JSS Academy of Higher Education & Research (JSS AHER), Mysore, India

Compendium

SDG Goal 14

SDG-14

Life Below Water

1. Introduction to Goal

The SDGs aim to sustainably manage and protect marine and coastal ecosystems from pollution, as well as address the impacts of ocean acidification. Enhancing conservation and the sustainable use of ocean-based resources through international law will also help mitigate some of the challenges facing our oceans. By 2020, effectively regulate harvesting and end overfishing, illegal, unreported and unregulated fishing and destructive fishing practices and implement science-based management plans, in order to restore fish stocks in the shortest time feasible, at least to levels that can produce maximum sustainable yield as determined by their biological characteristics By 2020, conserve at least 10 per cent of coastal and marine areas, consistent with national and international law and based on the best available scientific information By 2020, prohibit certain forms of fisheries subsidies which contribute to overcapacity and overfishing, eliminate subsidies that contribute to illegal, unreported and unregulated fishing and refrain from introducing new such subsidies, recognizing that appropriate and effective special and differential treatment for developing and least developed countries should be an integral part of the World Trade Organization fisheries subsidies negotiation By 2030, increase the economic benefits to Small Island developing States and least developed countries from the sustainable use of marine resources, including through sustainable management of fisheries, aquaculture and tourism.

2. Research Collaborations and their Outcomes

National / International Name of the Collaborator	Outcomes (if any)
National Institute of Biologicals, Govt of India, New Delhi	Professional in-depth specific training of the students (06) on Standardizations of biologicals and biosimilars
National Institute of Ocean Technology, Chennai	**Project work of student on marine biotechnology**
Pasteur Institute of India, Coonoor	Research Collaboration
Society of Biotechnologists, India	Join Symposium and Research Collaboration
Sudan Academy Of Science, Sudan	Research Collaboration
Kyushy University for Health and welfare, Japan	International Training in virology and Join Publication (02 Nos.) and join Presentations (02)

3. Marine biodiversity


Water and Land provide key natural resources including food, medicines, biofuels, and other products. They help with the breakdown and removal of waste and pollution, and their coastal ecosystems act as buffers to reduce damage from storms. Regionally, educational institutions can educate the students on keeping the water and land sources clean to a greater extent thereby allowing the local creatures to live.

JSSAHER has taken various action plans to sustainably manage and protect aquatic ecosystems and environmental conservation to avoid significant adverse impacts by environmental education and environmental conservation outreaches. The department has offered various environmental science and conservation programs at UG, PG and PG diploma level in both regular and open distance learning mode that certainly make an individual to know about the importance of environmental conservation and management of various environmental components. It has organized various environmental conservation walkathons and ecosystem restoration drives, awareness and education programs, national and international environmental events to bring resilience towards sustainable conservation of land and water ecosystems and control or eradicate the priority species. JSSAHER has implemented various technological and management strategies towards conservation of environmental and reduction of carbon food prints by declaring the campus as vegetarian, plastic free, eco-zone, etc. It has extended eco-friendly services like bicycle services, paperless communication in the campus including less energy consuming lighting, water saving toiletries and top system, etc. JSSAHER has conducted various environmental programs like tree plantation, waste to energy production (Biogas), vermicomposting, etc. It has also been involved in development of sustainable technology for water treatment and wastewater reclamation technology that using natural sunlight as an alternative driving energy.



Department of Water & Health ,JSSAHER organising the an awareness program and work shop at Seringapata on various technological and management strategies towards conservation of environmental and reduction of carbon food prints ,plastic free, paperless communication, water conservation , environment protection including life in water and land.

4. Awareness rally on environment was conducted.

Cleaning the Kaveri River at Srirangapatna during Save Kaveri Programme.

Painting/Drawing Competitions were conducted as a part of NSS Day Celebrations on the theme of Nature, Calamity & Service. The competition was won by Poojith Rajendran from M.Sc. Bioinformatics, Department of Water & Health .

5. Curriculum and course content supporting SDG 13

https://jssuni.edu.in/JSSWeb/UDData/Docs/Pharmacy-B-PHARM.pdf

45 Hours

Scope: To learn and understand the cultivation and production of crude drugs and their usefulness.

Objectives: Upon completion of the course, the student shall be able

1. to know the advances in the cultivation and production of drugs
2. know the evaluation techniques for the herbal drugs

Course Content:

UNIT-I **10 Hours**

Cultivation, Collection, Processing and storage of crude drugs:
Factors influencing cultivation of medicinal plants.
Pest management and natural pest control agents.
Plant hormones and their applications.
Polyploidy, mutation and hybridization with reference to medicinal plants
Conservation of medicinal plants

UNIT IV **08 Hours**
Study of biological source, chemical nature and uses of crude drugs containing following drugs
Secondary metabolites
Flavonoids – Tea, Ruta
Saponins – Liquorice, Dioscorea
Alkaloids-Vinca, Rauwolfia, Bellodonna, Opium
Tannins – Catechu, Pterocarpus
Terpenoids - Mentha, , Clove, Nutmeg
Resins: Benzoin, Guggul, Ginger, Asafoetida

UNIT-V **07 Hours**

Study of biological source, chemical nature and uses of crude drugs containing following drugs
Primary metabolites:
Carbohydrates: Acacia, Agar, Tragacanth, Honey
Proteins: Gelatin
Lipids: Castor oil, Chaulmoogra oil, Wool Fat, Bees Wax

Marine Pharmacognosy
Novel medicinal agents from marine sources.

https://www.jssuni.edu.in/JSSWeb/UDData/Docs/PHARMACYCOURSEOUTCOMES.pdf

6. Course out come

This course is one of the oldest specialisations in Herbal Medicines that is offered. Will learn and get experience about

1. Definition and objectives of Pharmacognosy. Information about the use of Medicinal plants. Plant as a source of drugs of pharmaceutical interest.

2. Extraction procedures for natural compounds, their differences and their applications the main pathways of aromatic amino acids, alkaloids, phenylpropanoids

3. Biogenesis and biological activity of natural products coming from mevalonate: terpenoids and steroids;

4. The biological activities of several compounds belonging to polyketides, terpenoids and steroids; and their traditional use and application in pharmaceutical and/or nutraceutical field.

5. Indian Traditional systems of Medicine.

6. Use of microscopic methods in the identification of natural drugs and herbal products, with emphasis on the use of light and scanning electron microscopes.

7. Principles and concepts in plant taxonomy, which include identification, classification, nomenclature, discussion of major recent/modern systems, family characterization and field work methods.

8. Marine natural product chemistry. Include examples of marine antineoplastic agents, marine toxins, and other pharmaceutically relevant marine natural products from various marine organisms.

9. Introduction to Herbal cosmetics and Nutrients.

http://www.pharmacy.dauniv.ac.in/Syllabus_M_Pharm.pdf

ADVANCED PHARMACOGNOSY - I
(MPG 102T)

SCOPE

To learn and understand the advances in the field of cultivation and isolation of drugs of natural origin, various phytopharmaceuticals, nutraceuticals and their medicinal use and health benefits.

OBJECTIVES

Upon completion of the course, the student shall be able to know the,

- advances in the cultivation and production of drugs
- various phyto-pharmaceuticals and their source, its utilization and medicinal value.
- various nutraceuticals/herbs and their health benefits
- Drugs of marine origin
- Pharmacovigilance of drugs of natural origin

	THEORY	***60 Hrs***
1.	**Plant drug cultivation:** General introduction to the importance of Pharmacognosy in herbal drug industry, Indian Council of Agricultural Research, Current Good Agricultural Practices, Current Good Cultivation Practices, Current Good Collection Practices, Conservation of medicinal plants- *Ex-situ* and *In-situ* conservation of medicinal plants.	12 Hrs
2	**Marine natural products:** General methods of isolation and purification, Study of Marine toxins, Recent advances in research in marine drugs, Problems faced in research on marine drugs such as taxonomical identification, chemical screening and their solution.	12 Hrs

THEORY **60 Hour**

UNIT 1 **12 Hrs**

Plant drug cultivation: General introduction to the importance of Pharmacognosy in herbal drug industry, General aspects involved in cultivation of medicinal plants. Factors affecting the cultivation of crude drugs. General aspects involved in the cultivation like Taxol, Artemisia,Guggul,Ginseng, Neem, Gymnema. Good manufacturing practice in collection of crude drugs.

UNIT I1 **12 Hrs**

Marine natural products: Definition, Present status, Classification of important bioactive agents from marine sources. General methods of isolation and purification. Study of Marine toxins, Marine bio medicals falling under the class of Cardiovascular, Anticancer, Antimicrobial,Anti-inflammatory and Antibiotic drugs.

UNIT II1 **12 Hrs**

Nutraceuticals: General introduction , Definition, Classification , Inorganic mineral supplements, Vitamin supplements, Digestive enzymes, Probiotics, Prebiotics, Dietary fibres, Cereals and grains, Health drinks, Antioxidants, Polyunsaturated fatty acids, Herbs as functional foods. Sources, name of marker compounds and their chemical nature, medicinal uses and health benefits of following:
i) Spirulina ii) Soya bean iii) Ginseng iv) Garlic v) Broccoli vi) Tea vii) Flax seeds viii) Black cohosh ix) Turmeric.

https://jisuniversity.ac.in/pdf/Syllabus-D-Pharm-latest.pdf

1.3 PHARMACOGNOSY Theory (75 hours)

1. Definition, history and scope of Pharmacognosy including indigenous system of medicine.
2. Various systems of classification of drugs of natural origin.
3. Adulteration and drug evaluation; significance of Pharmacopoeial standards.
4. Brief outline of occurrence, distribution, outline of isolation, identification tests, therapeutic effects and pharmaceutical applications of alkaloids, terpenoids, glycosides, volatile oils, tannins and resins.
5. Occurrence, distribution, organoleptic evaluation, chemical constituents including tests wherever applicable and therapeutic efficacy of following categories of drugs.

(a) Laxatives: Aloes, Rhuburb, Castor oil, Ispaghula, Senna.
(b) Cardiotonics-Digitalis, Arjuna.
(c) Carminatives & G.I. regulators-Umbelliferous fruits, Coriander, Fennel, Ajowan, Cardamom Ginger, Black pepper, Asafoetida, Nutmeg, Cinnamon, Clove.
(d) Astringentsâ€“Catechu.
(e) Drugs acting on nervous system-Hyoscyamus, Belladonna, Aconite, Ashwagandha, Ephedra, Opium, Cannabis, Nuxvomica.
(f) Antihypertensives-Rauwolfia.
(g) Antitussives-Vasaka, Tolu balsam, Tulsi.
(h) Antirheumatics-Guggul, Colchicum.
(i) Antitumour-Vinca.
(j) Antileprotics-Chaulmoogra Oil.
(k) Antidiabetics -Pterocarpus, Gymnema, Sylvestro.

https://jssuni.edu.in/JSSWeb/UDData/Docs/FLS-PG-Regulations-and-Combined-Syllabus.pdf

SEMESTER I

PAPER 1: PRINCIPLES OF ENVIRONMENTAL SCIENCES

4 CREDITS

Unit I:
Definition, scope and interdisciplinary nature of environmental science, environmental factors: structure, composition of Atmosphere, Lithosphere, Biosphere and Hydrosphere.

Unit II:
Biogeochemical Cycles of major environmental elements and significance: Carbon, Nitrogen, Phosphate, Sulphate, Hydrogen, Oxygen, Mode of energy transmission.

Unit III:
Ecology: Definition, subdivision, ecosystem- Terrestrial, Aquatic, Grass, flow of energy, food chain, food web, tropic level, ecological pyramid, eco-tone, edge effect

Unit IV:
Biomes and Habitat: Classification of biomes – Tundra, Taiga, Grassland, Desert, Evergreen and deciduous forests, Tropical rain forests and their characteristics, flora and fauna; Classification of Aquatic Habitats – Fresh water pond, Wetlands, Beels, Rivers – their characteristics, flora and fauna; Marine Habitats – Pelagic, Benthic, Inter-tidal Estuarine; Mangroves – their characteristics, flora and fauna

7. Publication

7.1 Environmental Lead Levels in a Coastal City of India: The Lead Burden Continues

First Author: Dr Prashant M. Vishwanath

7.2 Serotyping & molecular characterization for study of genetic diversity among seafood associated nontyphoidal Salmonella serovars

First Author: Patit Paban Bhowmick

7.3 Presence of Salmonella pathogenicity island 2 genes in seafood-associated Salmonella serovars and the role of the sseC gene in survival of Salmonella

First Author: Patit P. Bhowmick

7.4 Screening of school children for blood lead levels and attempts to reduce them by nonpharmacological means in a coastal city of India

First Author: Dr Prashant M. Vishwanath

7.5 Assessment of 210Po and 210Pb in marine biota of Mallipattinam ecosystem of Tamilnadu, India

First Author: Dr Suriyanarayanan S

7.6 Publications and Research by Ms.Naganandini M N Assistant Professor, JSS AHER

- Diversity of phytoplanktons in a waste stabilization pond at Shimoga Town, Karnataka State, India
- Chemical and biochemical composition of caviar from different sturgeon species and origins
- Design, synthesis and 3D-QSAR studies of new diphenylamine containing 1, 2, 4-triazoles as potential antitubercular agents
- Limnological studies in ponds and lakes of Dharwar
- Algae as indicators of organic pollution
- Phytoplankton diversity in lakes of Mysore district, Karnataka state, India
- Algal biodiversity in freshwaters and related physico-chemical factors
- Role of p53 circuitry in tumorigenesis: a brief review
- Seasonal Changes in Phytoplankton Communities in a Fresh Water Pond at Dharwar, Karnatak State, India
- Ecology of Certain Inland Waters of Mysore District Occurrence of Cyanophycean Bloom at Hosakere Lake
- Application of benthic diatom community in lake water quality monitoring.
- Bio-medical wastes disposal and management in some major hospitals of Mysore City, India.

- Fresh Water Algae as Indicators of Water Quality.
- Freshwater plankton ecology: a review
- Physicochemical and biological quality of ground water in Mysore City, Karnataka
- Hydrobiological studies in ponds and lakes of Dharwar (yemmekeri Pond) part1
- Revealing the molecular interactions of aptamers that specifically bind to the extracellular domain of HER2 cancer biomarker protein: An in silico assessment
- Synthesis, in vitro cytotoxicity, and anti-microbial studies of 1, 4-bis (4-substituted-5-mercapto-1, 2, 4-triazol-3-yl) butanes
- Ecological significance of biochemical parameters in certain fresh water lakes of Mysore
- Hydrobiological studies in ponds and lakes of Dharwar, 3 occurrence of twoeuglenoid blooms.

7.7 Phycocyanin Extracted from Oscillatoria minima Shows Antimicrobial, Algicidal, and Antiradical Activities: In silico and In vitro Analysis

Vaishali C Venugopal[1], Abhimanyu Thakur[2], Latha K Chennabasappa[1], Gaurav Mishra[3], Kunal Singh[4], Parth Rathee[2], Anjali Ranjan[2]

Background: Phycocyanin is an algae-derived protein, which binds to pigment for harvesting light. It has been reported in various species, including that of red algae, dinoflagellates, and cryptophyta. Importantly, phycocyanin has enormous applications, including cosmetic colorant, food additive, biotechnology, diagnostics, fluorescence detection probe, an anticancer agent, anti-inflammatory, immune enhancer, etc. In addition, several different algae were utilized for the isolation of cyano-phycocyanin (C-PC), but most of the purification methods consist of several steps of crude extraction.

Aim: To isolate C-PC from a new source of microalgae with better purity level and to evaluate its antimicrobial, algicidal, and antiradical activities.

Methods: Biological activity, permeability, pharmacokinetics, and toxicity profile of C-PC were predicted by in silico studies. C-PC was purified and isolated by using ammonium sulphate precipitation, ion-exchange chromatography and gel-filtration chromatography. C-PC was characterized by SDS-PAGE and elution profile (purity ratio) analysis. Antimicrobial and algicial activities of C-PC were evaluated by the microtitre plate based assays. Antiradical activity of C-PC was evaluated by DPPH- and ABTS*+ radical scavenging assays.

Conclusion: C-PC was extracted from Oscillatoria minima for the first time, followed by its quantitative as well qualitative evaluation, indicating a new alternative source of this important protein. Furthermore, the antimicrobial, algicidal, and antiradical activities of the isolated C-PC extract have been demonstrated by both in silico as well as in vitro methods.

7.8 C-PHYCOCYANIN OF SPIRULINA PLANTESIS INHIBITS NSP12 REQUIRED FOR REPLICATION OF SARS-COV-2: A NOVEL FINDING IN-SILICO

C-PHYCOCYANIN OF *SPIRULINA PLANTESIS* INHIBITS NSP12 REQUIRED FOR REPLICATION OF SARS-COV-2: A NOVEL FINDING *IN-SILICO*

T. Kiran Raj [1], R. Ranjithkumar [2], B. M. Kanthesh [3] and T. S. Gopenath [*1]

Division of Biotechnology & Bioinformatics [1], Division of Molecular Biology 3, School of Life Sciences, JSS Academy of Higher Education & Research, Mysuru - 570015, Karnataka, India.

Department of Biotechnology [2], Kongunadu Arts and Science College, Coimbatore - 641029, Tamil Nadu, India.

ABSTRACT: SARS-CoV-2 or COVID-19 is one of the deadly pandemics faced by the world population, which has infected 7 million and claimed the lives of 0.4 million people. In spite of a few drugs available to control the pandemics, a formal vaccine is the least that the world expects under the current scenario. However, the release of a vaccine is expected to come at the cost of its own time. SARS-CoV-2 replicates in the host cells with the aids of the molecular machinery of a complex formed by three non-structural proteins (NSPs) *viz*., nsp12, nsp8, and nsp7. Recent studies reveal that among the three NSPs, nsp12 is vital for viral replication and is the target for drugs. Several studies have linked the viral infection to a weaker immune system, which is quite likely to be targeted by the virus. In search of such a natural compound that might increase the immunity and block the viral replication within the host, we selected C-Phycocyanin of *Spirulina plantesis* to study its anti-viral property *in-silico*. Spirulina is a free-floating filamentous microalgae growing in alkaline water bodies. It is a well-known source of valuable food supplements, such as proteins, vitamins, amino acids, minerals, *etc*. In the present study, we focused on the possibility of C-Phycocyanin to inhibit the active site of nsp12, which is very much needed for viral replication. Auto Dock, Auto Grid, and Discovery Studios tools reveal that C-Phycocyanin inhibits the active site of nsp12 thereby interfering with the replication of the virus itself.

Keywords:

SARS-CoV-2, Non-structural proteins, Viral replication, *Spirulina platensis*, C-Phycocyanin

INTRODUCTION: Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) or CoVID-19 as it is commonly called, is one of the recently known viruses which belong to the Coronaviridae family [1]. These viruses possess RNA as their genetic materials, which are known to cause severe diseases in birds as well as mammals.

The viruses are constituted by enveloped positive single-stranded RNA genome with helically symmetrical capsids [2]. The term was derived from the Latin word *"Corona"* meaning crown [3]. The emergence of SARS-CoV-2 resulted in a pandemic situation throughout the world infecting more than 7 million people and also claimed the lives of almost half a million. Currently, there are no approved drugs for the treatment of SARS-CoV-2.

However, certain drugs used against SARS-CoV and MERS like Remdesivir and Hydroxy-chloroquine are currently being used, of which the former has shown some promising effects [4, 5].

In order to design a drug against the virus, it is equally important to understand the mechanism of action of the pathogen. SARS-CoV-2 has been shown to replicate in the host cells using RNA dependent RNA polymerases (RdRp). Further, the non-structural proteins such as nsp7, nsp8, and nsp12 of which the latter is an RdRp, form an active complex which is ATP dependent. Though this non-structural protein complex is required for the replication of the virus, recent studies have shown that nsp12 plays a major role in replication [6, 7].

With the world expecting a formal vaccine, which is not yet available, treatment for the pandemic is far from reach. It is noticed that spreading happens typically through respiratory droplets created while an infected person coughs or sneezes, similar to how influenza and other respiratory pathogens spread. Under the current circumstances, social distancing, usage of detergents, and self-isolation are the only options available to be

free from infection [8]. In the absence of suitable drugs and vaccines for the pandemic, several strategies of using alternative treatment methods are inevitable. Boosting of the immune system could be one of the strategies which might keep the virus away from infecting healthy individuals. One such strategy was initiated by CSIR-CFTRI (Central Food Technological Research Institute), under the Government of India to distribute supplements containing *Spirulina platensis* for the infected people. Though it is not an alternative treatment procedure, it is believed that the algae possess immunomodulatory functions, which might be important to boost the immune system of an individual.

Spirulina platensis is well known blue-green algae that grow in high alkaline conditions and specially used for its high nutritious contents that include amino acids, vitamins, proteins, polysaccharides, and other pigments. Further, cellular assays and animal studies conducted with cold water extracts of *Spirulina platensis* upon the viability and pathogenicity of several influenza A viral strains showed that the extract inhibited viral plaque formation and reduced viral replication in cell cultures, and importantly was shown to be safe and well-tolerated at high doses in cellular and animal toxicity studies.

In-vivo studies on influenza-infected mice given Spirulina extract had higher survival rates compared to vehicle-treated controls. Spirulina extract disrupted the hemagglutination of viral particles to erythrocytes, thus inhibiting the infection process [10].

Some of the compounds in Spirulina like calcium spirulan, which is made of sugar moieties and C-phycocyanin (CP) have been shown to possess anti-viral properties. Earlier *in-vitro* studies revealed that calcium spirulan was effective in treating Human Herpes Simplex Virus and Human AIDS Virus [9]. C-Phycocyanin (CP) is a light-harvesting, pigment-binding protein isolated from algae. Earlier studies demonstrated that CP displays typical apoptotic characteristics, such as nuclear condensation, DNA fragmentation, membrane blebbing, and cell shrinkage. The applications of CP in human tumor cells were found to arrest cell cycle at the G0/G1 phase which blocks the synthesis of DNA, indicating inhibition of tumor cell proliferation [24].

As C-phycocyanin of *Spirulina platensis* has been proved to possess several health benefits, the current study is aimed towards an understanding if C-Phycocyanin, which is an important component of the blue-green algae, can have any antiviral properties against the currently existing SARS-CoV-2 virus through an *in-silico* approach.

MATERIALS AND METHODS:

Protein Structure, Co-factors, and Substrates: X-ray crystal structure of complex nsp12, nsp8, and nsp7 (pdb id: 7btf) [11] were obtained from the Protein Data Bank (PDB) [12]. The substrate used for the docking study is C-phycocyanin, and the 3D structure of C-phycocyanin was generated using ChemSketch tool [13] in mol format. Chimera tool was used to identify the docking of the active site region of nsp12 and the substrate C-Phycocyanin by superimposing [14].

Docking: In order to understand the enzyme-substrate interaction, the substrate was docked into the active site of the protein (with co-factors nsp8-nsp7). Docking was performed by AutoDock 4.0 program[15] using the empirical free energy function and the Lamarckian Genetic algorithm [16]. For the ligand, Gasteiger partial charges were used, and the non-polar hydrogen molecules are conjoined. The grid map was calculated using AutoGrid, and the grid box dimension was set to 92*94*94 with a spacing of 0.192. After docking, the best conformation of the substrate interaction was analyzed for the interactive residues of substrates by Discovery Studio.

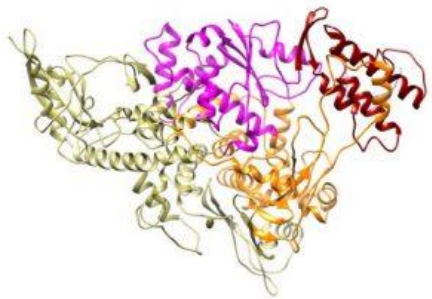


FIG. 1: STRUCTURE OF SARS-Cov-2 nsp12. THE nsp-12 STRUCTURE CONSISTS N-TERMINAL OF NIDOVIRUS WHICH IS HIGHLIGHTED IN TAN, FINGERS DOMAIN IN ORANGE, PALM DOMAIN IN MAGENTA AND A THUMB DOMAIN IN DARK RED

RESULTS:

Structure of SARS-CoV-2 nsp12 RNA-Dependent RNA Polymerase: The SARS-CoV-2 nsp12, which is an RNA-dependent RNA polymerase almost resembles a cupped right hand with fingers, palm and thumb subdomains as shown by earlier studies [17]. The nsp-12 structure consists N-terminal of nidovirus, which is highlighted in tan, fingers domain in orange, palm domain in magenta and a thumb domain in dark red **Fig. 1**. The polymerase region is comprised of a finger's domain (residues 398–581, 628–687), a palm domain (residues 582–627, 688–815), and a thumb domain (residues 816–919). SARS-CoV-2 nsp12 also contains a nidovirus-unique N-terminal extension (residues 1–397). The finger domains are found to possess index, middle, ring, and pinky loops. The thumb domain is found in the active site to which the finger loops reach to make contact in positive-stranded RNA virus polymerases. In SARS-CoV nsp12, the contacts between the index finger and the thumb domain are particularly extensive with the positioning of an alpha-helix in the index finger loop to pack with the thumb helical bundle. The index finger-thumb interaction site also forms the nsp7-nsp8 heterodimer-binding site, with most of the contacts made between nsp12 and nsp7. The nsp12 RdRp is found to possess minimal activity on its own but the addition of nsp7 and nsp8, which behave as the main co-factors, stimulates the highest polymerase activity [17].

Structure of SARS-CoV-2 nsp8 and nsp7 Cofactors: The nsp8 and nsp7 complex is depicted in **Fig. 2**. While the nsp8 C-terminal head region folds around the helical domains of nsp7, the N-terminal region of nsp8, which spans amino acid residues from 1–81 seems to possess a more extended or disordered conformation.

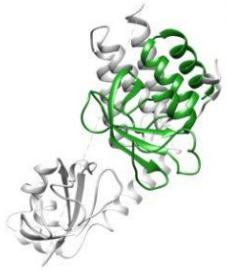


FIG. 2: STRUCTURES OF nsp8 AND nsp7 ARE DEPICTED IN GREY AND GREEN RESPECTIVELY

Interactions of nsp12 with nsp7 and nsp8: A large number of protein-protein interactions govern the SARS-CoV-2 RNA synthesis complex. Both nsp7 and nsp8 have essential roles in the formation and activity of the RNA synthesis machinery. Further, a strong interaction between nsp8 and nsp12 with the other viral nsps suggests that these two proteins form a hub for protein-protein interactions within the viral replication complex. The nsp12 outer region is a largely negative electrostatic potential, and the nsp7 and nsp8 surfaces contacting nsp12 are also relatively neutral. The second subunit of nsp8 contains some basic residues in the N-terminal region visible in the structure (residues 77–98), contributing to an extension of the positive electrostatics of the template-binding channel. More conserved nsp12 residues contact the nsp8 N-terminal region (residues 77–126), while contacts with the nsp8 C- terminal head domain are mediated primarily by main-chain atoms, which may have less stringent requirements in their amino acid composition to retain binding. The nsp12-nsp8-nsp-7 complex structure is depicted in **Fig. 3**.

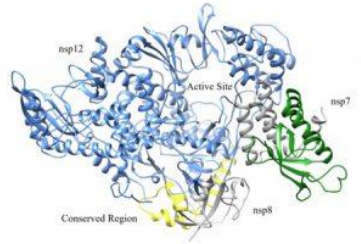


FIG. 3: STRUCTURE OF COMPLEX OF nsp12-nsp8-nsp7 OF SARS-CoV-2. Nsp7 IS SHOWN IN GREEN, nsp8 IN GREY AND nsp12 IN BLUE. THE nsp8 INTERACTS WITH THE CONSERVED nsp-12 RESIDUES (HIGHLIGHTED IN YELLOW), SPANNING AMINO ACID RESIDUES 77-126. THE ACTIVE SITE OF nsp12 IS MARKED TO WHICH THE NATURAL SUBSTRATE ATP BINDS UNDER NORMAL CONDITIONS OF THE VIRAL REPLICATION

The nsp7-nsp8 heterodimer binds to nsp12 on the thumb domain of the polymerase through which ATP enters the channel to reach the active site in the nsp12. The nsp12 index finger loop has been previously identified

as necessary for recruitment of nsp12 to replication complexes [17]. The binding of the nsp7-nsp8 heterodimer to this loop suggests that nsp7-nsp8 facilitates the interaction of nsp12 with additional components of the RNA synthesis machinery for incorporation into viral replication complexes.

Structure of C-Phycocyanin of *Spirulina Platensis*: *Spirulina* is a superfood, and C-Phycocyanin is a key ingredient, and it is believed to protect the liver and kidneys during detoxi-fication [18]. Several properties like antioxidation, detoxification, and importantly, inhibition of viral replication are some of the vital functions attributed to C-Phycocyanin present in Spirulina [19, 20]. It consists of four cyclopentane rings with two double-bonded oxygen and two carboxyl groups attached to it **Fig. 4**. 3D structure of C-phycocyanin in relation to its chemical structure [25] was obtained with chem sketch software.

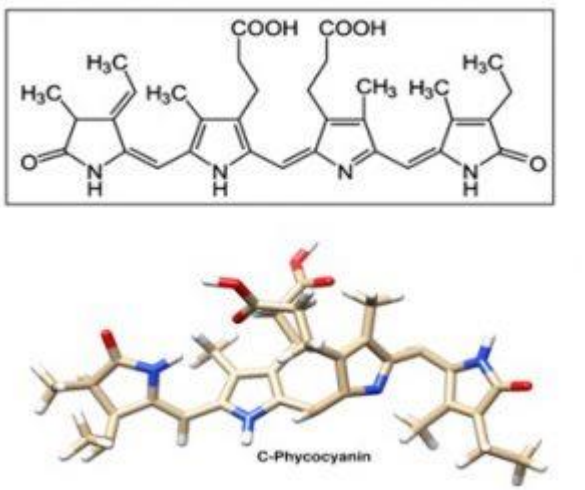


FIG. 4: STRUCTURE OF C-PHYCOCYANIN. THE CHEMICAL STRUCTURE WAS OBTAINED FROM AVAILABLE LITERATURE [25], AND THE 3D STRUCTURE OF C-PHYCOCYANIN OF *SPIRULINA PLATENSIS* WAS PREPARED USING CHEMSKETCH SOFTWARE

Interaction Study of C-Phycocyanin with the nsp Complex of SARS-CoV-2: The natural substrate for the nsp12 RdRp is the adenosine triphosphate (ATP) and the residues that interact with ATP are highly conserved throughout the coronavirus family [21]. ATP-bound crystal structures for SARS-CoV-2 nsp12 are not available in the PDB data bank. To guesstimate the binding mode of ATP in SARS-CoV-2 nsp12, the structure of SARS-CoV-2 nsp12 was superimposed with a poliovirus RdRp structure (PDBID: 2ILY) by using chimera tool **Fig. 5**.

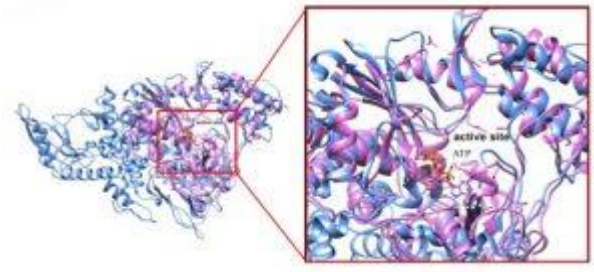


FIG. 5: THE SUPERIMPOSITION OF SARS-CoV-2 nsp12 WITH POLIOVIRUS RdRp FOR IDENTIFYING THE ACTIVE SITE REGION. THE POLIO RdRp SEEMED TO CLEARLY SUPERIMPOSE SARS-CoV-2. THE ENLARGED IMAGE SHOWS ATP, THE NATURAL SUBSTRATE BINDING TO THE ACTIVE SITE

After superimposition, the receptor residues such as Asp 760, Asp 761, Asp 618 Arg 553, and Arg 555 are identified as the active site residues, and then the substrate was docked. The following steps were generally applied: The nsp12-nsp8-nsp7 complex for docking studies was prepared by adding hydrogen atoms and gastiger charges to the system with their standard geometry. The mol2 file of the substrate C-Phycocyanin was loaded, and then grid box was set around the natural substrate active site region. Docking was performed for 1000 dock conformations of the substrate. The obtained poses were studied, and the poses that showed the best binding energy were selected and stored for substrate–protein interactions **Fig. 6**. Interestingly, it was observed that C-Phycocyanin interacts perfectly with the active site of the nsp12 RdRp similar to that of the natural substrate, ATP. Out of 1000 poses, 840 docked poses showed the lowest binding energy of -8.63 kcal/mol, and the average binding energy of all 1000 was -4 kcal/mol.

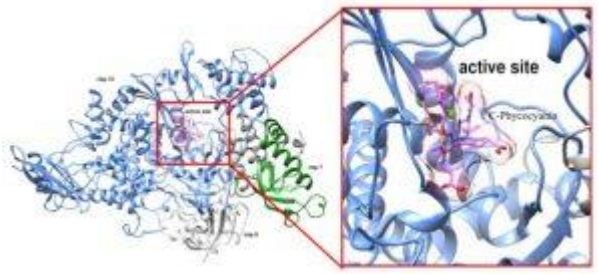


FIG. 6: THE NSP12-NSP8-NSP-7 COMPLEX (PDB ID: 7BTF) STRUCTURE WHERE GREEN INDICATES COFACTOR NSP7, LIGHT GREY INDICATES COFACTOR NSP8 AND BLUE INDICATES NSP12. THE ENLARGED IMAGE SHOWS THAT C-PHYCOCYANIN BINDS IN THE ACTIVE SITE OF THE NSP12, WHERE ATP MOLECULES NORMALLY BIND WHICH IN TURN ACTIVATES THE REPLICATION MECHANISM OF SARS-COV-2

TABLE 1: BINDING ENERGIES OF DIFFERENT DOCKING POSES OF C-PHYCOCYANIN TO SARS-CoV-2 nsp12

S. no.	Docked Pose	Binding Energy (kcal/mol)
1	840	-8.63
2	974	-8.57
3	347	-8.44
4	890	-8.32
5	869	-8.13
6	732	-7.9
7	60	-7.8
8	49	-7.79
9	211	-7.76
10	172	-7.48

A lowest binding energy for C-Phycocyanin indicates that the docked substrate might favour its interaction with the active site region and nearby residues. The top 10 lowest binding energies between the active site of nsp12 and C-Phycocyanin are represented in **Table 1**. Typically, the goal of docking here is to identify if C-Phycocyanin substrate can easily bind to the receptor nsp12-nsp8-nsp7 is energetically most favorable binding pose. The negative values of the docking energies for the substrate suggest that the latter (C-phycocyanin in this case) binds spontaneously without consuming energy. Based on the negative binding energy, we can predict that C-Phycocyanin is a potential molecule that can inhibit the replication mechanism by blocking the binding of ATP molecule, which is a natural substrate to nsp12, which is the key step in SARS-CoV-2 replication mechanism within the host.

From previous studies on poliovirus [22], it is found that the positively charged residues such as Lys159, Arg174, Arg163, Lys167, Lys172 and Lys359 interact with the triphosphate part of ATP and the diverse residues such as Lys61, Ile176, Glu177, Asp238 and Ser288, interact with nucleoside part of ATP. The negatively charged residue Asp323 interacts with the Mg^{2+} ion (here residues numbers are with respect to PDBID: 2ILY). The current in-silico observation is in line with earlier studies.

Based on binding energy, 840 conformations of C-Phycocyanin were considered to analyze if key residues of nsp12 does interact with the substrate, using the Discovery Studio tool. As expected, positively charged residues Lys 551, Arg 555, Arg 553, and Lys 798 interact with C-Phycocyanin, and the negatively charged residues Asp 760 interacts with the Mg2+ ion **Fig. 7**. The Lys 551, Asn 691, Ser 759, Cys 799, Trp 617, Glu 811, Tyr 619, Pro 620 are residues which interact with the substrate through Van der Waals forces. Arg 555, Arg 553, Asp 618 and Asp 760 makes a conventional bond with C-Phycocyanin and Leu 758, Trp 800 and

Lys 798 link through an Alkyl interaction (pi-alkyl interactions there is the interaction of pi-electron cloud over an aromatic group and electron group of any alkyl group) with the substrates. These are probable active site residues required for the replication to occur. As C-Phycocyanin interacts with these amino acids, it is highly expected to inhibit the replication mechanism of viruses.

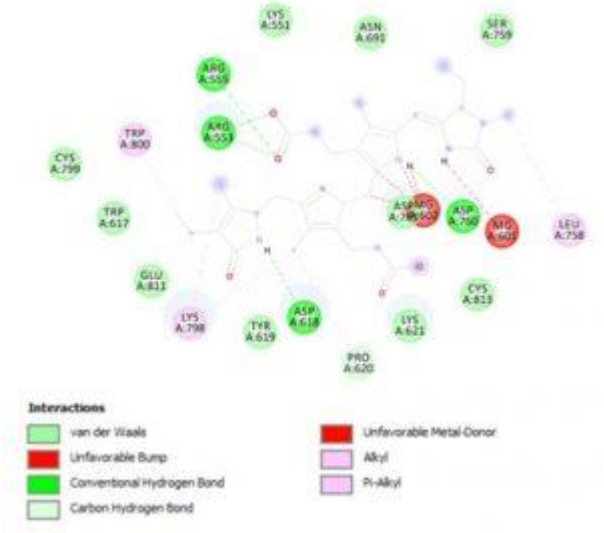


FIG. 7: 2D REPRESENTATION OF THE CHEMICAL INTERACTIONS OF C-PHYCOCYANIN WITH RECEPTOR nsp12-nsp8-nsp7

The image represents the interaction of C-Phycocyanin with aminoacid residues of the active site of SARS-CoV-2 nsp12. The interactions are of different types like van der Waals, Conventional Hydrogen Bonds, Carbon Hydrogen Bonds, Alkyl and Pi-Alkyl Bonds.

DISCUSSION: The emergence of SARS-CoV-2 resulted in a pandemic situation throughout the world, and there were no specific drugs or vaccines currently available for the treatment of the pandemic. However, broad-spectrum antiviral compounds that demonstrated activity against the earlier SARS-CoV or MERS-CoV are now being considered for the treatment of infection caused by the novel coronavirus SARS-CoV-2. For instance, the drug Remdesivir (RDV) which was used during SARS-CoV and MERS outbreaks are now being used for patients. RDV was demonstrated to compete with the ATP binding site of the nsp12 rdrp [5]. *In-vitro* studies suggest that once the ATP analogue binds to the active site of nsp12, RNA synthesis of the virus is arrested.

Therefore, targeting the active site of nsp12 might be one of the ways to curb the infection of SARS-CoV-2.

Search for Natural Ways of Treatment – Blue-Green Algae as Key Sources: Several studies are being conducted in search of treatment of SARS-CoV-2, which includes naturally existing organisms or compounds with antiviral properties. Several studies have been conducted on the use of blue-green algae against viral diseases such as HIV-1, HSV-2, RSV, *etc*. [23] 694 Cyanophyta (Blue green algae) members were screened for antiviral activity against HIV-1 and 529 taxa against HSV-2 and RSV. These studies showed high potentials of Cyanophyta members as antiviral agents. These studies revealed the immense potentiality of blue-green algae against viruses. The most commonly consumed and cultivated alga is *Spirulina* (also known as *Arthrospira platensis*), which also shows high antiviral activities and is one such organism that is quite well known to provide immuno-modulatory functions [23].

More advantages like anti-diabetes, anti-cholesterol, anti-oxidation *etc*, have been attributed to this blue-green algae for long, in addition to its high nutritive values. Being aware of its properties, CSIR-CFTRI (Council of Scientific & Industrial Research Centre for Food Technological Research Institute), Mysore, under the Government of India had recently announced the use of Spirulina supplemented food items to keep the immune system active to at least prevent the infection of SARS-CoV-2.

C-Phycocyanin Targets the nsp12 Active Site of SARS-CoV-2: *Spirulina platensis* is a superfood with many minerals and proteins in it and because it also contains anti-viral ingredients, it prompted us to look for compounds which might inhibit the replication of SARS-CoV-2. C-Phycocyanin and calcium spirulan present in *Spirulina platensis* are key compounds that are known to possess these anti-viral properties. We selected C-Phycocyanin for the current study. The basic interaction study between viral nsp12 and C-Phycocyanin hints

that the compound clearly competes with the ATP that binds to the active site of nsp12. C-Phycocyanin binds to the active site of the SARS-CoV-2 as shown in our *in-silico* study and might inhibit the viral RNA dependent RNA polymerase (RdRp) protein, thereby high jacking the replication mechanism of the virus, which, otherwise multiplies, synthesizes multiple viral proteins within the host cells and ultimately increases the toxicity in the infected people. However, the binding of C-Phycocyanin to the active site of nsp12 in spite of not being an analog of ATP deserves further immediate research.

C-Phycocyanin has antiviral properties, and it doesn't only inhibit the viral replication but also detoxifies the body by protecting the liver and kidneys by activating the immune systems. The initial study on the interaction of substrate, C-Phycocyanin in this case, with viral proteins seems promising. However, further advances in silico analysis, including dynamics and quantum studies along with *in-vitro* experiments, are inevitable to validate the effects of C-Phycocyanin against SARS-CoV-2. Though the current scenario, as predicted by recent studies, shows that strict preventive measures such as lockdown and social distancing might have proved to be effective [26], the post-lockdown era might be highly susceptible to the spread of the pandemic. The above finding might definitely lead to a breakthrough in identifying environmentally safe compounds against the deadly pandemic and C-Phycocyanin, being one such compound that exists naturally in Spirulina platensis can be one of the immediate reliefs from the infection, provided sufficient proven *in-vitro* data can be generated at the earliest.

CONCLUSION: SARS-CoVID-19 belongs to one of the large family of viruses (coronaviridae), which induces disorders including diarrhea, fever, cough, sneezing, difficulty in breathing, upper and lower respiratory tract infections and death if untreated. With the world looking for immediate relief either through drugs or vaccines, we took into account the blue-green algae, *Spirulina platensis* which is well known to possess anti-viral properties, in addition to its strong nutritional values. Specifically, we targeted one of the important ingredients, C-Phycocyanin, for its anti-viral property, particularly against SARS-CoV-2 through *in-silico* approaches. The first results clearly depict that C-Phycocyanin interacts with the nsp12 RdRp of SARS-CoV-2, which is the target for several drugs. To the best of our knowledge, this is the first report of C-Phycocyanin specifically targeting the active site of the main protein responsible for viral replication.

The report demands immediate dynamics and quantum studies along with *in-vitro* experiments. In the meanwhile, consuming Spirulina supplemented food ingredients might be one of the strategies to combat the deadly pandemic.

Author Contribution: T. Kiran Raj and T. S. Gopenath conceptualized the study. T. Kiran Raj conducted the experiments. T. S. Gopenath drafted the Manuscript. R. Ranjithkumar and B.M. Kanthesh helped with the Manuscript and Discussion.

ACKNOWLEDGEMENT: The authors would like to acknowledge the Management of JSS Academy of Higher Education & Research, Mysuru, Karnataka, for supporting the basic research ideas and also for the resources provided.

CONFLICTS OF INTEREST: The authors declare that there are no conflicts of interest.

Formulation and Evaluation of Polysaccharide Based Biopolymer – an Ecofriendly Alternative for Synthetic Polymer.

Nilani.P*, Raveesha.P, B. Rahul Nandkumar Kasthuribai.N, Duraisamy.B, Dhamodaran.P,& Elango.K Department of Pharmacognosy, JSS College of Pharmacy, Rocklands, Ootacamund, Tamilnadu. Email: p.nilani@jsscpooty.org Abstract: The Main objective of the present study was to develop polysaccharide based biopolymer films with similar properties comparable to synthetic polymer films using waste materials of plant origin ,especially by the utilization of starch and pectin from plant source namely Mangifera indica (Mango kernel starch) and Cyphomandra betacea (Tree tomato pectin) . To overcome the problems due to usage of plastics, to conserve non-renewable resources like petroleum, natural gas and coal, to maintain ecological balance and to reduce pollution it is the need of the hour to develop ecofriendly biodegradable plastics that are made from renewable resources. An effort had been taken to develop a polysaccharide based polymer film and to study the filmogenicity and biodegradability of mango kernel starch-polyvinyl alcohol cross linked film. Mango kernel starch was isolated and evaluated for the physiochemical property

and biodegradability of the prepared polysaccharide based film. The isolated starch showed a good physicochemical property and film forming property with polyvinyl alcohol and pectin. The developed polysaccharide based polymer film can be used as a substitute for synthetic polymer in pharmaceutical industry. Keywords: Polysaccharide based polymer, Mango kernel starch, Tree tomato pectin, Biodegradation

7.8 Algal Diversity in a Group of Fifteen Small Lakes of T. Narasipur Taluk, Mysore District, Karnataka State

Authors: **Umamaheshwari S**

Abstract and Figures

Phytoplankton distribution was investigated in 15 small lakes of T. Narasipur taluk in Mysore district of Karnataka. The data were subjected to PAST software program. Bray-Curtis Similarity Index was also calculated. Nine diversity indices were obtained that include Dominance index, Shannon and Weiner index, Simpson's index, Pielou's Evenness index, Menhinick and Margalef's index, Equitability index, Fisher a index and Berger-Parker dominance index. Sixty two species of algae were recorded of which Chlorococcales and Euglenophyceae members dominated. Species richness was observed in Harave Katte and Baw Kere, and species dominance in Holan Kere and Halgudu Kere. Diversity and Similarity indices are important in understanding the distribution and association of planktonic algae in freshwater lakes.

7.9 OPTIMIZATION OF CULTURE MEDIUM AND AN ANTIOXIDANT ASSAY OF BIOMASS OBTAINED FROM ALGAL SPECIES– Haematococcus lacustris

M. AKASSH Department of Pharmacognosy, JSS College of Pharmacy, JSS Academy of Higher Education & Research, Mysuru, India.
VIVEK GAHANAN Department of Pharmacognosy, JSS College of Pharmacy, JSS Academy of Higher Education & Research, Mysuru, India.
HAMSALAKSHMI . Department of Pharmacognosy, JSS College of Pharmacy, JSS Academy of Higher Education & Research, Mysuru, India.
SURESH JOGHEE Department of Pharmacognosy, JSS College of Pharmacy, JSS Academy of Higher Education & Research, Mysuru, India.
V. SIVASUBRAMANIAN Phycospectrum Environmental Research Centre (PERC), Chennai, India.

Abstract

In the present study, the various effects like aeration rates, vitamins, and nitrogen sources are examined with the growth of *Haematococcus lacustris* (*H. lacustris)* in a condition where the cells are subjected to 24 hrs lighting with continuous aeration. There are various physical and chemical parameters which control the growth rate of *H. lacustris.* The aim of this study was to investigate and compare the effect of culture media and light intensities on the growth of *H. lacustris* in batch culture. There are two main stages of growth involved, mainly the green stage and red stage. In the green stage the cells are divided and forms the maximum cell concentration of $404x10^4$ ml^{-1}, which corresponds to the growth rate of $33x\ 10^4$ with a light intensity of 2500 -5000 lux. the culture solution was subjected to 24x7 lighting along with the aeration.

With the studies done on the antioxidant activity by DPPH method for the biomass of *Haematococcus lacustris*, linear scavenging activity of up to 29% was observed. Hence this species shows significant antioxidant activity when compared to anti-oxidant obtained from other natural and synthetic sources. An extensive study can be done on animals to prove the activity against various free radicle causing diseases with valid data.

https://www.jssuni.edu.in/JSSWeb/UDHP.aspx?PID=346

8. Research Collaborations and their Outcomes related to SDG 13

8.1 Collaboration

Name of the Collaborator	Outcomes (if any)
National Institute of Biologicals, Govt of India, New Delhi	professional in-depth specific training of the students (06) on Standardizations of biologicals and biosimilars
National Institute of Ocean Technology,Chennai	**Project work of student on marine biotechnology**
Pasteur Institute of India, Coonoor	Research Collaboration
Society of Biotechnologists, Inda	Join Symposium and Research Collaboration

8.2 Ongoing research project related to SDG 13

https://jssuni.edu.in/jssaher/research/research-centers-of-excellence-details-1.html

Center of Excellence in Molecular Biology and Regenerative Medicine (CEMR)

- Impact of ambient air pollution on lung growth immunity and macrophage plasticity
  Extramural Ongoing Projects

Principal Investigator: Dr. Rajesh Kumar Thimmulappa

Title: Impact of ambient air pollution on lung growth immunity and macrophage plasticity

Funding Agencies: DBT-Ramalingaswamy Fellowship **Grants:** 88.00 Lakhs

Contributing departments: Biochemistry, JSSMC,JSSAHER

- Role of marine organisms/Phyto principles for the treatment of breast/colorectal carcinoma

Principal Investigator: Ms. Asha Jose
Duration: 5 Year
Institute: JSS College of Pharmacy
Department: Department of Pharmacology

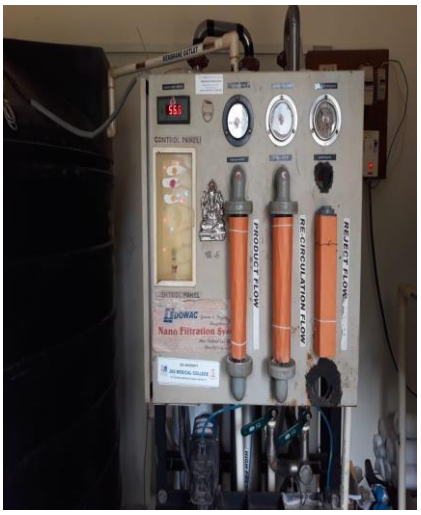
CONSERVATION AND FRESH-WATER ECOSYSTEMS

The Rainwater harvesting

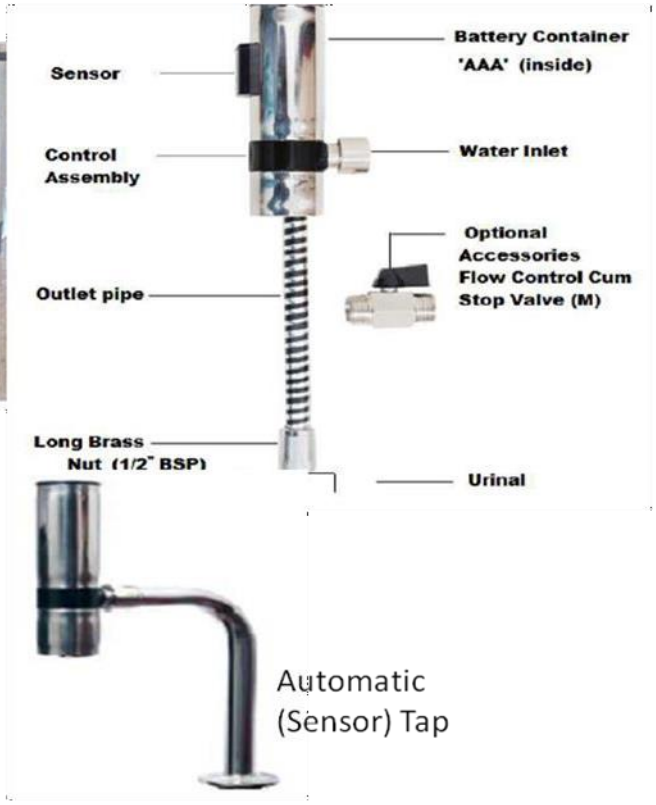
JSSAHER is having rainwater harvesting tank and connectivity of about 30,000 litres storage. 10 no's of ground water and bore well recharge pits / points and 02 no. of infiltration tank of 15,000 litres capacity. One tank of 10,000 litres capacity is made for re-use of RO rejected water for gardening purpose. Water sprinklers are in place.

RO Waste Management

Sl. No.	Name of the Institutions	Capacity
1	JSS Medical Institutions Campus, Mysuru	3,000 Lph
2	JSS College of Pharmacy Campus, Mysuru	1,000 Lph
3	JSS College of Pharmacy Campus, Ooty	2,000 Lph



Touch free water taps



Touch-free usage to eliminate cross-contamination
Easy to install and maintain.(external wall mounting)
International advanced electronic technology with high sensitivity and stability.
Water saving programme.
Ideal for replacements and retrofitting of most makes.

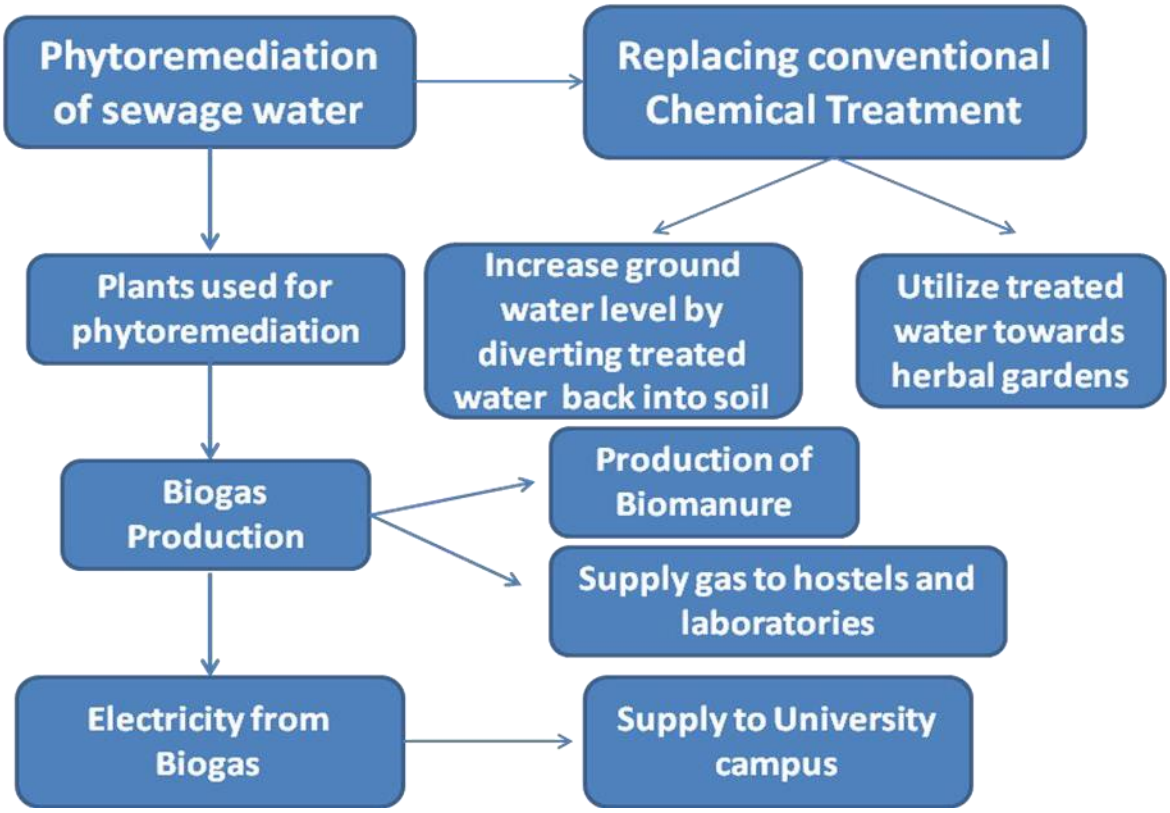
Automatic
(Sensor) Tap

Phytoremediation of Sewage Water

One of the sustainable wastewater management is through phytoremediation

Phytoremediation is defined as treatment of sewage water by employing plants to recycle water for further usage. Although phytoremediation water

is not fit for drinking, it can be used to increase ground water level or as a source of water for gardens and herbals in campus. While the treated water can be reused, the plants used for treatment can be used as raw materials for biogas production and bio manure production. Further, electricity is produced from the biogas produced. The project is for master's degree internship or a major project for B.Sc., students.



Awareness rally at Srirangapatna about Environment.

Awareness rally at Srirangapatna about Environment. Date

Cleaning Kaveri at Srirangapatna during Save Kaveri Programme

Awareness rally during Save Kaveri Campai gn at Srirangapatna

Awareness rally during Save Kaveri Campaign at Srirangapatna

DEPARTMENT OF WATER AND HEALTH
(Faculty of Life Sciences)
and
DEPARTMENT OF HEALTH SYSTEM MANAGEMENT STUDIES
JSS Academy of Higher Education & Research
(Deemed to be University) Accredited "A+" Grade by NAAC

NSS Special Annual Camp at Majjigepura	
Rally on Water usage and Environmental management- Dr. Raghu Ram Achar **Cleaning activities near the convention hall and temple premises of Majjigepura**	**"Water Resources" Special lecture by Dr. Shivaraju HP, Assistant Professor, FLS, JSS AHER**

Rally on Water usage and Environmental management.

Special lecture by Dr. Shivaraju HP, Assistant Professor, FLS, JSS AHER on water resource management

DEPARTMENT OF WATER AND HEALTH
(Faculty of Life Sciences)
and
DEPARTMENT OF HEALTH SYSTEM MANAGEMENT STUDIES
JSS Academy of Higher Education & Research
(Deemed to be University) Accredited "A+" Grade by NAAC

Free Medical Camp with Nutritional Assessment

Involvement of Villagers for the flag hoisting sessions.

Flag hoisting sessions

Waste Collections Drive

Plantation Drive

Shibira Jyoti Preparations

Volunteers taking oath for Swach Bharath and National Integrity

Shibira Jyoti Event

Valedictory Function

DEPARTMENT OF WATER AND HEALTH
(Faculty of Life Sciences)
and
DEPARTMENT OF HEALTH SYSTEM MANAGEMENT STUDIES
JSS Academy of Higher Education & Research
(Deemed to be University) Accredited "A+" Grade by NAAC

JSS ACADEMY OF HIGHER EDUCATION & RESEARCH
(DEEMED TO BE UNIVERSITY) MYSURU

Group Photo with the best volunteers of the camp.

Group Picture of the Volunteers at Majjigepura

NSS Programme Officer
NSS Programme Officer
Department of Water and Health
Faculty of Life Sciences
Jagadguru Sri Shivarathreeshwara University
MYSURU-570 015

HEAD
HEAD
Dept. of Water & Health-Faculty of Life Sciences
JSS Academy of Higher Education & Research
Sri Shivarathreeshwara Nagar, Mysuru-570 015