റമ്പൂട്ടാൻ	Rambutan	Sapindaceae	Tree
47	<i>Manilkara zapota</i>	സപ്പോട്ട	Sapodilla	Sapotaceae	Tree
48	<i>Mimusops elengi</i>	ഇലഞ്ഞി	Spanish Cherry	Sapotaceae	Tree
49	<i>Wodyetia bifurcata</i>	Fox Tail Palm	Fox tail palm	Arecaceae	Tree
50	<i>Roystonea regia</i>	Royal palm	Royal palm	Arecaceae	Tree

4.1.1. Invasive Alien Species (IAS)

An invasive alien species refers to an alien species whose introduction and spread threaten the habitat (CBD, 2002). Following is the list of alien species recorded in the present study. *Acacia auriculiformis*,

Acacia mangium, *Cleodendrum trichotomum*, *Gliricidia sepium*, *Chromolaena odorata*, *Lantana camara*, *Merremia vitifolia*, *Solanum paniculatum*, *Crotalaria retusa*, *Euphorbia hirta*, *Sphagneticola trilobata*, *Mikania micrantha*, *Mimosa diplotricha* are identified as the invasive alien species of the campus. *Acacia auriculiformis* found to be most dominant invasive alien tree species in the college campus. IAS can be classified into high risk, medium risk, low risk, and insignificant species based on their potential to produce negative impacts. *Wedelia trilobata*, *Mikania micrantha*, *lantana camera*, *Chromolaena odorata*, *Mimosa diplotrich* and *Merremia vitifolia* are high risk IAS found in the campus. Pollens of *Acacia* species are reported as allergens and causes respiratory disorders such as bronchial allergy and asthma. Allelochemical produced by invasive plants cause growth retardation of native plants. IAS also have rapid and high propagation potential. If not managed effectively it can cause threat to the current diversity of the campus.

4.2. Nakshathra Vanam

The initiative for Nakshatra Vanam is a green initiative done in the campus. The initiative worked for the collection of the 27 plants (for 27 stars) from various parts of Kerala and planted in the form of potted plants for the time being. This is expected to raise as a miniature forest area in the forthcoming years. The details of the plants such as Scientific name, vernacular name, common name, family and their respective stars are given in table 3.

Table 3. List of STAR plants in NCAS campus

1	<i>Strychnos nux-vomica</i>	കാഞ്ഞിരം	Strychnine Tree	Loganiaceae	Tree	Aswathy
2	<i>Phyllanthus emblica</i>	നെല്ലി	The Indian gooseberry	Phyllanthaceae	Tree	Bharani
3	<i>Ficus racemosa</i>	അത്തി	Cluster Fig	Moraceae	Tree	Karthika
4	<i>Syzygium cumini</i>	ഞാവൽ	Java Plum	Myrtaceae	Tree	Rohini
5	<i>Senegalia catechu</i>	കരിങ്ങാലി	Black cutch	Fabaceae	Tree	Makayiram

6	<i>Diospyros ebenum</i>	കരിമരം	Ebony	Ebeaceae	Tree	Thiruvathira
7	<i>Bambusa bambos</i>	മുള	Giant Thorny Bamboo	Poaceae	Herb	Punartham
8	<i>Ficus religiosa</i>	അരയാൽ	Peepal Tree	Moraceae	Tree	Pooyyam
9	<i>Mesua ferrea</i>	നാഗകേശരം	Cobra Saffron	Calophyllaceae	Tree	Ayyillyam
10	<i>Ficus benghalensis</i>	പേരാൽ	The banyan	Moraceae	Tree	Makam
11	<i>Butea monosperma</i>	പ്ലാശ്	Flame of The Forest	Fabaceae	Tree	Pooram
12	<i>Ficus microcarpa</i>	കല്ലിത്തി	Malayan Banyan	Moraceae	Tree	Uthram
13	<i>Spondias pinnata</i>	അമ്പഴം	Hog plum	Anacardiaceae	Tree	Atham
14	<i>Aegle marmelos</i>	കൂവളം	Bael	Rutaceae	Tree	Chithira
15	<i>Terminalia cuneata</i>	നീർമരുത്	Indian Laurel	Combretaceae	Tree	Chothi
16	<i>Flacourtia Montana</i>	വയങ്കത	Mountain Sweet Thorn	Salicaceae	Tree	Visakham
17	<i>Mimusops elengi</i>	ഇലഞ്ഞി	Spanish Cherry	Sapotaceae	Tree	Anizham
18	<i>Aporosa lindleyana</i>	വെട്ടി	Scepa lindleyana Wt.	Phyllanthaceae	Tree	Thrikketta
19	<i>Vateria indica</i>	വെള്ളപ്പെൻ	White Dammar	Dipterocarpaceae	Tree	Moolam
20	<i>Salix tetrasperma</i>	വഞ്ചി	Indian willow	Salicaceae	Tree	Pooradam
21	<i>Artocarpus heterophyllus</i>	പ്ലാവ്	Jackfruit Tree	Moraceae	Tree	Utharadam
22	<i>Calotropis gigantea</i>	എരുക്ക്	Crown Flower	Apocynaceae	Shrub	Thiruvonum
23	<i>Prosopis juliflora</i>	സാലിമരം	Mesquite	Fabaceae	Tree	Avittam
24	<i>Neolamarckia cadamba</i>	കടമ്പ്	Burflower Tree	Rubiaceae	Tree	Chathayam
25	<i>Mangifera indica</i>	മാവ്	Mango Tree	Anacardiaceae	Tree	Poororuttathi
26	<i>Borassus flabellifer</i>	കരിമ്പന	Palmyra Palm	Arecaceae	Tree	Uthrattathi
27	<i>Madhuca longifolia</i>	നാട്ടിലിപ്പ	Mahua	Sapotaceae	Tree	Revathi

4.3. Organic Farming

Organic farming practices in the campus under the NSS unit is an appreciable effort performed by the faculty and students of the college. The space selected for the same is ideal as it is a free space of the campus. The practice of the NSS volunteers in the field such as planting, watering, manuring, weeding and harvest is a best practice. The chief produce from the farm area include papaya, bitter gourd, pumpkins, snake gourd, finger gourd, lady's finger and cow pea. Fruit produce of the farm include pomegranate, sapota, rambutan, butter fruit, custard apple and tamarind. All this are produced by way of organic agricultural practice. Bio waste generated in the campus is processed in the field itself to prepare farm manure and the same is being used in vegetable and fruit tree farming activities.

4.4. Animal Biodiversity

Top carnivore visitors of the college campus include several species of snakes, *Varanus bengalensis* and vultures. Animal and bird watching initiatives of the campus notices over 12 types of cranes, 15+ types of migratory birds, 100+ species of butterflies, 60+ species of beetles and other common arthropods. Round the year assessment for complete faunal assessment and documentation is recommended for complete faunal biodiversity documentation.

4.5. Apiary

In order to be in harmony with the productivity of the land in nearby area college has initiated to place bee hive in the campus and the same gives production in the form of honey periodically. The nearby plantations and the agricultural lands are the chief sources of nectar for the honey bees. This gives revenue for some of the college activities.

4.6. Threats to biodiversity

Construction based waste materials is a hurdle for the smooth access within the campus even though utmost care is taken by the administration and management to keep it low. Mass clearance of plants

and trees for construction works is the main reason behind the disappearance of many native plants and trees, which is otherwise common in the area. It also causes habitat destruction and eventually affect the faunal diversity of the campus. The invasive species such as *Acacia auriculiformis*, *Mikania micrantha* and *Chromolaena ordata* are present in the campus. These aliens are a threat for indigenous species.

4.7. Recommendations

In order to improve the diversity of the campus, the following suggestions are proposed:

- Faculty and student Initiative is required for mass greening activities other than the efforts of the management.
- Miyawaki afforestation method can be tested in the campus
- Waste water can be used to water the plants in the organic farming area.
- Planting of avenue tree species, medicinally useful trees and fruit yielding trees may be promoted in the coming years.

5. Water analysis and its management

5.1. Analysis of water quality

General Water Quality Indicators are parameters used to indicate the presence of harmful contaminants. Testing for indicators can eliminate costly tests for specific contaminants. Generally, if the indicator is present, the supply may contain the contaminant as well. For example, turbidity or the lack of clarity in a water sample usually indicates that bacteria may be present. The pH value is also considered a general water quality indicator. High or low pHs can indicate how corrosive water is. Corrosive water may further indicate that metals like lead or copper are being dissolved in the water as it passes through distribution pipes.

5.1.1. Turbidity

Turbidity is a measure of suspended minerals, bacteria, plankton, and dissolved organic and inorganic substances. Turbidity often is associated with surface water sources. The tested water sample is found to possess turbidity within the limit.

5.1.2. pH

The pH of water is a measure of acidity or alkalinity. The pH is a logarithmic scale based on a measure of the free hydrogen ions in the water. The scale runs from 0 to 14, where 7 is considered neutral, 0 to 7 is acidic and 7 to 14 is alkaline. Because pH can be affected by dissolved minerals and chemicals, it is an important indicator of the change in water chemistry. Water with a pH below 6 or above 9.5 can be corrosive to metal plumbing pipes and fixtures.

The results from the samples collected showed a pH of 5.5 which shows the slightly acidic nature of water samples which might be brought to the safe limit by adding hydroxides.

5.1.3. Alkalinity

Alkalinity is a measure of the capacity of water to neutralize acids. The predominant chemicals present in natural waters are carbonates, bicarbonates and hydroxides. The bicarbonate ion is usually prevalent. However, the ratio of these ions is a function of pH, mineral composition, temperature and ionic strength. Water may have a low alkalinity rating but a relatively high pH or vice versa, so alkalinity alone is not of major importance as a measure of water quality.

Alkalinity is not considered detrimental to humans but generally is associated with high pH values, hardness and excessive dissolved solids. High-alkalinity waters also may have a distinctly flat, unpleasant taste. It is found that the water sources analysed has very low alkalinity and hence safe.

5.1.4. Total Dissolved Solids (TDS)

High concentrations of TDS may affect taste adversely and deteriorate plumbing and appliances. The Environmental Protection Agency (EPA) recommends that water containing more than 500 mg/L of dissolved solids not be used if other less mineralized supplies are available. However, water containing more than 500 mg/l of TDS is not dangerous to drink. The tested samples are well within the allowed limit and hence safe.

5.1.5. Total Hardness

Hardness is the property that makes water form an insoluble curd with soap and primarily is due to the presence of calcium and magnesium. Very hard waters have no known adverse health effects and may be more palatable than soft waters. Hard water is primarily of concern because it requires more soap for effective cleaning; forms scum and curd; causes yellowing of fabrics; toughens vegetables cooked in the water; and forms scale in boilers, water heaters, pipes and cooking utensils.

The hardness of high-quality water should not exceed 200 mg/L measured as calcium carbonate. Water softeners will correct hard water of more than 200 mg/L. The values for the sample showed 6 mg/L which is very low.

5.1.6. Chloride

High concentrations of chloride ions can cause water to have an objectionable salty taste and corrode hot-water plumbing systems. High-chloride waters have a laxative effect for some people. An upper limit of 250 mg/L has been set for chloride ions, although noticing the taste at this level is difficult, and even higher concentrations do not appear to cause adverse health effects. An increase in the normal chloride content of water may indicate possible pollution from human sewage, animal manure or industrial wastes. The samples under consideration showed only a value of 11.8 mg/L and therefore suitable for domestic purposes.

5.1.7. Sulphates

The observed level of sulphate in the sample tested is very low and well within the limit. The upper limit recommended for sulphates is 200 mg/L. Water containing high levels of sulphates, particularly magnesium sulphate (Epson salts) and sodium sulphates (Glauber's salt) may have a laxative effect on people unaccustomed to the water. These effects vary among individuals and appear to last only until

they become accustomed to using the water. High sulphate content also affects the taste of water and forms a hard scale in boilers and heat exchangers.

5.1.8. Iron

Iron in concentrations greater than 1.0 mg/L may cause brown stains on laundry, plumbing fixtures and sinks. A metallic taste also may be present, and it may affect the taste of beverages made from the water. High concentrations of iron, however, do not appear to present a health hazard.

5.1.9. Fluoride

The tested samples showed fluoride concentration well within the limit. Fluoride concentrations of 0.7 to 1.2 mg/L in drinking water will protect against dental cavities. Elevated fluoride levels also may cause skeletal damage and bone disease. Because low levels of fluoride are common in groundwater, most municipalities add fluoride to the water.

5.1.10. Nitrates

High nitrate levels may cause methemoglobinemia (infant cyanosis or “blue baby disease”) in infants who drink water or formula made from water containing nitrate levels higher than recommended (45 mg/L). Adults can drink water with considerably higher concentrations than infants without adverse effects. The test result from the sample, however, showed 3.66 mg/L.

5.2. Bacteriological Test

All water has some form of bacteria in it. The presence of bacteria does not mean the water is unsafe to drink. Only disease-causing bacteria known as pathogens lead to disease. Total coliform bacteria are a group of several kinds of bacteria commonly found in the environment, including soil, vegetation and untreated surface water.

A positive total coliform test would indicate unsanitary conditions and the possible presence of disease-causing organisms. Further testing should include the subgroup fecal coliform and its subgroup, *Escherichia coli* (E. coli). Disease-causing microbes (pathogens) can cause diarrhoea, cramps, nausea, headaches or other symptoms. These pathogens may pose a special health risk for infants, young children and people with severely compromised immune systems. However, the samples tested from the college source showed a negative result for the E. Coli bacteria which means the water is safe. It should be also noted that the test for total coliform is positive and hence preventive measures such as chlorination are suggested to ensure maximum safety.

5.3. Recommendations

- Undertake periodic study to access undesirable changes in the water quality of existing water resources and its timely treatment.
- Water storage capacity to be increased drastically in order to meet the growing needs of the campus.
- Efficient use of water usage by students to be promoted.
- Regular maintenance activity to be done for reducing contamination.
- Maintenance and monitoring of valves in supply system to avoid overflow, leakage and spillage
- Having motion sensor taps
- Developing creative solutions using informatics to prevent severe water shortage crisis.
- Rain water harvesting

6. Indoor Air Quality

In recent studies it is reported that humans spend majority of their lifetime in indoor environments. Classrooms, libraries, and laboratories are the major indoor environment for a college student. Dust from various sources is the chief contaminant noticed in the present study. Indoor dust is expected to be an important matrix that exposes humans to a broad spectrum of chemicals. Some of these pollutants are reported to be endocrine disruptors, mutagenic and carcinogenic. Even though Mulanthuruthy area

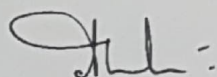
as a whole is free from several pollutants and air born contaminant risk of Ernakulam district, care to be taken for promoting a stable indoor environment by conducting periodic air quality analysis.

6.1. Recommendations

- Air Quality assessment to be done.
- Heavy metal analysis to be done for the campus.
- Regular equipment cleaning in the smart classroom is suggested i.e. once in a month

7. Conclusion

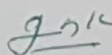
This assessment focused on the biodiversity, waste management, water quality assessment and green initiatives in the campus. It is recommended to promote planting of native species that enhance our natural environment and ecology, rooftop rainwater harvesting as a better option for effective water management and continuous monitoring of hazardous substances in indoor air and dust.



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