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Decolourisation of textile-dye-containing effluents using biofilm:A case study

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Abstract

Bioremediation based on microbial technologies has been extensively used for treating coloured textile wastewater. In this research, the potential application of the indigenous and exogenous bacterial cultures, found as biofilm were investigated for colour removal. Initial study in the treatment of the textile wastewater showed that the mechanism involved in decolourisation was degradation, which was carried out *via* molecular technique involving amplification of the DNA sequence responsible for decolourisation using pure dye; Orange II. In laboratory scale experiment, the bacteria were grown as mixed culture in suspension and biofilm using shake flasks technique. Their abilities to decolourise textile wastewater were studied under semianaerobic conditions. Generally, bacteria in the form of biofilms were found to remove colour at faster rates compared to that of suspended cells. Evidence of biofilm formation during decolourisation of textile wastewater was also examined using SEM.

Introduction

The textile industry uses more than 100 billion gallons of water each year in its preparation and dyeing processes. In Malaysia, textile wastewater accounts for 22% of the total volume of industrial wastewater (Rakmi, 1993). The textile wastewater has strong colour in the form of persistent organics and also variety of the other pollutants including chloride, ammonia, organic nitrogen, nitrate, phosphate and heavy metals such as Fe, Zn, Cu, Cr and Pb (McMullan *et al.,* 2001). Synthetic dyes have been used increasingly in textile and dyeing industries because of its cost effectiveness in synthesis,firmness, and variations in colour compared with natural dyes (Griffiths, 1984). Synthetic dyes also can be classified by their chromophores such as azo, antraquinone and indigo chromophores. Azo dyes used in the textile industry are constituted the largest group of over 10,000 commercial dyestuffs which account for the majority of the synthetic dyes (Villegas-Navarro *et al.*, 2001). Many studies indicated that most of the azo dyes were affected human health as they are highly toxic (McMullan *et al.,* 2001). Since azo dyes are relatively resistant to biological and chemical degradation, therefore, it makes colour removal in particular, a major interest of scientific research (Banat *et al.*, 1996). The presence of very small amount of dyes in water (less than 1 ppm for some dyes) is highly visible and affects the aesthetic merit, water transparency and gas solubility in lakes, rivers and water bodies. The removal of colour from wastewaters is often more important than the removal of the soluble colourless organic substances, which usually contribute the major fraction of the Biochemical Oxygen Demand (BOD). Methods for the removal of BOD from most effluents are fairly well

established. However, dyes are more difficult to treat because of their synthetic origin and mainly complex aromatic molecular structures. Such structures are often synthesized to resist fading on exposure to sweat, soap, water, light or oxidizing agents and this renders them more stable and less amenable to biodegradation (Seshadri *et al.*, 1994). Despite the existence of a variety of chemical and physical treatment processes, bioremediation of textile effluent is still seen as an attractive solution due to its reputation as a low-cost, environmentally friendly, and publicly acceptable treatment technology (Banat *et al.*, 1996). A number of biological processes such as biosorption have been proposed as having potential application in removal of dyes from textile wastewater (Bustard *et al*., 1998). Mechanisms involved in the colour removal of wastewater include adsorption, transformation or metabolisation of coloured textile effluent by bacterial cells. Microbial consortium in the form of biofilm has the ability to decolourise and metabolize dyes since the presence of intracellular mechanisms that will bring about the degradation or biosorption of dyestuffs (Watnick and Kolter, 2000). Biofilm usually composed of a mixed microbial population of cells growing on surfaces surrounded by exopolysaccharides (EPS). Consequently, in most natural environments, biofilm is the prevailing microbial lifestyle. The EPS secreted by various types of bacterial strains serve mainly to protect the bacteria against desiccation and predation, as well as to assist in adhesion to surfaces. The formation of EPS generally occurs in two forms: capsule, which is tightly bound to the surface of bacterium and slime, which is only loosely attached to the bacterium (Abrahamson *et al*., 1996). EPS are also considered as the most immediate interfacial boundary between the bulk aqueous phase and the bacterial cells. EPS generally consist of a wide variety of macromolecular compounds including acidic polysaccharides and proteins, as well as lipids (Fang *et al.,* 2002). This study aimed at investigating the potential application of biofilm consisting of selected indigenous and exogenous bacteria in the bioremediation of colour from textile wastewater.

Most recent advances

Studies carried out at the research laboratories have resulted in the isolation of various mixed bacterial cultures capable of growth on several kinds of azo (Amaranth), diazo (Remazol Red) and reactive dyes (Synazol Blue, Synazol Yellow), both under aerobic and anaerobic conditions (Mohd Zahari *et al.*, 2004, Husin *et al.*, 2003). Furthermore, they also were capable of growing in filter sterilized textile wastewater (fstw) supplemented with glycerol 0.5% (Mohd Zahari *et al.*, 2004). 26 different types of pure cultures were isolated from wastewater and biofilm formed in textile treatment ponds. Most of them were gram-negative bacteria, non-motile and produced exopolymeric substances (EPS). Referring to Figure 1, it was clearly shown that different concentration (mg/L) SF Red 3BS showed maximum absorption peak of 517.5 nm and 542.5 nm in fstw. The selection of SF Red 3BS was based on it being one of the commonest dye used in all steps of dye processing. However, the absorbance value of each concentration for this dye at both wavelengths is not shown. These isolates were further screened for colour removal using synthetic dye; SF Red 3BS (CDM + 100ppm dye) and filter sterilized textile wastewater (fstw) in separate experiments (Table 1).

According to Figure 1, filter sterilized textile wastewater (fstw) brought the maximum absorbance at 517.5 nm and 542.5 nm. It should be noted that, fstw as originated from real wastewater, collected from the textile treatment pond with initial colour concentration of 519.0 ADMI units. In particular, colour intensity of fstw was lesser than the real wastewater by 21.8%; that is 405.9 ADMI units. The wastewater was further filtered using 0.2 µm pores filter membrane

to remove indigenous microorganisms (culturable and unculturable microorganisms) by using of 0.2μm pores filter membrane. However, by doing so, some of the other wastewater parameters such as COD, TSS and colour intensity were generally decreased.

Table 1: Screening on colour removal by potential isolates in SF Red 3BS in a synthetic medium (CDM) and filter sterilized textile wastewater (fstw)

Types of Sample	CDM + 100 ppm dye after 3 days incubation		Fstw after 12 hours incubation	
	Residual Colour (ADMI Unit)	Colour removal (%)	Residual Colour (ADMI Unit)	Colour removal (%)
Control	9320	0	406	0
Bacillus cereus	5840	37	146	64
Aeromonas hydrophila	740	92	28	93
Aeromonas caviae	800	91	51	87
Enterobacter aerogenes	1100	88	27	93
Citrobacter freundii	800	92	84	79
Shigella flexneri	1000	89	112	72

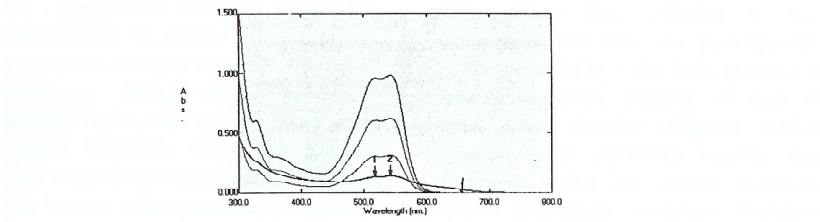


Figure 1: Spectrum of filter sterilized textile wastewater (fstw) and pure dye used for screening (____) Filter sterilized textile wastewater (IX); (.....) SF Red 3BS (100 mg/l); (__) SF Red 2BS (50 mg/l); (___) SF Red 3BS (25mg/l); at two maximum peaks: (1) 517.5 nm;(2) 542.5 nm.

Numerous bacteria capable of dye decolourisation have been reported. Referring to Table 1 above, it was shown that from the 26 bacteria isolated, six bacteria were capable of decolourisation over 50%; these were later identified as *Bacillus cereus*, *Aeromonas hydrophila, Aeromonas caviae, Enterobacter aerogenes, Citrobacter freundii* and *Shigella flexneri* using the 16S rRNA analysis. Effort to isolate bacterial cultures capable of degrading azo dyes started in 1970's with reports of a *Bacillus subtilis*, then *Aeromonas hydrophila* followed by the *Bacillus cereus* (Banat *et al*., 1996). Similar observation achieved by Husin *et al.* (2003) where *Aeromonas hyrophila* and *Bacillus cereus* in the form of biofilm had shown the same ability to treat coloured textile wastewater. Banat *et al.* (1996) had also reported that

isolation of such microorganisms proved to be a difficult task. Extended periods of adaptation in chemostat cultures are needed to maintain the performance of the isolates. As an example, a gram-positive bacteria; *Bacillus cereus*, showed a decrease of colour removal from 96% (Husin *et al.*, 2003) to only 64% after 12 h of incubation. Stock cultures were preserved at -80°C with addition of 12.5% glycerol into fstw. Even though they were isolated from enrichment cultures previously, they were maintained in fstw as sole carbon sources in semi-anaerobic conditions for over a year (Husin *et al.*, 2003). This might cause in disruption of intracellular function due to cell dwarfing in very limited nutrient condition (Yu *et al.*, 2001).

An investigation into the efficiency of growth and decolourisation for these cultures, exogenous and selected indigenous, concluded they were facultative, with an ability to grow under both aerobic and anaerobic conditions in fstw, but with highest growth rate and decolourisation under semi-anaerobic conditions in fstw; 37°C, with shaking (100 rpm), with initial pH of 7.4. Growth and decolourisation of two mixed culture were enhanced in fstw supplemented with 0.5% (v/v) sterile glycerol. Further test using the shake flasks technique in separate experiment, including two types of mixed culture; selected indigenous isolates (*Bacillus cereus, Aeromonas hyrophila and Aeromonas caviae*) and selected exogenous isolates (*Enterobacter aerogenes, Citrobacter freundii* and *Shigella flexneri*) were compared to see any differences in their efficiencies to decolourise filter sterilized textile wastewater(fstw).

Mechanism of decolourisation

Following screening study for dye decolourisers,6 of the isolates (ANB1, ANB2, ANB3, Cb01,Cb02 and Cb15) were selected to further determine their mechanism of decolourisation via molecular probing. This involved amplification of two genes (I*sfA* and *ssu*D) for enzyme synthesis of aromatic sulphonates degradation (Quadroni *et al.,* 1999). For this purpose, genomic DNA of the most potential bacteria, *Aeromonas caviae* was extracted using Promega Wizard Genomic DNA Purification Kit. The genomic DNA and suitable primers were used for the amplification of the desired gene. The sample of genomic DNA (1 µg) was mixed with 10 pmol of forward and reverse primers and 2x PCR Master Mix (25 µL). Four sets of different primers were used to amplify the genes of interest (Table 2). Polymerase Chain Reaction (PCR) was performed for 25 cycles 94°C for 1 min, 50°C for 1 min and 72°C for 2 min. PCR products were observed by agarose gel electrophoresis.

Bacterial decolourisation of azo dyes could either be due to azo reduction and/or desulphonation. The disappearance of colour is due to the reductive cleavage of azo bond(s), which is catalysed by enzymes such as flavin reductase and quinone reductase (Russ *et al.,* 2000). For decolourisation of sulphonated azo dyes, the release of the sulphonic group may be required to decolourise the azo dye since desulphonation results in the destabilization of the benzene ring structure (Kertersz and Wietek, 2001). Since decolourisation of azo dyes by the all six selected isolates above may involve desulphonation and / or azo reduction, primers of genes for desulphonation (Table 2) were used to amplify the I*sfA* gene and *ssu*D gene. The amplification of the I*sfA* gene and *ssu*D gene yielded fragments of ~700 bp and ~1400 bp respectively from bacterium *Aeromonas caviae*. This might signify the possibility of desulphonation by this bacterium, which is related to decolourisation of the sulphonated azo dyes (result not shown).

Table 2: Different types of primer for amplifying genes involved in dye degradation

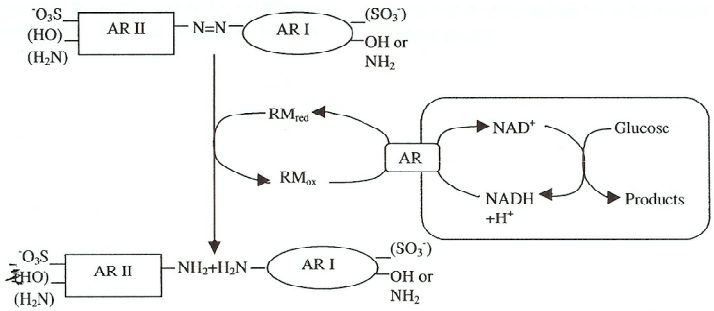
Primer	Tm(°C)	Expected size (bp)	References
lsfA gene			
LsfAfor 5'-CAA GCT CAA GGA CCA GTT CG	59.4	639	Quadroni *et al.* (1999)
LsfArev 5'-C AG CGA AGG CAC GAT TAC C	58.8		
ssuoperon			
Ssuprofor2 5'- AAG AGC TCC CCA AAG GTT ATC GCG	64.4	5300	Kahnert *etal.* (2000)
Ssuprorev1 5'-TCG TGC AAG CGC TCT TCC	58.2		
ssuF gene			
SsuFfor 5'-AGC CAT CAA CGT TCG TAA CC	57.3	216	Quadroni *et al.* (1999)
SsuFrev 5'-AGC TTG GCG ATG GAG ACC	58.2		
ssuDgene			
EE24for 5'-CAT CTG GAA GCT TAC TCA ACT G	58.4	1220	Kahnert *etal.* (2000)
EE27rev 5'- ATA ACC AAG CTT TCA CTG GCG	57.9		

Proposed mechanism on decolourisation

Several researchers from the University of Stuttgart, Germany had experimentally proven that azo dye reduction *in vivo* may involve the role of bacterial cytoplasmic and extracellular 'azoreductases'. Stolz *et al.* (2000) reported on gram-negative isolate *Sphingomonas sp.* BN6, which has recently, through molecular analysis, been shown to represent a novel species named *Sphingomonas xenophaga* after its ability to "eat foreign compound". It was demonstrated that an extracellular mechanism of dye reduction existed in addition to the nonspecific cytoplasmic enzymes which functioned as azoreductases by transferring electrons via reduced flavin groups to the dye molecule and thus bringing about a purely chemical reduction. Refering to Figure 2, Keck *et al.* (1997) demonstrated that certain quinone-based compound generated during metabolism of specific substrate acted as mediators shuttling redox equivalents to azo dye molecules from the bacterial membrane. Russ *et al.* (2000) had investigated if cytoplasmic enzymes played any role in dye decolourisation *in vivo*, a flavin reductase [NAD(P)H: flavin oxidoreductase] was cloned and overexpressed in both *E. coli* and *S. xenophaga*. In cell extracts, the strains with overexpressed flavin reductase demonstrated elevated azoreductase activity; however in whole cell studies these strains showed little improvement in their dye decolourising capabilities. Russ *et al*. (2000) also provided evidence that reports of aerobic azoreductases could be explained by the isolates in which such a phenomenon was described having elevated flavin reductase activities.

Figure 2: Proposed mechanism for the redox-mediator-dependent reduction of azo dyes by *Sphingomonas xenophaga*

BN6. (AR: Azoreductase, RM: Redox mediator). Reproduced from Keck *et al*. (1997).



Decolourisation with bacterial biofilms- Anaerobic-Aerobic biodegradation of dyes

Experiments on the use of selected bacteria for colour removal were conducted using shake flasks technique. Real wastewater (Non-fstw) and filter sterilized textile wastewater (fstw) with initial concentration 405.9 ADMI units and 519.0 ADMI Units respectively, were inoculated with either mixed culture of the exogenous or selected indigenous bacteria. For Set (A) experiment, the fstw consisted of *Bacillus cereus* : *Aeromonas caviae* : *Aeromonas hydrophila*, at the ratio of 1:1:1 (v/v). However, for Set (B) experiment, the bacteria involved were *Enterobacter aerogenes* : *Citrobacter freundii* : *Shigella flexneri* also at the ratio of 1:1:1 (v/v). Both sets of experiments were carried out under varying conditions to compare the effectiveness of suspended cells and biofilm in the treatment of textile wastewater. The percentage of decolourisation by 11 different systems after 12 h of incubation by both exogenous and indigenous biofilm is presented in Table 3.

After 12 hours of incubation under optimized condition (37°C, 100 rpm, pH 7.4, supplemented with 0.5% glycerol), both the exogenous (Set B; Systems 4 and 10) and indigenous biofilms (Set A; System 10) achieved almost complete decolourisation (~97%) compared to suspended cells (Systems 5 and 11) which below 80%. From the results obtained, it is important to note that decolourisation of the wastewater containing indigenous microbes (System 6), that containing culturable and unculturable microorganisms; showed only about 1.8% of decolourization compared to the wastewater containing selected bacteria (System 8 and 9) in suspension (29% for Set A; 19% for Set B) and in the form of biofilm (46% for Set A; 48% for Set B). This strongly indicated that the use of selected bacteria capable of colour removal played a significant role in enhancing decolourisation of the wastewater in the absence of added glycerol.

Table 3: Rate of decolourization (% h^{-1}) in shake flasks experiment

Number of system	System components	Rate of decolourisation per hour (0-12h)		Rate of decolourisation per hour (0-12h)	
		A	B	A	B
1	fstw	0.00		0.00	
2	fstw + biofilm	3.74	2.28	2.52	4.25
3	fstw + suspended cell	1.58	0.90	1.92	0.92
4	fstw + biofilm + glycerol	4.15	8.19	2.22	0.08
5	fstw + suspended cell + glycerol	4.52	5.09	1.01	2.75
6	non-fstw	0.15		0.01	
7	non-fstw + glycerol	1.46		0.58	
8	non-fstw + biofilm	3.87	4.04	2.59	4.42
9	non-fstw + suspended cell	2.40	1.62	3.75	1.84
10	non-fstw + biofilm + glycerol	8.12	8.08	0.23	0.22
11	non-fstw + suspendedcell + glycerol	6.56	5.98	0.33	0.35

Note:
Non-fstw : Wastewater contained indigenous bacteria (Initial concentration: 519.0 ADMI Unit)
fstw : filter sterilized textile wastewater (Initial concentration: 405.9 ADMI Unit)
A : Mixed indigenous culture *(Bacillus cereus : Aeromonas caviae : Aeromonas hydrophila)*
B : Mixed exogenous culture *(Enterobacter aerogenes : Citrobacter freundii : Shigella flexneri)*

During the decolourisation study, the rate of colour removal was monitored with time over a period of 24 h. In general, it was found that there were two distinct linear regions that corresponded to two different rates of decolourisation (data not shown, calculated rates shown in Table 3). During the first 12 h of incubation, the rate of decolourisation was higher of biofilm bacteria; System 10 (Set A & B) and System 4 (Set B) was higher (1.2-1.6 times) than those in suspension (System 11). This may be attributed to the presence of extracellular polymers (EPS), which provide diffusion barrier against high inhibitory concentrations of toxic substances, allowing better survival of the bacteria in the form of biofilm. In addition, structural feature of biofilm provide both aerobic and anaerobic zones which were both required for complete mineralisation of the dye. Besides that, biofilms also offer higher solids retention times necessary to prevent washout of adapted microorganism (Jiang and Bishop, 1994). Accordingly, control experiment showed the addition of a meager amount of glycerol (0.5%) contributed a medial effect on decolourisation; rate of decolourisation form System 7 (1.46% h-1) which incorporates the glycerol, was higher than System 6 (0.15% h-1).

As for the suspended cells in the presence of indigenous (System 11), the addition of glycerol showed increased rate of decolourisation to about 1.5-1.7 times more than that without glycerol (System 9) during the first 12h of incubation. Glycerol may be used as an alternative carbon source for growth and may also act as an electron donor for the colour reduction (Nigam *et al.,* 1996 b) during the first 12h of incubation.

Experiments using selected indigenous and exogenous microbes in fstw, showed a similar profile on decolourisation. Rates of colour removal by potential microbes in the formed of biofilm (System 2) were much higher (about 2.5- 4.6 times) compared to suspended cells (System 3) during the first 12 h of incubation. The rate of decolourisation remained unchanged after 12 h. The low efficiency of potential microbes in decolourisation may be related to the low population of cells present and low tolerance towards the toxic elements in the wastewater. Furthermore, dye chromophore act as the sole source of nutrient (carbon and energy source), bacterial growth is dependent on dye degradation, which in turn may contribute to a longer adaptation period and slower rate of decolourisation. The presence of bacteria in the form of biofilm is advantageous since the biofilm provides aerobic and anaerobic zones, which may facilitate complete mineralisation of dyes (Jiang and Bishop, 1994).

Fig. 3(a): Biofilm form by the potential indigenous; *Bacillus cereus, Aeromonas caviae* and *Aeromonas hydrophila* in fstw

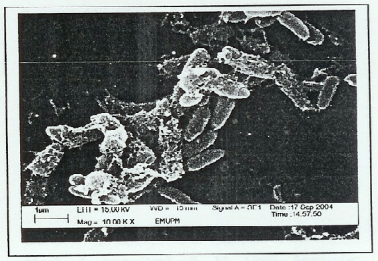


Fig. 3(b): Biofilm form by the potential exogenous; *Enterobacter aerogenes, Citrobacter freundii* and *Shigella flexneri* in fstw

From the work that has been carried out, the best system for dye removal of the textile wastewater is System 10, which indigenous microorganisms contained selected bacteria in real wastewater (or non-fstw) in the form of biofilm. Closer examination of the biofilm clusters using SEM revealed that most of the bacteria were attached to the support matrices by means of extracellular strands. The morphology of biofilm formed by the indigenous and exogenous during the treatment of textile wastewater is shown in Figure 3(a) and 3(b) respectively. At some stage of growth, weblike structure termed as "bioweb" comprising of EPS was found as part of biofilm (Paulsen *et al.*, 1997). This morphology was reported to facilitate quicker plugging of pore throats by trapping floating biofilm fragments and other detritus. Meanwhile, both figures also illustrated the population of cells growing on surface of support matrix enveloped in a matrix of exopolymers. Electron microscopy studies demonstrated that the biofilm is not found as simple layers of bacteria, but are enveloped in the exopolymers. In this manner, biofilm enhances the removal of toxic organic compounds such as those found in textile wastewater (Fang *et al*., 2002).

Bioremediation of textile-dye-containing effluent using biofilm had worked effectively either in the presence of great potential indigenous microbes such as *Bacillus cereus, Aeromonas caviae, Aeromonas hydrophila* or selected exogenous bacteria *Enterobacter aerogenes, Citrobacter freundii* and *Shigella flexneri* in the wastewater. From the work had been carried out, it was also suggested that a great potential of decolouriser bacteria in the form of biofilm system provide a complete decolourisation with only hours of exposure.Biofilm structure and spatial distribution influence all biofilm properties, including fixed cell activity. Biofilm structure and formation can be observed by electron microscopy techniques, enhanced in some cases by image analysis. Mechanism study on decolourisation may take advantage of biofilm processes in textile wastewater treatment system. Therefore, further studies are needed to develop simpler and more precise analytical methods for bacterial biomass correlated with enzyme activity estimation and a better knowledge of the composition and function of the biofilm.

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Air Quality Modeling : A Review

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Introduction

Environmental pathway analysis provides the link between qualification of source emissions and assessments of receptor exposure (eg. human exposure) through estimation of the ambient concentrations of contaminants in the various environmental media.

Two basic techniques can be employed to investigate environmental pathways: analytic sampling programs & mathematical fate modelling. Sampling programs are costly to design & implement, therefore, computerized mathematical models of environmental processes are frequently used to generate information unavailable by other means or to estimate data (i.e. environmental conc.) that would otherwise be costly to obtain.

Mathematical environmental fate modelling generally requires a knowledge of (1) the distribution of the releases of the material into the natural environment, (2) the environmental conditions influencing the fate (transport, transformation) of the chemical compounds, (3) the physical & chemical properties of the material, and (4) techniques (models) for analyzing the information gathered (Bonazountas *et al.* 1995).

Mathematical Models

Mathematical equations of air pollution models describe the process by which pollutants injected into the atmosphere are diluted. Dispersion models for atmospheric pollutants are useful decision support systems for air pollution management. They are an ideal complement to air quality control networks, allowing the study of the impact of pollution sources and in short, they enhance the understanding of the dynamics (emission, transport, transformation) of air pollution as a system (Calbo *et al.*, 1994).

A number of mathematical formulations are available to be used to describe the atmospheric diffusion process, but the one that enjoys the widest use is in the form of Gaussian Plume Model equation. Gaussian models are often preferred for operational use in Environmental Impact Assessment (EIA) studies because they are simple, require limited data and use minimal computation facilities. In the present paper, an attempt had been made to discuss different air quality models based on Gaussian dispersion equation.

1. **IITAQ model** (Mohan. M & Siddiqui, T.A., 2003) -

The IITAQ model is a numerical box model developed for an elevated source that incorporates improved parameterizations of physical processes in the atmospheric boundary layer & at the same time avoids the disadvantages of 3-D numerical models with detailed physics. The model uses more realistic & easily adaptable input parameters. The main input

parameters are wind & eddy diffusivity, profiles and dispersion coefficients that make extensive use of Monin-Obukhov similarity theory & other recent formulations for the estimation of turbulence parameters.

The mathematical differential equation representing the diffusion of air pollutants released from a source is given by the following diffusion-transport equation.

$$\frac{\partial C}{\partial t} + u\frac{\partial C}{\partial x} + v\frac{\partial C}{\partial y} + w\frac{\partial C}{\partial z} = \left[K_x \frac{\partial C}{\partial y}\right] + \left[K_y \frac{\partial C}{\partial y}\right] + \frac{\partial}{\partial z}\left[K_z \frac{\partial C}{\partial z}\right] + S + T$$

where, C is the concentration of any given pollutant, K_x, K_y and K_z are the eddy-diffusivities in x, y and z directions respectively. Similarly u, v and w are the wind components in x, y and z directions respectively. S and T represent source and sink terms respectively.

2. GRAM model (Fisher & Sokhi, 2000)-

GRAM model was designed for the assessment of air quality concentrations, particularly the short-term peak concentrations. Factors which are likely to lead to high road side concentrations are taken into consideration in the model.

The short term peak concentration in the center of an urban area was estimated by assuming worst-case meteorological conditions (category G), a low wind speed of 1 m/s & a low mixing depth of 100 m. The concentration at the centre of the urban , C_{urban} is derived from the integral:

$$C_{urban} = \sqrt{\frac{2}{\pi}}\frac{q}{u}\int_{10}^{d}\frac{dx}{\sigma_z(x)}$$

where, $\sigma_z(x)$ describes the vertical dispersion based on the R91 model assuming typical urban roughen, q is the emission density (kt/km^2/yr), u is the wind speed & d is the distance (km).

The contribution from vehicles on a road to the concentration in the vicinity C_{road} when wind direction is across the road, is given by-

$$C_{road} = \sqrt{\frac{2}{\pi}}\frac{Q}{u}\frac{1}{\sigma_z(x)}$$

where Q is the emission strength per unit length of road, u is the wind speed & $\sigma_z(x)$ is the vertical dispersion as a function of distance x from the road.

When wind blows along the road, the concentration in the vicinity is

$$C_{road}(y) = \frac{Q}{\pi u}\int_{0}^{l}\frac{dx}{\sigma_z(x)\sigma_y(x)}\exp -\frac{y^2}{2\sigma_y(x)^2}$$

where the integration is now along the road, l is the length of the road, the receptor is at distance y from the road centre line and $\sigma_y(x)$ is the lateral dispersion.

3. UGEM model (Murphy-Klimova *et al.*, 1998)-

The air pollution transport model UGEM (University of Greenwich Evaluation Model) has been developed to evaluate medium-range transport & deposition of sulphur & oxidised nitrogen from all types of sources of emissions in the UK. UGEM is a receptor-oriented, Lagrangian type model, which yields annual average concentrations & depositions of SO_2, particulate SO_4, NO_2, particulate NO_3 and nitric acid (HNO_3) across the UK.

The concentration C^l of pollutant l along air main trajectories weighted according to wind direction is

$$\frac{dC^l}{dt} = -\left(\frac{v_d{}^l}{h} + k_w^l P + k_c^{m,l} - k_c^{l,m} \right) \times C_o^l$$

Where, k_w^l is the wet scavenging ratio, v_d^l is dry deposition velocity(m/s), $k_c^{l,m}$ is chemical conversion rates from pollutant l to pollutant m (m/s), P is annual level of precipitation(mm/yr).

4. EMITEMA- EIM model (Costa *et al.*, 1996) -

The EMITEMA-EIM model is a atmospheric emission model, developed for the estimation of air pollutants –NO_X, CO, SO_2, particles, methane and several VOC_S (alkanes, alkenes, aromatics and aldehydes). The emission sources studied were road traffic, air traffic, industrial activities, gas stations, domestic heating & biogenic emission from forests. In case of road traffic, three kinds of emissions were considered-

(i) Hot emissions—Hot emissions are the emissions from vehicles after they have warmed up and their engines are thermally stabilized (water temperature over 70°C).

The hot emissions of pollutant i in a stretch of a road way 'r' of type 'p' (stretch, road or highway),

$$E_r^{ihot}(k,t) = \sum_{j=1}^{m} N_{jr}(k,t) L_r(k) F_{jp}^{ihot}$$

where, E_r^{ihot} is the hot emission, N_{jr} is the number of vehicles of j categories for r type of roadway, Lr is length per area and F_{jp}^{ihot} is the emission factor.

(ii) Cold start emission- Cold start emission take place while vehicles are warming up (Eggleston *et al*., 1989).

The cold start emissions of pollutant 'i' in a stretch 'r'of a street, E_r^{icold} is

$$E_r^{icold}(k,t) = N_r(k,t) \beta M F^{ihot} \left(\frac{F^{icold}}{F^{ihot}} - 1 \right)$$

where, $E_r^{i\,cold}$ is the cold start emission, N_r is the number of gasoline cars that drive along the stretch during the time span, b is the fraction of mileage driven with cold engines, M is the total annual mileage of gasoline cars, $F^{i\,hot}$ & $F^{i\,cold}$ are the hot & cold emission factors.

(iii) Evaporative emissions— Evaporative emissions account for the evaporation of gasoline both from the fuel tank and the carburettor. Evaporative emission E_r^{ievap} is estimated as-

$$E_r^{ievap}(k,t) = F^{ievap} N_t(k,t) \frac{L_r N_r}{\sum L_r N_r}$$

where, F^{ievap} is the evaporative factor, N_t is the total number of gasoline cars that drive through all the streets, L_r is the length of the stretch & N_r is the number of cars in r stretch.

5. IITLT model (Goyal *et al*., 1994)-

The IITLT model is designed to estimate long term concentrations of non-reactive pollutants due to emissions from area & point sources during calm wind conditions (4< 2 m/sec).

In this model, the receptor-oriented Gaussian plume model of Hanna (1974) has been adopted to obtain the concentrations of SO_2, SPM and NO_X due to area sources along with the monthly wind roses & the stability frequencies. The ground-level concentrations at each receptor due to area sources is the sum of all the contributions of grids upwind of the receptor & is given by

$$C = \sum_j C_j = \frac{\sqrt{2/\pi}}{a(1-b)u} Q_j \left(X_{j+1}^{1-b} - X_j^{1-b} \right)$$

where, C_j is the concentration due to an area source of strength Q_j located at the j^{th} upwind grid, a and b are the stability parameters and u is the mean wind speed. X_j and X_{j+1} are the upwind distances of the j^{th} and $(j+1)^{th}$ grid from the receptor point.

6. GFLSM model (Luhar & Patil, 1989)-

A simple General Finite Line Source Model (GFLSM), based on the Gaussian diffusion equation is formulated to determine the pollutant concentration for any orientation of wind direction with roadway along a finite line source. The basic approach to develop this model is the coordinate transformation between the wind coordinate system (X_1,Y_1,Z_1) and the line source coordinate system (x,y,z).

Assuming a hypothetical line source along Y_1 direction so that the wind is perpendicular to it, the concentration at receptor R due to this line source is given by (Csanady,1972)-

$$C' = \frac{\theta}{2\pi\sigma'_y\sigma'_z\bar{u}} \left[\exp\left\{ -\frac{1}{2}\left(\frac{z-\mu}{\sigma'_z} \right)^2 \right\} + \exp\left\{ -\frac{1}{2}\left(\frac{z+H}{\sigma'_z} \right)^2 \right\} \right] \times \int_{-1/2}^{1/2} \exp\left[-\frac{1}{2}\left(\frac{y'_1 - y_1}{\sigma'_y} \right)^2 \right] dy'_1$$

where, θ is the source emission rate per unit length, z is the height of the receptor above the ground, H is the height of the line source $\overline{U}$, is the mean ambient wind speed at source height H, σ'_z and σ'_y are the vertical and horizontal dispersion coefficients respectively and are functions of distance X and stability class. The prime (') symbol indicates the parameters in wind coordinate system.

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An appraisal of a waste water treament plant for pulp and paper mill

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Abstract

Due to stringent requirement so fregional regulatory agencies as also about environmental protection, there is a growing concern that is being shown in implementing wastewater management schemes. However, the approach towards solving wastewater management problem is still not that serious as a result, wastewater treatment plants are inadequately designed and constructed. Moreover, after commissioning of treatment plant, there are problems of poor operation and maintenance. All these finally adversely affect the treated wastewater quality, thus, defeating the basic objective of environmental protection. A filed study conducted on one of the pulp and paper manufacturing industry has been presented in the paper alongwith shortcomings and possible remedial measures for achieving improvements.

Key Words:- *Wastewater management, Pulp and Paper mill, Appraisal of Treatment Plant, appropriate strategies, discernible improvement.*

Introduction

One of the water polluting industry is pulp and paper manufacturing industry. To meet the ever increasing demand of paper for various uses, there has been phenomenal growth in pulp and paper manufacturing industry. As a result, large number of pulp and paper making plants have been established. Depending on the raw materials and process technology adopted as also production capacity the paper mills have been grouped in 3 categories namely small,medium and large. While large and medium paper mills use conventional raw materials such as bamboo and wood, the small pulp and paper mills are based on cheaper raw materials like bagasse, waste paper, waste rags etc. These raw materials are the waste products and are relatively economical as compared to bamboo and wood. Moreover use of bagasse and waste paper helps in conservation of forest resources, thereby minimizing the adverse impacts on ecology and biodiversity of the region.

Generally it is seen that there is a tendency in industrial owners to concentrate on production with the sole aim of achieving maximum profits from the investments made while little or no attention is paid to the safe disposal of wastewaters into environment. It is only in recent years that due to stringent regulatory requirements, lot of awareness has been generated amongst the industries and public at large towards environmental protection.

One of the paper mill located in central India was using bagasse and waste paper as a raw material for pulp and paper making and had installed a wastewater treatment plant for the treatment of combined wastewaters. Due to inadequate design and improper operation and

maintenance, the treatment plant was not functioning well and as a result the desired standards for treated wastewater could not be met. In the present paper, an attempt has been made to pin-point the descripencies in design and operational problems and inadequacies in the satisfactory performance of the wastewater treatment plant. Possible solutions to remedy these problems have also been deleneated.

Manufacturing Process

The paper mill had an installed capacity to manufacture 30 MT of Kraft paper per day. Unconventional raw materials such as bagasse, wheat straw, waste paper, and hessein bags were being used as main raw material. Bagasse from sugar mills or wheat, straw was used upto 70-80% while the remaining 30-20% was from waste paper, gunny bags or hessein bags.

Bagasse cooking is done in 10% caustic solution in separate digesters rotating at 0.5 RPM. Steam in injected at 170^{0}C and 100 psi pressure. Digestion is continued for 4-5 hours. Pulping of gunny bags or hessein bags is carried out in separate digesters with 6% caustic solution for a period of 6 hours at 170^{0}C temperature and 100 psi pressure. The pulp is then passed through sand trap and screens and subjected to washing at 2-3 stages, At this stage, black liquor is drained out. Pulp from waste paper is prepared in hydro-pulper unit and cleaned by passing through sand trap and screen.

In stock preparation section, washed pulps namely rag pulp, waste paper pulp and bagasse pulp are mixed together in a specified proportion and passed on to blending chest. Chemicals are added to it to achieve strength and durability. The pulp is then sent for blending for providing desired pulp to water ratio before sending it to paper machine. The paper machine consists of moving wire mesh and rotary driers. Steam is injected into the driers to remove moisture from the sheet of paper. Finished kraft paper is finally cut to the desired size and it is made ready for marketing. The moisture content of finished paper varies from 2-8% by weight with an average value of 4-5%. Schematic block diagrams for waste paper pulp, bagasse pulp and paper making are depicted in **Figure1.**

Water Consumption

The paper mill used to draw raw water from the nearby perennial river to the tune of 4500 m^3/d. The water received adequate treatment in conventional water treatment plant alongwith ion exchange for removal of dissolved solids before sending it to steam generation plant.For washing of pulp and floor washing and other miscellaneous uses, raw water was directly being used. The break-up of water consumption is as follows:

Process	4000-4500 m^3/d
Water Consumption per MT	130-150^3/MT/d

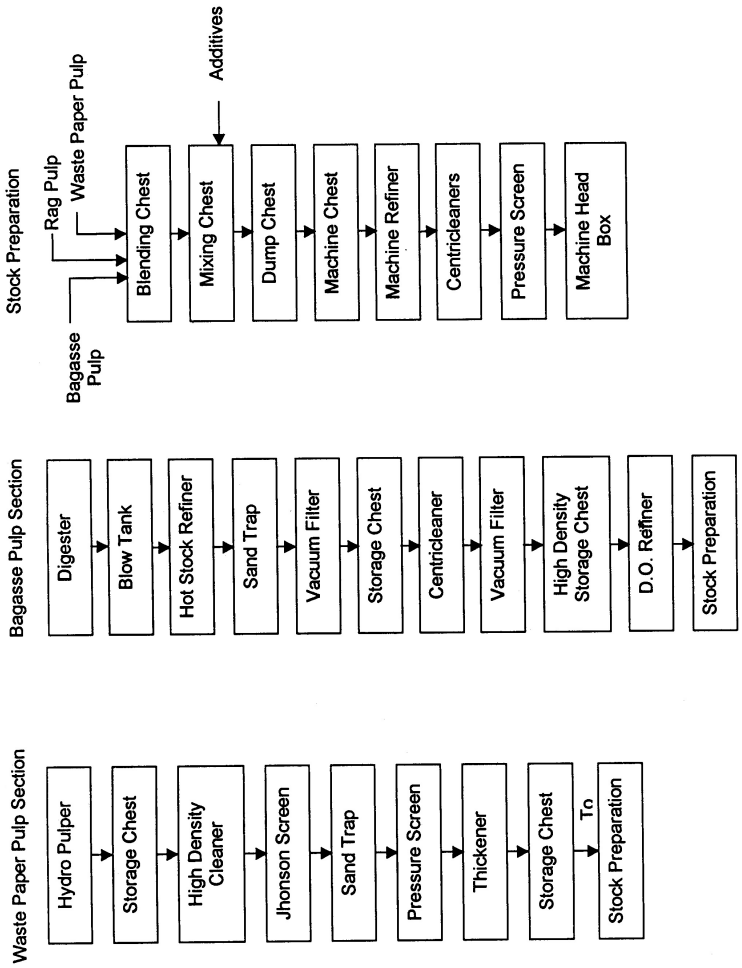

Figure 1: Schematic Block Diagram for Pulp and Paper Manufacture

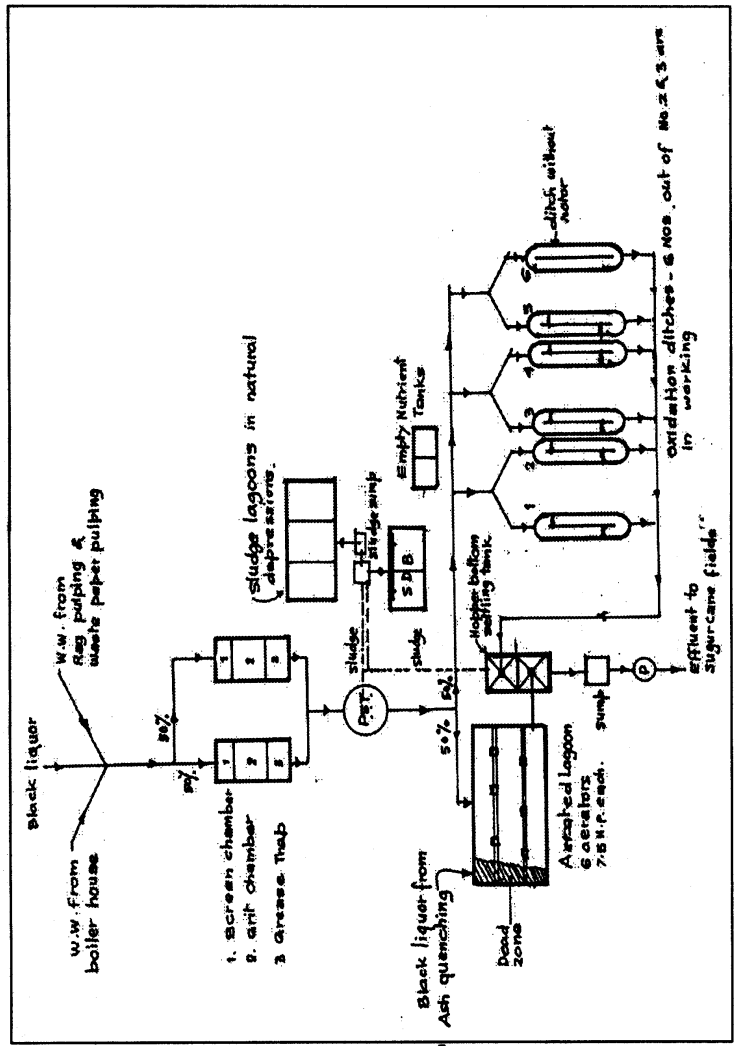

Figure 2: Schematic Flowsheet for the Existing Wastewater Treatment Plant for Pulp & Paper Mill

Wastewater Sources and Quantity

During pulp and paper production, wastewater is emanated from different sources as indicated below:

Black liquor from cooking section
Pulp washing
Boiler blowdown and regenerant water from ion exchangers
Pulp thickener
Paper machine

During the field visit, black liquor drain boiler house drain were separate and wastewaters from other sources was being discharged in a common drain. The wastewater from paper machine was being recycled back for it's reuse. A portion of black liquor was utilized for quenching the burnt hot ash from the boiler.

The wastewater originating from different process sections was between 3000-3600 m^3/d with an average quantity of 3250 m^3/d. Wide variations in waste water quantity were encountered depending on number of process units working at a time. Due to absence of facilities for flow measurements, actual quantities flowing in different drains could not be ascertained. However, the break-up of total wastewater quantity could be obtained and is as follows:-

*Black liquor from 2 bagasse pulp section	1000 m^3/d
*Rag plant section	700 m^3/d
*Boiler blowdown	200 m^3/d
*Waste paper pulp section	650 m^3/d
*Excess wash water from paper machine	500 m^3/d
*Floor washings and misc. wastewater	200 m^3/d
Total Quantity	3250 m^3/d

Existing Wastewater Treatment Facilities

A wastewater treatment plant was provided by the industy and was commissioned at the time of initiation of production. The treatment plant receives combined wastewater and segregation of different wastewater was nonexistent. The wastewater treatment plant comprises the following units:

*Screen

*Grit Chamber

*Grease Trap

Primary Settling Tank
Oxidation Hopper Ditch - 6 Nos
Secondary Setting Tank-2 Nos
*Aerated Lagoon
*Singe Drying Beds-2 Nos
Schematic treatment flowsheet of the WWTP is shown **in Figure2**.

The wastewater treatment plant was designed based on assumed characteristics and kinetic constants for biological treatment units. Design basis of the WWTP was as follows:

Flow	3000 m^3/d
pH	9.5 to 9.8
BOD_5, 20^0C	700 to 800 mg/l
S.S.	1000 to 1200 mg/l

The combined wastewater after treatment in screen, grit chamber and grease trap is passed on to primary setting tank with 3 hours detention time where bulk of the suspended solids settle down and the clear supernatent is led to oxidation ditch and aerated lagoon in equal proportion for biological treatment. The wastewater after oxygenation in both the units is passed on to hopper bottom setting tank of 3.5 hours detention time. The wastewater from secondary settling tank after separation of biological solids is stored in a sump wherefrom it is pumped for utilization on land as a source of irrigation water for sugarcane fields.There is no direct discharge of treated wastewater into near by water body.

Field Observations and Critical Appraisal of WWTP

With a view to plan the strategies for achieving significant improvements in the quality of treated wastewater, a field visit was made for onsite observations on the WWTP wherein each unit of the treatment plant was seen for technical appraisal. The observations made and shortcomings noticed in the WWTP are discussed below.

Screen

*Spacing of screen bars was not uniform as a result of which some of the floating matter was getting passed on to grit chamber.

*Removal of screenings from the screen was not being done at regular intervals.Due to this, heaps of screenings were observed in nearby area.

Grit Chamber

*Grit in huge quanity was seen deposited at the bottom of grit chamber. This had resulted in carry over of gritty material to subsequent treatment units. This had also caused reduction in designed detention time.

Grease Trap

*Foam was observed to be floating over the liquid surface in the grease trap.

Primary Setting Tank

*Due to operation of different pulp sections for meeting the requirements, some of wastewater discharges were intermittent as a result, there were wide fluctuations in the wastewater quantity. In absence of equalization tank, it used to impose shock loads on the treatment plant. In particular the primary settling tank was seen adversely affected as observed from the persistence of suspended solids in the supernatant.

Oxidation Ditch

*There were six units of the oxidation ditch working in parallel. The ditches were constructed in brick masonry. Due to poor workmanship and poor quality construction, masonry walls of 3 ditches got collapsed and bottom of all ditches got severely damaged.

*Out of 6 ditches, only 2were in working condition at the time of field visit. This has resulted in inadequate treatment to the primary treated wastewater.

*Each ditch was provided with 2 horizontal rotors of 3.7 KW (5HP) capacity and out of 10 rotors, only 4 were working.

*The depth of immersion of rotor blades was not uniform in case of rotors in working condition and it was on higher side as compared to desirable value of 16 cm for proper oxygenation to take place.

*2 RCC tanks were seen provided for nutrient (N & P) storage, mixing and addition but these were completely empty with the result that the biological treatment units did not receive nutrient dozing even it is required.

*Arrangement for recirculation of sludge was non-existent. As a result, desired MLSS concentration could not be maintained in the mixed liquor. This had also disturbed the organic loading to the ditch resulting in poor treatment efficiency.

Appraisal of the design of oxidation ditch indicated F/M=0.1, MLSS=5000 mg/l, oxygen requirement= 2 kg of O_2 per kg BOD applied and HRT=26 Hrs. Out of these parameters, MLSS concentration of 5000 mg/l appeared to be on much higher side, particularly in view of the absence of sludge recirculation facility. Spot testing of mixed liquor from one of the ditch indicate MLSS concentration of 2700 mg/l which not only disturbed the organic loading but also resulted into poor treatment efficiency and poor quality of treated effluent.

Aerated Lagoon

*Aerated lagoon of size 60mx50mx3.5m+1m freeboard was constructed in earthwork with sloping sides.

*The lagoon was designed on the basis of arbitrarily chosen value of the system rate constant as 0.234 per day and a detention time of 4 days was provided.

*For oxygenation of the contents of lagoon, 6 aerators of 7.5 HP each were provided. The alignment and spacing of the aerators was not proper since the adjacent aerators were moving in the same direction with depth of immersion varying between 10 to 40 cm. Due to this, even after operating all the aerators, desired oxygenation was not taking place as could be seen from D.O. value between 1.2-1.5 mg/l. At the corners of the lagoon, dead pockets had formed due to insufficient oxygenation. Moreover, depth of lagoon itself being 3.5m was causing low D.O. in bottom layers.

*The black liquor used for quenching the hot ash from boiler was seen getting percolated from the sides and bottom of lagoon due to non-provision of impermeable lining on the sides and bottom of the lagoon which was adversely affecting the functioning of the unit.

Secondary Setting Tank

*2 units of the SST in the form of hopper bottom setting tank with size of each as 12mx 6mx 3m were provided. The oxygenated wastewater from aerated lagoon and oxidation ditch was getting treated in the tank.

*Lot of scum was seen floating over the liquid suface of SST and disludging was not done at regular intervals resulting into sludge deposition within the tank itself and consequently there was reduction in designed detention time.

*The oxidation ditch was designed for 5000 mg/l MLSS concentration while in the aerated lagoon, MLSS concentration in the range of 300-500 mg/l was observed. With these concentrations, the effective MLSS of the combined oxygenated wastewater works out to 2700 mg/l. With such MLSS, for effective removal of S.S. to take place, the SST should have been designed based on solids loading rate with an average value of 4.5 kg MLSS/m^2/d. Instead, the SST was desinged based on the assumed value of surface overflow rate as 20 m^3/m^2/d. This was certainly affecting the treatment efficiency of SST.

Sludge Drying Beds

*At the WWTP, 2 sludge dryingbeds of size 25mx8m were provided. With the sludge from PST with 5% solids content and biological sludge from SST with 1% solids content, the area of sludge drying beds(400 m^2) was inadequate for effective drying and the removal of sludge in semi-solid state once a week was being practiced.

*The design of drying beds based on 5 days drying period and 60 cm depth of sludge. Both these value were inadequate since for effective drying, a dry cycle period of 10 days and a depth of sludge of 30 cm is considered. Due to this shortcoming at the design stage itself, the drying of sludge was not proper.

Strategies for Improvements in the Functioning of Wastewater Treatment Plant

In view of the problems in the design, construction and operation of the WWTP as also shortcomings noticed during field visit, there was a need to formulate most appropriate strategies for achieving discernible improvement in the performance of WWPT with the sole objective of meeting the regulatory requirements. Unitwise suggestions/modifications were suggested as mentioned here under.

Screen

*Spacing of screen bars needs to be made uniform by rearranging the bars so as to have a spacing of 100 mm centre to centre.

*The screening needs be stored separately for drying then dispose of by burning or burying in low lying areas.

Grit Chamber

*Removal of settled grit from the grit chamber needs to be done at regular intervals.The grit removed need be disposed off in low lying area.

*For improving functioning of grit chamber, horizontal velocity of flow need be controlled by installing velocity control device such as parshall flume or proportional flow weir at the outlet of chamber.

GreaseTrap

*The floating foam over the liquid surface need to be removed with the help of nylon scoops or by spraying anti-foaming agent on the surface.

Primary Setting Tank (PST)

*In view of variations in the wastewater flow, there is a need to even out variations by providing equalization basing of adequate capacity. This needs to be provided with mixing arrangement (0.02-0.04HP/1000 gallons volume) for preventing solids from settling within the equalization tank itself.

*A pump of suitable capacity (15 HP) needs to be provided for pumping the equalized flow at a constant rate. This will help in improving the performance of subsequent treatment units.

*Desludging from the PST needs to be done at regular intervals. This will aid in the improvement of existing efficiency.

Oxidation Ditch

*The walls and bottom of oxidation ditch (6 Nos) need to be repaired and reconstucted with sturdy construction. To prevent percolation of wastewater, plastering with waterproof cement be provided to all surfaces coming in contact with the liquid.

*It needs to be ensured that all the 6 ditches alongwith their rotors are kept in operation simultaneously for effective treatment. The depth of submergence of rotor blades needs to be kept at uniform depth of 16 cm for achieving proper aeration of the contents.

*The success of the biological treatment of wastewaters depends on maintenance of BOD:N:P ratio as 100:5:1 and if the wastewaters are found deficient in nitrogen or phosphorus, these are required to be supplemented externally in the term of urea for nitrogen and superphosphate for phosphorus.

With a view to maintain the F/M ratio at the designed level, it is necessary to keep MLSS concentration at a particular level with variations in a narrow range.For this, biological sludge from secondary setting tank needs to be recirculated back to oxiation ditch at suitable recirculation ratio. This ratio needs to be adjusted based on experience with the operation of ditch.

Aerated Lagoon

* The aerated lagoon should be provided with impermeable lining on the sides and bottom. This will help in preventing seepage from the lagoon and cosequently protect the underground water resources from pollution.
* The alignment of the aerators should be so selected that the adjacent aerators rotate in opposite direction and the circle of influence of one aerator touches with the other aerator. For proper splashing action and exposure of waste water droplets to atmospheric oxygen, it is necessary that the depth of submergence of the aerator blades be kept at 100-150 mm.
* It is normally seen that aeration of waste water from pulp and paper mills generates foam in the aeration tank which may become air borne and with the favourable wind velocity , it can get spread in nearby locality , thus disturbing the local residents. Foaming during aeration of pulp and paper mill waste water takes place due to presence of lignin. To overcome this problem, antifoaming agents such as ethyl hexanol need be sprayed over the liquid surface. The dose of this chemical can be fixed after gaining experience on its application.
* In order to see as to whether oxygenation is taking place effectively or not, D.O. levels needs be monitored at various depths along the length and breadth of the aeration tank and it needs to be seen that the D.O. in the mixer liquor of the aeration tank is maintained in the range of 1.5-2.0 mg/l.

Sludge drying Beds

* The area of existing sludge drying beds was worked out considering only primary sludge quantity, sludge layer thickness of 50 cm and dry cycle period of 5 days. To take care of secondary biological sludge (with 1% solids concentration), additional 10 beds of size 65 m x 50 m x 1.05 m need be provided. This has been worked out based on sludge layer thickness of 25 cm and dry cycle period of 10 days for effective drying of sludge.
* The sludge cake after drying needs to be removed and disposed of at a identified site free from human habitation and other activities.

Conclusion

For meeting the requirements of regional regulatory agencies , it becomes mandatory for all manufacturing industries to provide a well designed , constructed , operated and maintained wastewater treatment plant. However, provision of treatment plant receives last priority since the industry is more interested in maximizing the economic benefits and minimizing the cost of production which also includes cost to be incurred on environmental protection. The field survey conducted on one of the paper mill revealed that there were descripencies in the design, construction and operation of the waste water treatment plant. With a view to solve these shortcomings , strategies have been formulated and delineated in the paper.

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Pharmacological and ethnomedicinal studies of *Tridax procumbens* linn family (Compositeae) for anti-asthmatic activities

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Abstract

Tridax procumbens linn. of family- *Compositeae (Asteraceae)* is found plentifully in the plane areas near rivers and on marshy land. The villagers use this plant in bronchial asthma, dysentery and diarrhaea. Leaf juice is generally used to kill the bed bug in cote and wooden furniture and to protect the woods from termites etc.The whole herb juice in decoction is used by the villagers to check the hemorrhage of wounds.The detailed chemistry of the insecticidal compound was carried out, which revealed the structure of the compound. In the present communication, an effort has been made to screen the *Tridax procumbens*,a common plant used in folk medicines.

Introduction

The practices of traditional medicine are based on hundreds of years of belief and observations which create the development and spread of modern medical system. In some countries traditional medicines remain an integral part of formal health system and exist at equal footing with modern medicine.The methods of practices of traditional medicine many appear to be numerous and dissimilar but they all represent variations of three basic activities, faith healing, hygiene measures and drug therapy. Traditional medicine plays an important role in health care in India.

Survey of certain pharmacologically active phytoconstituents in wild plants, which are commonly used in folk medicine, have attracted our attention during the past few decades. The results of these studies have proved to be of much significance for their commercial exploitation.Many reports are available now on the photochemical screening of plants of a particular geographical region.However, only few are concerned with plants, used by rural folks and tribal peoples.

Materials and Methods

Tridax procumbens L.(Compositeae) is a common weed found throughtout India and used for a variety of medicinal purposes. The whole herb was collected from the field of village Chiocholi(Gavasne Forest) district Betul, India

During months of Feb- March (A voucher specimen is preserved in the Herbarium) shade-dried and powered to a fine mesh extraction and purification: Air dried powdered material was soxhlated in acetone for 24 hours and solvent was evaporated under reduced pressure in vacuum evaporator. A dark green semi-solid substance was obtained which accounted for 0.01% of the total dried powdered material. The crude extract was diluted with acetone to made 10% stock solution, dilutions were made from this stock solution. The crude extract was initially tested on TCLP plate of Silica Gel “G” (0.22mm) where total eight spots were obtained using Benzene: Methanol (9:1). The crude extract was then poured into an open glass column (65cm x 4cm) and

eluted with C_6H_6: MeOH (9:1) and about 7 fraction were collected. Some fractions overlapped when subjected to TLC.They were once again eluted using the same solvent system. The different fractions were collected in the small glass vials and were kept in refrigerator. Out of seven fractions obtained, fraction FR_5 (Brown colour) was analyzed spectroscopically for active constituents.

Results

Purification,isolation and structural elucidation of biologically active compound:

The purification and isolation of biologically active compound from crude extract of *Tridax procumbens* was done by column chromatography and TLC.Table(1) indicates the results for column chromatography of petroleum, ether, acetone and methanol extracts of *Tridax*. A total of nine fractions were obtained. The solvent system used for column chromatography are Benzene:P. Ether(4:1),P. Ether:Acetone (9:1) and CCl_4:CH_3COOH(5:1).The detail of the percentage yield, weight of each and colour characteristic have been mentioned in Table(1).

TLC of crude extract

The three crude extracts obtained throught soxhletion were preliminarily examined on TLC plate using silica Gel "G" and different solvent systems as indicated in Table(2). For P.Ether extract Benzene : P.Ether (2:3) gave two spots and $CHCI_3$: Ether(4:1) gave three spots.

In acetone extract of three different combinations using Benzene :Ether (4:1) four spots were obtained while in Benzene: Methanol (9:1) eight spots were obtained .

For methanol extract four combinations were used, which gave three and one each .In the last three combinations with different revalues and different behaviour pattern as already indicated in Table 2.

Further purification

The column purification fractions were further identified for their purity on TLC Plates. Fraction FR, using C_6H_6: P. Ether (2:3) gave three spots thus it seems to be mixture of compounds whereas FR_2, gave no spot presuming it to be a purified compound. With Benzene: Methanol (9:1) also FR and FR_2, gave no further splitting hence was thought to be purified. Erections five to nine were tested using $CHCl_3$: Ether (4:1) in which fractions 3coded FR_6, FR_8 and FR_9, gave no further spot thus assumed to be purified whereas fractions coded FR_5 and FR_7 gave two spots each indicating a further need of their purification . The characteristics of each spot in UV and visible light along with their Rf values have been already mentioned in Table 3.

Isolation and structural elucidation of compound

Isolation and structural elucidation of the purified fraction over IR,UV, HNMR and mass spectrum were carried out using spectrophotometer at R.S.I.C, Chennai. The IR spectrum revealed the absorption at 3010 cm^{-1}, (C=C-H), 2940 cm^{-1} (CH_3), 1990 cm^{-1} (Amides), 1450 cm^{-1} (C-H-1), 1370 cm^{-1}, 1210 cm^{-1}, 750 cm^{-1} (monosubstituted aromatic ring) and 660 cm (monosubstituted aromatic ring).

The UV spectra showed absorption at maximum , 412 nm, H-NMR showed intense peak at S 0.945 (7-C Methyl Group), S.170 (6H), S. 4.27 (3H), S 7.20 (Orthopteron of the aromatic ring). The $CHCl_3$, soluble fraction of the methanolic extract of the whole hert, *Tridax procumbens* which yielded a flavones glycoside (Fig. 1)

The present survey work will be useful in the commercial utilization of *Tridax procumbens* as a medicinal plant for curing dysentry , diarrhoea and to check the haemorrhage of wounds. Sinha and Dogra also reported pharmacological study of the medicinal plants and mentioned that it would be quite helpful for commercial utilization of the medicinal plants in the country. Yadav and Kumar(1996) also reported similar compound in *Tridax procumbens* Linn.

Medicinal Use

Leaves are used for curing bronchial catarrh, dysentry, diarrhaea and haemorrage of wounds. Leaf juice is also insecticidal and piscicidal.

Fig 1 : Trihydroxy -6,3 D Di methoxy Flavone 5-0-α–1–rhmnoyranoside

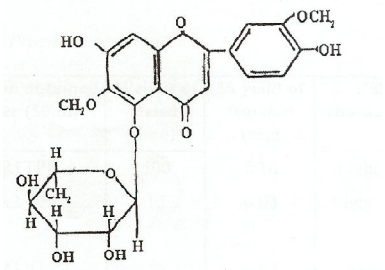

Table 1: Column Chromatography of *Tridax procumbens* Linn.

Plant Extract	Solvent system power (50 ml)	Fraction obtained dried (mg)	Weight of fraction (mg)	% yield of characteristics	Colour
Tridax P. Ether	Benzene: P.Ether	FR_1 TPP	500	0.10	Light Green
production	2:1	FR_2 TPP	15	0.03	Light yellow
	$CHCl_3$:Ether				
Extract	4:1	FR_3 TPP	11	0.02	Yellowish
	Benzene:methane	FR_4 TPP	60	0.12	Green Yellow
	9:1				
Tridax procumbens	Benzene:Acetone	FR_5 TPP	620	0.12	
	4:1	FR_6 TPP	25	0.13	Brown
		FR_7 TPP	10	0.05	Milky Colour
	P.Ether:Acetone	FR_8 TPP	110	0.02	Light Yellow
		FR_9 TPP	320	0.022	Green
Tridax procumbens	CCl_4 : CH_4COOH			0.064	Yellow
	5:1				

Table:2 TLC of Crude extract of *Tridax procumbens* Linn

Plant extract	Solvent system used in TLC	No. of Spots	Behaviour		Rf Value of each Spot
			Visible light	UV light	
Tridax procumbens	Benzene:P.Ether	**2 Spots**			
	2:3	Spot -I	Invisible	Blue	0.25
		Spot-II	Brown	Yellow	0.35
P. Ether Extract	$CHCl_3$: Ether	**3 Spots**			
	4:1	Spot-I	Dark yellow	Fluorescent	0.18
		Spot -II	Yellow	Brown	0.25
		Spot -III	No spot	Fluorescent	0.12
Tridax procumbens	Benzene : Ether	**7 Spots**			
		Spot-II	Green	Dark blue	0.44
Crude		Spot-III	Light Yellow	Green	0.64
Acetone		Spot- IV	Invisible	Fluorescent	0.94
Extract		Spot-V	Visible	Light Yellow	0.85
		Spot-VI	Invisible	Fluorescent	0.94
		Spot- VII	Dark Green	Black	0.92
	Chloroform:Ether	**4 Spots**			
	4:1	Spot-I	Blue	Green	0.071
		Spot-II	Yellow	Green	0.271
		Spot-III	Invisible	Fluorescent	0.875
		Spot-IV	Yellow	Green	1.000
	Benzene: Methanol	**8 Spots**			
	9:1	Spot-I	Green	Black	0.07
		Spot-II	Yellow	Fluorescent	0.15
		Spot-III	Yellow	Invisible	0.26
		Spot-IV	Yellow	Red	0.50
		Spot-V	Green	Blue	0.75
		Spot-VI	Green	Black	0.84
		Spot-VII	Yellow	Green	0.96
		Spot- VIII	Green	Green	1.00
	Benzene : Methanol	**3 Spots**			
	9:1	Spot-I	Dark Green	Black	0.92
		Spot-II	Green		1.00
		Spot-III	Yellow	Green	0.96
	Chloroform: Ether	**1 Spot**			
	4:1	Spot-I	Green	Reddish Black	1.00
	Benzene: Acetone	**1 Spot**			
	4:1	Spot-I	Light Green	Black	0.75
	Benzene: P.Ether	**1 Spot**			
		Spot-I	Yellow	Green	0.24

.Table 3: TLC of Purified compound of *Tridax procumbens* Linn.

Solvent	Purified fraction	No. of Spots	Colour Characterization in		Rf value of each spot
			Visible light	UV light	
Benzene :P Ether	FR_1 TPP	3 Spots			
9:1		Spot-I	Brown	Invisible	0.10
		Spot-II	Invisible	Yellow	0.25
		Spot-III	Invisible	Blue	0.35
	FR_2, TPA	No Spot	No Spot	No Spot	Nil
	FR_3, TPA	No Spot	No Spot	No Spot	Nil
	FR_3, TPA	No Spot	No Spot	No Spot	Nil
Chloroform: Ether	FR_5, TPA	2 Spot			
		Spot-I	Dark Yellow	Fluorescent	1.12
		Spot-II	Creamy	Invisible	0.56
		No Spot	No Spot	No Spot	Nil
		2 Spots			
		Spot-I	Yellow	Brown	0.18
		Spot-II	No Spot	Fluorescent	0.25
		No Spot	No Spot	No Spot	Nil
		1 Spot			
		Spot-I	Invisible	Fluorescent	0.12

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Benthic Fauna and its Ecology of River Ganga from Rishikesh to Haridwar (Uttaranchal) India

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Abstract

Benthic Fauna of river Ganga in relation to physico-chemical characteristics of water has been investigated. A total of 10 groups of benthic fauna were collected. Ephemeroptera was found as dominant during the course of study. Benthos were found maximum in winter months. The physico-chemical characteristics of river Ganga were found almost in limits.

***Key words**: Benthos, Ecology, Physico-chemical, Ganga*

Introduction

Due to unpropotional growth of population and industries , the quality and purity of Ganga water has deteriorated considerably. The religious importance of the Ganga may exceed than that of any other river in the world. It has been revered from the earliest times , and Hindus regard it today as the holiest of all rivers.

At Rishikesh-Haridwar, the Ganga cuts across the Shivalik hills and for the first time enters the plains. The discharge of domestic and industrial sewage, makes water unpotable and also severely affects the bio-productivity of the aquatic system. These discharge consists of large number of chemicals and heavy metals these waste materials react with each other as a result , the water pollutes and may become toxic and effects the macrobenthic diversity of river.

The aquatic fauna are the natural indicators of water quality .Today no proper information is provided regarding the macro-invertebrates of river Ganga at Rishikesh-Haridwar. In the present study an attempt has been made to collect information regarding the macrobenthic diversity of river Ganga.

Materials and Methods

For limnological study of river Ganga the water samples were collected fortnightly from different sampling stations for a period of one year.

Various physico-chemical parameters were analyzed following the standards methods of APHA (1998), Trivedi and Goel (1986), Mathur (1982) and Khanna and Bhutiani (2004). While the benthos were identified with the help of Day(1878), Hutchinson(1957), Needham and Needham (1972).

Results and Discussion

The results of the present study are given in table 1-3 and figure 1and 2 . In the present study the minimum (11.25°C± 0.35) and maximum (20.00 °C ± 0.00) , temperature was observed in the month of January and September respectively. The water temperature showed an upward trend from January to April followed by a downward trend from May onwards. Similar trend was also reported by Khanna (1993), Khanna and Chugh (2004), Badola and Singh (1981).

Temperature showed an inverse relationship with dissolved oxygen through out the year, this is due to maximum photosynthesis when temperature was minimum. Maximum (11.15 mg/l ± 0.07) DO was observed in January and minimum (7.60 mg/l ± 0.14) in July. From May onwards there is decrease in DO due to increased turbidity which retarded the photosynthesis in aquatic flora. Maximum (485.00 J.T.U ± 162.63) turbidity was observed in July and minimum (0.00 J.T.U ± 0.00) in the month of January, February and March. Singh *et al*. (1982), Khanna and Chugh (2004) reported similar results.

The value of BOD was observed maximum (3.85 mg/l ± 0.70) in July and minimum (1.95 mg/l ± 0.07) in February . A negative relationship has been observed between BOD and DO contents. Similar pattern was observed by Verma *et al*. (1984).

According to Ray *et al*. (1966) and Khanna (1993) maximum free CO_2 have been observed in rainy season in Ganga river. Maximum (4.65 mg/l ± 0.07)and minimum (1.15 mg/l ± 0.07) value of free CO_2 had been reported in the month of July and January respectively. Quadri and Shah (1984) reported similar observations.

The maximum (2.10 m/s ± 0.00) and minimum (0.35 m/s ± 0.00) value of velocity was observed in the month of August and March respectively. The velocity started increasing from May onwards due to melting of snow at the place of origin of river. Again beyond September velocity starts decreasing. Similar results were given by Khanna (1993) . In the present investigation residues were maximum (3048.00 mg/l±62.67) in July and minimum (129.50 mg/l± 23.33) in February this was due to maximum velocity in rainy season. Similar conditions were reported by David (1956) and Verma and Shukla(1969).

Transparency was maximum (170.10 cm ± 2.69) and minimum (2.00 cm ±1.27) in the month of February and August. Badola and Singh (1981), Chugh (2000) reported similar pattern.

During the course of study the pH was observed slightly alkaline . Maximum (8.06 ± 0.06) and minimum (7.63 ± 0.01) value of pH was recorded in February and July respectively. Similar observations were reported by Sangu and Sharma (1985) and Bhutiani (2004).The highest concentration (97.50 mg/l ± 6.36) and lowest concentration (44.00 mg/l ± 1.41) of alkalinity was observed in the months of January and August respectively. Holden and Green (1960), Abden (1948 a), Khanna and Chugh (2004) gave similar findings.

The value of total nitrogen was observed maximum (0.63 mg/l ± 0.07) in August and minimum (0.10 mg/l ± 0.01) in January. Swarup and Singh (1979) observed similar results. Khanna (1993) observed minimum value of total nitrogen in rainy season.

The total percentage of Benthic fauna in river Ganga was observed as Ephemeroptera (30.52 %) , Lepidoptera (25.07 %) , Odonata (2.03 %) , Zygoptera (0.08 %), Tricoptera (12.64%), Hemiptera (1.05%), Coleoptera (2.24%), Diptera (45.21%) ,Gastropoda (0.25%) and Annelida (0.17%).

In the present investigation Ephemeroptera was found as dominating. The Benthic Fauna of river Ganga were attached by increased turbidity which reduces the benthos as also

reported by Das and Pathani (1978).

The index of similarity of Benthic fauna during different months was found to be very close to 1.0 in most of cases except in the month of July and August.

The results indicates that Benthos were maximum in January and February i.e. winter months which was due to low temperature, high dissolve oxygen , low velocity and transparency of water along with other suitable conditions . Similar findings have been reported by Khanna (1993) in river Ganga.

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Table 1: Monthly Variation in Physical parameters of river Ganga

Months	Temperature (°C)	Turbidity (JTU)	Velocity (m/sec)	Transparency (cm)	Total Residue (mg/ l)
September	20.00±0.00	375.00 ±21.21	1.78±0.11	6.70±1.56	1019.50±419.31
October	18.75±0.35	75.00±7.07	1.03±0.46	67.50±10.61	193.50±98.29
November	15.00 ± 0.00	57.50±3.54	0.65±0.00	97.50±17.68	172.50±10.61
December	11.75 ±0.35	32.50±3.54	0.55 ± 0.14	127.75± 3.89	160.00± 0.00
January	11.25± 0.35	0.00± 0.00	0.40± 0.07	152.62± 3.32	198.50± 3.54
February	13.25 ± 1.06	0.00± 0.00	0.37± 0.00	170.10± 2.69	129.50± 23.33
March	15.50 ± 0.71	0.00± 0.00	0.35± 0.00	158.00± 3.54	170.00± 14.14
April	19.75 ± 0.35	27.50± 3.54	0.60 ±0.00	134.30± 10.04	179.00± 4.24
May	19.25 ± 0.35	92.50± 10.61	1.10± 0.00	16.00± 0.00	204.00± 8.49
June	19.00 ±0.00	200.00± 42.43	1.16± 0.08	11.00± 4.24	752.00± 565.69
July	18.00 ±0.00	485.00± 162.63	1.98± 0.11	3.00± 0.71	3048.00± 862.67
August	18.75 ±0.35	450.00± 0.00	2.10± 0.00	2.00± 1.27	1740.50± 741.76
Annual Average	16.69 ±3.20	12.08± 151.63	1.00± 0.63	78.87± 68.37	663.88± 898.76

Table 2: Monthly varitions in Chemical parameters of river Ganga

Months	pH	D.O (mg/l)	BOD (mg/l)	Free CO_2 (mg/l)	Alkalinity (mg/l)	Total Nitrogen (mg/l)
September	7.78±0.04	8.35± 0.07	2.75± 0.07	2.01±0.00	57.50± 3.54	0.40± 0.00
October	7.78± 0.04	9.05± 0.78	2.70± 0.14	1.85± 0.07	65.50± 4.95	0.38± 0.30
November	7.87± 0.06	9.65± 0.21	2.33± 0.00	1.60± 0.00	80.50± 2.21	0.30 ±0.01
December	7.83± 0.00	10.25± 0.35	2.40± 0.14	1.40± 0.00	75.50± 0.71	0.23± 0.04
January	8.04± 0.04	11.15± 0.07	2.20± 0.06	1.15± 0.07	97.50± 6.36	0.10± 0.01
February	8.06±0.06	11.10± 0.01	1.95± 0.07	0.75±0.21	87.50± 3.54	0.19± 0.01
March	7.93± 0.04	10.00± 0.71	2.15± 0.07	1.70± 0.14	89.50± 0.71	0.45± 0.07
April	7.99± 0.20	9.00± 0.71	2.45± 0.07	2.55± 0.07	92.50 ±3.54	0.50± 0.14
May	7.80± 0.00	8.75± 0.07	2.66± 0.14	3.10± 0.00	67.00 ±2.83	0.45± 0.07
June	7.73± 0.04	8.35± 0.21	3.15 ±0.35	3.45± 0.07	52.50± 0.71	0.60± 0.00
July	7.63± 0.01	7.60± 0.14	3.85± 0.7	4.65± 0.07	46.50± 2.21	0.35± 0.07
August	7.71± 0.01	7.80 ±0.14	3.55± 0.07	3.65± 0.07	44.00± 1.41	0.63± 0.07
Annual Average	7.85 ±0.14	2.69± 1.50	2.33± 0.56	2.33 ±1.77	71.33± 18.56	0.36± 0.14

Table 3: Benthic Fauna in the river Ganga

Months	Ephemerop-tera	Lepido-ptera	Odonata	Zygop-tera	Tricop-tera	Hemip-tera	Coleop-tera	Diptera	Gastro-poda	Annelida	Average
Sept.	30	2	–	–	3	1	–	13	–	1	5.00 ± 9.63
Oct.	57	8	1	–	18	2	1	50	–	–	13.7 ± 21.77
Nov.	70	12	3	–	32	1	3	96	–	–	21.70 ± 34.31
Dec.	91	17	3	–	44	3	6	150	–	–	31.40 ± 50.77
Jan.	120	30	3	1	97	3	11	180	2	–	44.70 ± 64.35
Feb.	145	21	9	1	50	5	15	275	2	–	52.30 ± 89.80
Mar.	85	15	6	–	30	2	9	148	1	–	21.60 ± 49.01
April	50	9	3	–	15	3	5	102	1	–	18.80 ± 32.86
May	37	5	6	–	6	1	2	47	–	–	10.40 ± 16.99
June	29	1	2	–	4	2	1	17	–	–	5.60 ± 9.67
July	5	–	–	–	–	1	–	6	–	1	1.30 ± 2.26
Aug	3	–	–	–	–	1	–	2	–	2	0.80 ± 1.14
Annual Average	60.16 ± 43.98	10.00 ± 9.40	3.00 ± 2.79	0.16 ± 0.38	24.91 ± 28.49	2.08 ± 1.24	4.41 ± 4.94	90.50 ± 84.73	0.41 ± 0.66	0.33 ± 0.65	19.60 ± 16.95
Total Percentage	30.52	25.07	2.03	0.08	12.64	1.05	2.24	45.21	0.25	.17	

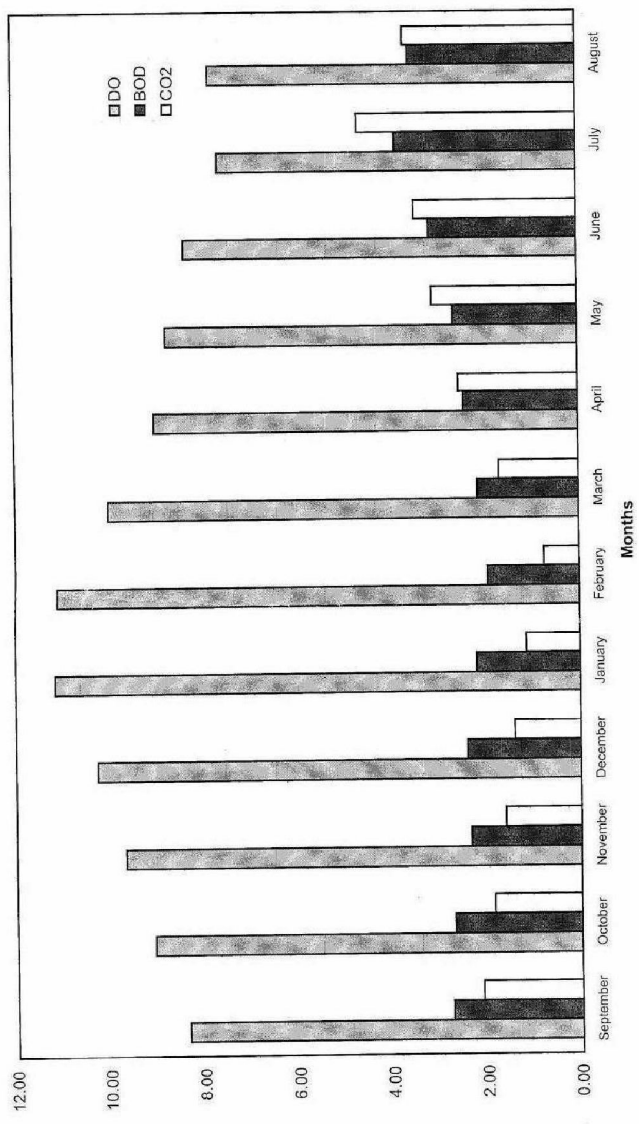

Fig. 1: Comparative study of free CO2, Dissolved Oxygen and BOD

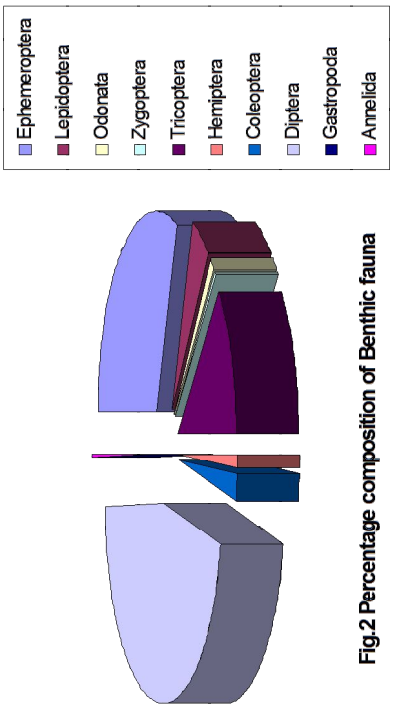

Fig.2 Percentage composition of Benthic fauna

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Limnology and Biodiversity of Fish Fauna in Virla Reservoir M.P. India

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Abstract

The limnological factors in Virla reservoir of west Nimar district (Khargone) that were monitored for two years (July 2001 to June 2003) show high positive correlations among different factors such as alkalinity and phosphates (0.893),transparency and dissolved oxygen (0.885), pH and alkalinity (0.873), alkalinity and BOD (0.859), pH and phosphate (0.826), BOD and phosphate (0.764) [Table- 2]. The total number of 29 species of fishes were recorded in Virla reservoir with order Cypriniformes contributing maximum of 19 members (65.51%) of species followed by four members (13.79%) of order Ophiocephaliformes.

Introduction

All organisms have unique characteristics and maintain ecological balances (equilibrium).For enhancement of fish production and suitable management , it is necessary to interact fish species with abiotic and biotic factors. Probable threats and measures to fish conservation were also studied. Some of the important contributions in this regard are those of Menon (1949), Singh and Shromany (1964), Pandey (1999) and Rema *et al*. (1999). The present study deals with the ecology and fish diversity in this reservoir which receives water from the local nullah and the adjacent agricultural field during rainy season.

Material and Methods

The Virla reservoir is an irrigation water body having a total length of about 270 m, a catchment area of about 50 sq. Kms.. The gross storage capacity is about 525 hectare. It is located near Virla village of Khargone district headquarters that falls under 21^0- 50'-30'' latitude and 75 ^{0}-23'-30'' longitude and is 309 meters above the mean sea level.

The physico-chemical parameters such as water temperature, transparency, pH and dissolved oxygen were measured at site with mercury thermometer, Secchi disc, digital pH meter and Winkler's method. Besides this total alkalinity , BOD, total hardness , free carbondioxide,phosphates were analysed in laboratory by following the standard methods of APHA (1989). Fishes were caught with the help of local fishermans during course of study by operating cast net and drag nets collected and identified according to Jayaram (1994), Srivastava (1980) and Day (1958).

Results and Discussion

Water temperature ranged from 19.20^{o}C to 34.20 ^{o}C. The minimum value was recorded during the month of January and the maximum during June. The trend of variation is mainly affected by seasons and contribute to biodiversity of fish in aquatic system. Transparency values ranged from 57 to 170 cms. The maximum value was observed in the month of January when the water of reservoir was most clear with high transparency. The water was dirty with the mini

mum transparency ,during the rainy season when sand and silt came with runoff water to the reservoir. Transparency is an important factor which affects survival and growth of fish and biodiversity of fish in aquatic habitat.

pH of the reservoir fluctuated from 7.38 to 9.26 with the minimum value during December and the maximum during June. It shows direct significant correlation (r= 0.873) with total alkalinity. Same trend was also reported by Bhutiani (2004). Total alkalinity varied from 133 mg/l to 256 mg/l. The highest value was observed in the month of June while the lowest in the month of January.Dissolved oxygen fluctuated from 5.80mg/l to 9.84 mg/l. The highest concentration that was recorded in winter month shows inverse correlation with BOD, total alkalinity , water temperature and pH. It depicts positive correlation with transparency which enhances the photosynthesis activity. The same type of results were also recorded by Khanna (1993).

The value of BOD ranged between 3.26 mg/l to 5.53 mg/l. The lowest value was recorded in month of January, while the maximum in the month of August. It shows negative correlation with transparency and dissolved oxygen.Free carbon dioxide value ranged between 3.86mg/l to 4.55 mg/l. It was observed in the month of December and January, which shows more respiratory activities and incomplete utilization in photosynthesis. Similar trend was obtained by Khanna and Chugh (2004).

The value of total hardness varied from 150 mg/l to 233 mg/l. It was low during winter season.Phosphate varied from 0.20 mg/l to 0.50 mg/l. The maximum value was found during the rainy season which may be due to the influx of the rain water .The same observation was recorded by Sharma and Hussain (1999), Das *et al.(*2000) and Das and Chand (2003). The phosphate is one of the important nutrients which influences the productivity . This nutrient play an important role in food chain and ichthyobiodiversity in aquatic ecosystem.

Various species of fishes contributes the biodiversity of the reservoir. under investigation included the fishes that came to the reservoir through local nullah, adjacent agriculture fields and those of reservoir itself. Subsistence dominant fishery of reservoir are categorised as major carp , cat fishes, murrel and miscellaneous. The observed fishes in reservoir have been tabulated in table 1.

It was found that the fish biodiversity of Virla reservoir contributed Cypriniformes maximum of 19 numbers of species (65.51%) followed by four numbers (13.79%) of Ophiocephaliformes, two numbers (6.90%) of Perciformes and Mastacembeleformes and one number (3.45%) of Clupeiformes and Beloniformes. Due to more fecundity of major carp and suitable environmental condition there exists a relatively higher number of Cypriniformes. Such type of observation was also recorded by Talwar and Jhingran (1991) and Das and Chand (2003) in inland fishes.

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Table 1: List of Fishes recorded in Virla Reservoir during July 2001 to June 2003

ORDER	FAMILY	GENERA
Cypriniformes	**Cyprinidae**	1. *Catla catla*
		2. *Cirrhinus mrigala* (Ham)
		3. *Cirrihinus reba* (Ham.)
		4. *Labeo rohita* (Ham)
		5. *Labeo calbasu* (Ham)
		6. *Labeo bata* (Ham)
		7. *Puntius ticto* (Ham)
		8. *Puntius sophore* (Ham)
		9. *Rasbora daniconius* (Ham)
		10. *Namachelius botia* (Ham)
		11. *Nemachelius beavani* (Ham)
		12. N*emachelius aurius* (Ham)
	Siluridae	1. *Ompok bimaculatus* (Bloch)
		2. *Wallago attu* (Sclin)
	Bagridae	1. *Mystus seenghala* (Skyes)
		2. *Mystus tengara* (Ham)
		3. *Mystus aor* (Ham)
	Schielbeidae	1. *Eutropiichthys vacha* (Ham)
	Saccobranchidae	1.*Heteropneustus fossilis* (Bloch)
Clupeiformes	**Notopteroidae**	1. *Notopterus notopterus* (Pallas)
Beloniformes	**Belonidae**	1. *Xenentodon cancila* (Ham)
Ophiocephaliformes	**Ophiocephalidae**	1. *Channa marulius* (Ham)
		2. *Channa gachua* (Ham)
		3. *Channa striatus* (Bloch)
		4. *Channa punctatus* (Bloch)
Perciformes	**Centropomidae**	1. *Ambasis nama* (Ham)
		2. *Ambasis ranga* (Ham)
Mastacembeleformes	**Mastacembelidae**	1. *Mastacembelus armatus* (Lac)
		2. *Mastacembelus pancalus* (Ham)

Table 2: Correlation Matrix of Physico-Chemical factors at Virla reservoir durng July 2001 to June 2003

Parameters	Water Temp.	Transpare-ncy	pH	CO_2	Alkalin-ity	D.O.	BOD	Hardn-ess	Phosph-ates
Water Temp.	1	-0.651	0.879	-0.605	0.885	-0.706	0.652	0.762	0.821
Transparency		1	-0.718	0.651	-0.827	0.885	-0.839	-0.259	-0.784
pH			1	-0.562	0.873	-0.786	0.747	0.726	0.826
Carbondioxide				1	-0.592	0.518	-0.450	-0.332	-0.511
Alkalinity					1	-0.895	0.859	0.497	0.893
DO						1	-0.988	-0.238	-0.794
BOD							1	0.190	0.764
Hardness								1	0.579
Phosphates									1

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Traditional Ecological Knowledge, Biodiversity and Resource used Practices in High altitudes Region of Western Himalayas

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Abstract

The people located in Sangla valley in the state of Himachal Pradesh are economically poor due to its inaccessibility and inhospitable geo-climatic setup but they are remarkably rich in social and cultural milieu and endowed natural wealth. Subsistence farming practices, livestock husbandry and trading off the minor forest resources such as medicinal plants, wild edibles and timber are the only means of economy of the rural people. People are socially categorized as tribal. They have their own empirical and innovative knowledge experienced/ inherited through trial and error with the locally available biological resources and diverse geo-climatic conditions thus, establishing a perfect harmony with the nature. The practices of conservation of cultural and biological diversity have been practicing since time immemorial. The preservation of forests on the ground of social-cultural-religious cult and mythological beliefs has become a matter of adopting the strategies of revival of degraded landscape. There is need to adopt integrated model of options to achieve a meaningful development by incorporating indigenous knowledge with complex ecological/environmental milieus with present social and economic conditions derived on scientific parameters so that sustainability of the area could be maintained for long term.

Introduction

Although, western Himalaya covers approximately 11 per cent of the Himalayan landmass, about 90 per cent people lived in villages. People were well aware of the values of conserving social, cultural and biological resources and have devised effective methods to conserve and protect them. The people are highly traditional and have characteristic manifestation of man's cultural interactions with nature. These in turn, evolved multitude of strategies to make effective and harmonious use of resources. During this process, these ethnical societies have restored to cultural adjustments for a harmonious articulation between community techniques and technologies. Nonetheless, culture played a vital role in the management of biological resources of the area. In case if natural resources are not able to fulfill the basic needs of the individuals then society starts changing resulting into a new era of tribal culture. The society decides its own goals and methods of its own, ensuring sustained improvement in the quality of life without affecting the traditional values. Therefore, culture plays vital role in development and conservation of traditional society and biological resources (Pernetta and Hill, 1984; Cohn, 1984; Ramakrishnan, 1992; Scott and Walter, 1993; Davis and Wali, 1994; Singh, 2001). The linkages between local knowledge, culture and conservation in Himalaya have not received any significant recognition (Singh *et al*., 1996). This study will therefore, analyses the cultural facets where innovation of science and technology is not going to flavour significant change in their life style but rather rejuvenating their indigenous knowledge based conservation practices could be helpful for improvement in their overall socio-economic conditions and sustainability of the area.

Study Area

The study village are located in the Sangla valley which is nested in the Kinnaur district of Himachal Pradesh in India. It belongs the part of Great Himalayas conversing from 31° 6' to 31° 30' N and 78° 10' to 79° E. The length of the valley is about 65 km which covers an area of nearly 300 sq. km. accommodating approximately 9500 inhabitants. The valley comprises of a number of small watersheds that finds their way into the Baspa river. The hamlets are scattered all along the valley. The strips of cultivable lands in valley vary from a few hectares to a few kilometers. The valley is relatively wider near Sangla village. Vegetation cover on the left bank of the river is in general, very sparse. Tree species like *Quercus semicarpifolia* and *Betula utilis* were predominantly found at higher elevation. North facing slope is relatively gentle and has adequate vegetation cover, farm fields, soil cover and sporadic settlements. Perpetual snow cover usually covered upper most part of the mountain peaks. A major part of the valley remains cut-off from other parts of the State due too heavy snow fall during winter period. The rocks varied in the region with age from pre-cambrian to permocarboniferous. Schists, gneisses, granites, quartzites, phyllites, conglongrates, quartzites slate, dolomite and limestone are the major rock types. Rocks have been highly exposed along the Karchham-Sangla road. Soil is sandy to sandy loam and is highly fragile. Thus, the problem of land slide and erosion is rather very common in places where the land is not properly terraced.

There are four seasons: spring starts from middle of March to middle of May; summer from mid May to mid September; autumn from mid September to November and winter season form December to March. The summer is mild and with the on set of monsoon there is a gradual decline in the temperature. After the receding of monsoon the mercury drops further thus winter sets in. The period from November to March is of coldest duration. On the basis of rainfall, the district can be divided into two zones- wet zone and dry zone. Usually rainfall occurs in monsoon and winter periods.

Methodology

After reconnaissance of the valley, out of 11 villages located in entire valley, three villages namely Batseri/Bosering, Rakchham and Chhitkul representing distinct elevation were finally selected for thorough study. While selecting the villages it has been ensured that these villages would represent all characteristics of the valley. Equal representation was given to each village and a total of 75 per cent families were selected and interviewed randomly for documentation of indigenous knowledge based activities. The questionnaires were designed based on interactive discussions with individual and group of the people in entire valley. None of the farmers interviewed had a history of involvement with this study projects. The fields of farmers were visited and an inventory was made for crops and biological resource use and conservation practices. All the respondent farmers were categorized into three farm size classes ie., small (farm land having < 1 ha), medium (1-2.5 ha) and larger farm (>2.5 ha). Most of the interviewees belong to small and medium size of land holdings. Women were given equal preference at the time of filling the questionnaires. All information relating to endowed resource use patterns, conservation values and plants used as medicines for traditional health care system were thoroughly documented. Further, farming practices such as factors favouring cultivation of indigenous landraces, crop diversity and cropping patterns and use of different tools and craftsmanship were extracted through a thorough, detailed discussion and filling up questionnaires over a period of years 1996-97. The role of in-depth rooted culture in eco-development and management programmes were also noted from individual viewpoints and were put them altogether into ecological, social and economic development framework.

Results and Discussion

The salient features of the three study villages are mentioned in Table 1. The village Chhitkul is located at higher elevation (3400m), Batseri is situated at lower elevation (2800m) whereas Rakchham village is settled at middle elevation (3000). Road ends at Chhitkul, that is the last village of the Sangla valley. Batseri to Chhitkul area has been declared as Rakchham Sanctuary under Wild Life (Protection) Act 1972 of Government of India. There is no vegetation cover around the Chhitkul except stunted growth of *Berberis* species. This village remains under snow for a period of about 4-5 months. Per household cultivable land holdings of the study villages is less than one ha which is close to other study are too (Singh *et al*., 1997a,b). Area not available for the cultivation and area under cultivable waste (including common grazing lands and sacred area) are higher in Rakchham village followed by Batseri. Rearing of the livestock is an integral component of farming system. Distress selling of sheep and goat to earn money is not uncommon. Better climate, geography and soil cover supports high varieties of crop cultivation in Batseri village as compared to other two villages. Livestock holding is higher in Chhitkul village, which reveals that their economy depends primarily on animal rearing. There are eleven villages scattered along the Sangla valley. The houses are two storied which are built up of stones and woods. These are either slated or flat roofed and are white washed and shining. The ground floor is used for cattle shed while the upper storeyed for living purpose. It is considered that people are from the Aryan stock, but a significant trace of Mongoloid feature has also been noticed in them. The inhabitants are generally of dark complexion but good looking with a well built muscular stature. They are frank, active, generous, hospitable and highly honorable in their dealings. Two principal castes/kanets *ie*., rajaput and scheduled castes are common. Apart from Hinduism, people mostly follow the trend of Buddism. Sheep and goat rearing is very common. The villagers believe in swears of the local deity. There is also a sprinkling of polyandry practiced amongst the people. The people are mostly dressed in woolen clothes. Their clothing is well suited to the climate and culture. Women wrap up a woolen shawl like garments locally known as *dohru* in a slightly different way than the *saree*.

Social and cultural variability, environmental/ecological complexity and diverse geo-climatic conditions have characterized the interactive functions of various subsystems such as agriculture, domestic, forest and animal husbandry in varieties of ways and means of indigenous knowledge based techniques and technologies of self dependency (Table 2a,b,c,d). In this process, people have been utilizing locally available resources in various ways. Preparation of organic manure based on local knowledge and resources derived from dung and urines of animals, beddings and collected forest based leaf litter, and other locally available resources like waste fodder, weeding materials, vegetable waste and other domestic/agricultural wastes were used commonly. Indigenous knowledge regarding use of wild edibles and medicinal plants, trading off minor produce, cultivation of traditional crops and artisan activities related to formulation of implements are amongst some of the common indigenous practices. Since long time, people have developed a symbiotic relationship with endowed natural resources and cultural values. Traditional ways of operating farming systems have evolved centuries ago through a magnitude of empirical oriented trial and error over spatio-temporal scale. Indigenous technique of harvesting and managing natural water resource for various purposes is very common. They use water for drinking purpose, irrigation of crops, running watermills to make flour, use of sawmills to make plumber, plank etc. Incorporating the scientific inputs to modify

these old systems for better hydropower use will be an asset to the tribal people. Diverting water through small canals and pipes will indeed be helpful for proper use of water rather making big dams/hydro-electric project thus that threatening the fragile ecosystem of newly born mountains of Himalaya. Altogether it has been noted that people are rich in terms of indigenous ecological knowledge and managing available resources as well. Similar practices have also been reported from other region of the Himachal Pradesh (Singh *et al*., 1996; Singh *et al.*, 1997a,b). Protecting forest (sacred groves) areas on the ground of religious beliefs have also been noted in the area, which is rich in biological and cultural diversity (Singh, 1997; Singh, 2000). Such practices were regulated through informal committee consisting of head priest (*Talrasa*) and other five peoples. Similar practices were also noted from other part of the Himachal Himalaya (Singh *et al*,. 1996).

As such the subsistence farmers cultivate a total of 16 crops as staple food (Table 3). All crops are of local breed. Crops like wheat (*Triticum aestivum*), jao (*Hordeum vulgare)*, ogla (*Fagopyrum tataricum*) and phapra (*F. esculentum*) were cultivated as major food crops. Farmers are well knowledgeable regarding quality of different crops and various farm fields in terms of production and nutrient management. They also take care of slope, direction and face in relation to performance of crops. Rotation of farm fields for the replenishment of nutrients is common practices. Leguminous crops were sown either monoculture or mixed cropping. Majority of the crops were harvested during rainy season; heavy snowfall does not permit the cultivation of winter crops. Crop diversity in the study area is significantly high when compared with north east Himalaya (Mishra and Ramakrishnan, 1982), central Himalaya (Pandey and Singh, 1984) and other mountainous regions (Garcia-Ruiz and Lasanta Martinez, 1993; Sarmiento *et al*., 1993). As compared to mixed cropping in other parts of the Himachal Pradesh (Singh *et al*., 1997b), single crop cultivation is quite common in the study area. Landscape diversity and environmental complexity have favoured the evolution of multiple ways of cultivation of varieties of local crops. Crop cultivation in valley and terraced lands varies and depends on local knowledge of field quality. However, introduction of fruit bearing tree like apple in Batseri and at the lower parts of Rakchham is hardly 15 years old. Large-scale plantation of apple in the area is required through landscape study and planning (Singh and Ram, 1997).

In their traditional health care system, twelve plant species were used as medicinal purposes (Table 4). The use pattern varies upon the species and ailments. Knowledge regarding preparation of ingredients and doses used for respective diseases were highly praised worthy. Some of the medicinal plants were also used to cure animal diseases. High market demand/ extraction of medicinal plants like *Aconitum heterophyllum, Jurinea macrocephala, Picrorrhiza kurrooaa* and *Podophyllum hexandrum* has resulted large scale collection imperil habitat and biodiversity threat. Older people have faith and love in use of medicinal plants and also show their enthusiasm to teach the younger generation. Imparting scientific knowledge for cultivation of agricultural fields and waste lands which are close to similar climatic regions of high altitudes could promote economic benefits to subsistence farmers and also could accelerate regeneration of species in their natural habitat. Thus, establishing a harmonic symbiotic relationship between demand and natural existence seems for preservation of altogether social, cultural, economic and natural heritage.

Indigenous knowledge pertaining to the use of plants for different purpose has been noted among the people of the study villages (Table 5). Leaves of species of *Pinus, Abies, Picea* and *Cedrus* are collected once a year (on 25th October) for the purpose of bedding and making organic manure deriving from mixing leaf litter and farming waste with dung and urine of animals

which is ultimately used for crop production. Similarly, leaves of *Betula, Eugenia, Juglans* and *Salix* are used for fodder purposes during the lean period. The area is endowed with a rich variety of wild edible species of food value. Wild edibles have been known for their high nutritive values, which improved milk production of milch cattle, goats and sheeps and also kept the body warm during the chilled winter season. Hard labour and low monetary value involved in the collection of wild edibles have not yet attracted market demand. Therefore, availability and growth of these plants are not limited. There is an urgent need to improve the utility values of these wild edible plants by innovating value added products so that better economy could be rendered to the farmers.

Similarly, people have been using a number of plant species for fuel wood, timber, tools and implements making on a routine basis (Table 6). For proper equitable sharing and management, collection of leaf litter and fuel wood is allowed once a day in a year (in the month of November). Usually two people from a family are allowed for wood collection. Such practices are strictly observed in remotely located villages and are controlled through informal committee of the village. Such practices helped in equitable use of natural resources so that long-term indigenous conservation practices could be maintained. Further, people are well aware regarding the artisan work to fulfill their day-to-day domestic needs and activities. Some of them are skilled in preparation of wooden and bamboo based items while a few of them for making iron articles symbolizing their interdependence and self-sufficiency. However, poor people largely depend on indigenous tools/implements to save their economy. It has been felt that there is a strong need to improve the capacity of the locally designed implements such as watermills, *raksh* and *khadi* so that small scale industry coupled with employment could be generated at the household level.

All animals domesticated in the area are of local breed (Table 7). Cows, bullocks, goats, sheep, mules, ponies and yaks constitute the major livestock. Wild yak used for the breeding purposes and the offspring's of yak is used for a wide variety of purposes such as milk, wool, and drought work. Bullocks are used for ploughing of agricultural fields. Traditional knowledge related to preparation of milk products is very unique. Sheep and goats are domesticated merely for wool production and distress selling and also for meat fetching. As such mules and pones are usually reared small land holders and poor people to fulfill their livelihood and drastically used for transportation work in harsh geo-climatically conditions prevailing in the area.

Conclusion

The tribal people of the Sangla valley in Kinnaur district of Himachal Pradesh have indigenously been conserving natural resources since generations and were well aware about their environmental protection and sustainable use. Socio-cultural diversity, geo-climatic variability and environmental complexity favour people to develop symbiotic relationship with the locally available resources and precarious nature that has resulted/experienced through various empirical knowledge they have accumulated through trial and error. Such conducive practices have not only helped the people for better upliftment of livelihood but also altogether management of entire watershed/landscape in general. Economy of the people could be improved by empowering the efficiency of the locally available resources, enhancement of local knowledge, developing participatory approach of local people and institutions/programmes, encouraging small scale industries, increasing market values of medicinal plants and food items, proper use of water resources in terms of micro-hydels, sensitization of people for participation in development planning and awareness building in indigenous know-how and do-how based packages/practices. Altogether, planning for the improvement of their overall economy should be based on the

cultural, social sentiments of the local people and incorporation of scientific knowledge so that overall sustainability of the area could be maintained for long-term basis.

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Table 1. Salient feature of the study area/Sangla valley.

Feature	Attributes
Geographical/administrative setup	Kinnaur district, Sangla valley
Elevation gradient (m amsl)	2800-3400
Climate	Sub-tropical to humid temperate
Soil types	Sandy loam
Agriculture system	Terraced rain-fed and irrigated valley land
Cultivation of traditional staple food crops	16
Introduced cash crops	Fruit trees (Apple, pear)
Forest types	Broad leaves and conifers
Alpine and permanent pasture	Exist
Human and livestock population	Moderate
Sheep and goat rearing	Common
Existence of area under cultivable waste	Common
Literacy rate (%)	33

Table 2a. Predominance of domestic based indigenous knowledge in the Sangla valley.

Attributes	% Response
Existence of traditional houses	100
Availability of skilled person (mason, blacksmith)	20
Settlement near natural water source and avalanche prone area	100
Construction of houses using locally available resources	90
Designing of houses tuned to local geo-climatic conditions	100
Dependency on hydro-power operated water and saw mills	100
Preparation of handicraft items	90
Designing of locally available resource based implements/tools	100
Preparation and uses of traditional dresses	100
Existence of village level committee	100
Resolution of social conflicts at village level	100
Beliefs in local deity	100
Participation in fair and festivals	95
Practice of polyandry system	60
Practice of kitchen garden system	100
Practice of barter system	85
Use of local chulah for energy conservation	100
Preparation of energy rich food in winter	100

Table 2b. Existence of agriculture based indigenous knowledge in Sangla valley.

Attributes	% Response
Cultivation of local crops	100
Preparation and usage of organic manure	100
Operation of traditional breeding patterns	100
Traditional pattern of storage of food grains	100
Usage of local implements/tools in farming activities	100
Adequate knowledge on fragmented land use system	100
Belief in traditional knowledge based farming practices	100
Alternate lopping of agro-forestry tree species	90
Maintenance of agro-forestry species to prevent soil erosion	100
Adequate knowledge on thinning/weeding of crops	100
Know-how on inward/outward terracing pattern to protect soil/water	100
Preparation of terrace/bund cementing with stone, trees/shrubs/grasses	100
Management of water resources	100
Rich knowledge on different crops in different fields	100
Knowledge on field quality and land use/cover practices	100
Cultivation of leguminous crops for replenishment of nutrients	100
Knowledge on crops rotation, patterns, sequences, slopes and directions	100

Table 2c. Indigenous knowledge related to forest based practices on use and conservation resources in Sangla valley.

Attributes	% Response
Use of wild edibles	95
Use of medicinal plants as traditional health care	100
Knowledge on habitat of species distribution	90
Conservation of biodiversity through religious beliefs	100
Conservation/collection of forest resources through traditional norms	100
Usage of forest resources to make tools/implements	100
Designing of tools/implements eco-friendly to farm and forest resource	100
Collection of dead wood as fuel and leaf litter for bedding	100
Conservation and maintenance of community land	100
Maintenance of natural water supply from forested area	100
Knowledge on their right values	95

Table 2d. Local knowledge on animal systems in Sangla valley.

Attributes	% Response
Domestication of wild animals and its breed	100
Operation of traditional breeding pattern	100
Preference of animals suitable to local geo-climatic conditions	100
Preference of animals required less feed/fodder	100
Local techniques of preparation of organic manure	100
Local techniques of keeping animals in harsh environment	100
Know-how to keep room hot through bedding process	100
Know-how for formation of value added products of animals produce	100

Table 3. Diversity of crops in Sangla Valley.

Category and common name	Scientific name
Coarse grain	
Amaranths	*Amaranths spp.*
Barley, jao	*Hordeum vulgare*
Buckwheat, ogla	*Fagopyrum tataricum*
Buckwheat, phapra	*F. esculentum*
Bathu	*Chenopodium spp.*
China	*Echinochloa frumentacea*
Makki, maize	*Zea mays*
Fine grain	
Wheat	*Triticum aestivum*
Oil seed	
Mustard	*Brassica spp.*
Pulse	
Moong	*Vigna mungo*
Pea	*Pisum sativum*
Rajmah	*Vogma sinensis*
Vegetable	
Cabbage, gobhi	*Brassica spp.*
Moli	*Raphanus sativus*
Potato	*Solanum tuberosum*
Salgam	*Brassica spp.*

Table 4. Local knowledge related to use of common medicinal plants in Sangla valley.

Botanical/local name	Usages
Aconitum heterophyllum/ patish	Root powder one tea spoon twice daily cure colic and indigestion.
Banium paraclum/ kala jeera	Seed powder two spoon daily cure jaundice, cough, cold
Berberis spp./Kashambal, chava	Root powder three spoon daily used to cure joint pain
Dactylorhiza hatagirea/Hathpanja	Paste of tuber is applied on cuts, wounds three times daily
Dioscorea deltoidea/singli-mingli	Tuber used as soap and stomach problems two tea spoon
Hippophae spp./surachu	Seed oil cures body pain, shoot juice used against colic
Jurinia macrocephala /dhoop, gugal, shur	Root extract 10 ml 2-3 times used as stimulant during child birth, check excessive bleeding and fever
Nardostachys grandiflora /Balchhar, khome	Root extract 5ml 3-times daily cure hysteria, epilepsy and root powder one tea spoon 3-times cures gastric problems
Picrorrhiza kurrooa/ karoo, kori	Root powder two tea spoon twice daily cures colic, body ache, diarrhea
Podophyllum hexandrum /Bankakroo	Root powder one tea spoon 3- times daily cures colic and vomiting.
Saussurea lappa/kuth	Root extract one tea spoon 2-times daily cures cough, cold
Taxus baccata/Sigacha	Powder of bark 1gm per cup used in tea for cancer treatment

Table 5. Knowledge related to use of various plant resources in Sangla valley.

Botanical/local name	Litter	Fodder	Fuel/ timber/ tools	Edibles	RitualPurpose
Abies pindrow/rai,rahi	Mi	__	Ma	__	Yes
Betula utilis/bhojpatra, shrabra botang	__	Ma	Ma	__	Yes
Cedrus deodara/deyar ,kelbangbotang	Mi	__	Ma	__	Yes
Eugenia spp/jamun, krun	__	Mi	__	Fr	__
Hippophae spp./surachu	__	__	__	Fr	__
J uglans regia/akhrot,kachh	__	Ma	Ma	Fr	__
Picea morinda/tosh, pan	Mi	__	Ma	__	Yes
Pinus excelsa/lim	Ma	__	Mi	__	Yes
Pinus gerardiana/chilgoza	Ma	__	Mi	Se	Yes
P. longifolia/chilambotang, golda	Ma	__	Mi	__	Yes
Prunus armeniaca/behmi	__	__	__	Fr,Pi,Oi	__
P. avium/khotali, cherry	__	__	__	Fr	__
P. persica/khurmani,chuli	__	__	__	Fr,Pi,Oi	__
Salix spp./ willow, shon	__	Ma	Mi	__	__
Viburnum coriaceum	__	__	__	Fr	__

Ma-major; Mi-minor; - no use; Fr-fruits; Se-seeds; Pi-pickle; Oi-oil

Table 6. Local implements and tools used in Sangla valley.

Common/local name	Purposes	% Used
Hal and jua/nag, gral, koal	Ploughing the farm fields	100
Gaiti and kuti/khot	Digging, weeding	100
Kulhari/lasta	Cutting of wood, hedges	100
Basula/washing	Wood finishing and plank making	90
Darat,hasia/thame, chatam	Cutting of hedges, crops, grasses etc	100
Kilta/koting	Carrying of organic manure, food grains etc.	100
Rassi/lat	Made up of sheep hairs and used as rope	100
Kot/kot	Akhrot tree and act as quantification of grain	90
Gharat/gandhotar	Act as watermills to grind grains	20
Takli/tawali	Spinning of wool	95
Raksh, khadi/phoshang, khadi	Preparation of shawl, pattu and patti	100

Table 7. Usage of different local livestock in Sangla valley.

Common/local name	Purposes	% Used
Bail, bullocks/ Joo, gara, gira, buma	Ploughing and drought work	100
Gai, cow/ Jomo, gare, gire, bume, brume	Milk, milk products, wool and products	100
Bher, sheep/ Hulas	Breeding, drought, wool, skin as baggage preparation	100
Bher, sheep/ Khas	Milk, wool and baggage preparation	100
Bakri, goat/ Balu	Breeding purpose, wool, drought, baggage	100
Bakri, goat/ Bhakhor	Milk, wool and products and baggage	100
Ghora, mule/ Rang	Carrying luggage, grains etc.	100
Gadha, ash, ponies/ Phoch	Used as carrier	100
Yak/ Yak	Domesticated wild animal act as breeder	100

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Antibacterial activity of *Mimusops elengi* (Bakul)

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Abstract

Mimusops elengi (Linn.) extracts were evaluated for antibacterial activity against human pathogenic bacterial strain of Gram positive and Gram negative bacteria. The methanolic extract showed the maximum activity against *Streptococcus mutans, Staphylococcus aureus and Bacillus subtilis* (16 mm) and petroleum ether extract showed the minimum activity against *Streptococcus mutans* (9 mm) by well diffusion method. The use of *M. elengi* extracts as a potential antibacterial agent and the treatment of dental caries has been suggested.

Key words: *Antibacterial activity, M. elengi, Dental caries, CFU(Colony forming Unit)*

Introduction

The medicinal plants have been evaluated for possible antimicrobial activity and to get remedy from a variety of ailments due to microorganisms. *Mimusops elengi* is a large glabrous ever green tree. It belongs to family Sapotaceae (Kirtikar and Basu, 1984). It is widely distributed throughout the greater parts of India. The bark and fruit enjoy a considerable reputation in Indian medicine as an astringent and tonic and are used in the treatment of diarrhoea and dysentry (Niranjan *et al*., 1995).Several chemical substances from the plant such as saponins ,steroids, terpenoids and alkaloids have been reported (Misra and Mitra, 1967)and isolated (Satyanarayana *et al.* ,1997). The leaf extract of plant showed antibacterial activity against *B. anthracis, B. mycoides, B. subtilis, Salmonella typhi and Staphylococcus aureus* (Kapoor *et al*., 1969).

However, there is no report of antimicrobial activity of *Mimusops elengi* against dental caries bacteria. Therefore, the antibacterial activity of *M. elengi* against dental caries bacteria and other pathogens have been studied.

Materials and Methods

The material was collected from the plants present in the campus of Gurukul Kangri University, Hardwar, Uttaranchal. They were shade dried at room temperature and then powdered by using blender. The 100 gm. of powdered plant material was loaded in soxhlet assembly and extracted by sucessively in four different solvents i.e. petroleum ether , acetone, methanol and water. The polarity of the solvents would leach out compounds soluble in the particular solvent.

A total of 11 bacterial cultures were used in the screening. Muller Hinton Agar media (Himedia No. M-173) was used to carry out antimicrobial studies. Inoculam of each organism was prepared by inoculating a loopful growth from freshly prepared culture in to respective broth media. The inoculam was further diluted in sterile normal saline solution to provide 10^5 CFU/ml.

0.1 ml of approximately diluted broth culture of test bacteria was evenly mixed in Muller Hinton Agar. Wells of 8 mm diameter were punched into agar with sterilized cork borer and each

well was filled with 45 µl (100 mg/ml) of plant extracts solvent for blank and antibacterial drug (ampicillin 100 µ g/ml) for positive control. The plates were incubated for 24 hrs. at 37°C.

The antibacterial activity was evaluated by measuring the inhibition zone diameter (Ahmad *et al*., 1998).

Results and Discussion

The antibacterial activity of extracts of *Mimusops elengi* against various test organisms at the concentration of 100 mg/ml were determined as presented in Table 1. The plant extracts were effective against both Gram +ve and Gram -ve bacteria. The extracts were found to be less effective as compared to ampicillin . The methanolic extract is effective as compared to other extracts because the antibacterial compounds (triterpenoid, saponin, glycosides) (Sen *et al*., 1995; Sahu *et al*., 2001) leached in more quantity . In general the extracts were highly inhibitory to, *K. pneumoniae, S. mutans* and *S. aureus* but the methanolic extracts shows maximum zone of inhibition 16 mm against *K. pneumoniae, S. mutans* and *S. aureus*.

A variety of constituents have been isolated from *Mimusops elengi* they are saponin, pentacyclic triterpenes, mimusopgenone, steroidal glycosides. These organic compounds shows the antibacterial activity against *S. aureus* (Kapoor *et al*. ,1969; Scalbert, 1991).

It is expected that the nature and presence of more than one active plant constituents may be responsible for enhanced antimicrobial activity in the crude extracts. The results encourage that the screening of medicinal plants hopefully will provide valuable substances to be exploited in the disease management of not only human and animals but also of plants as bacteriocides.

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Table 1: Antomicrobial activity of *M. elengi* extracts in different solvent

Inhibition zone (mm)					
Pathogens	Extracts				Antibiotic
	Pet. ether**	Acetone**	Methanol**	Water**	Ampicillin 100mg/ml
Staphylococcus aureus	14	15	16	15	24
S. epidermidis	10	13	15	14	23
Streptococcus mutans	9	12	16	14	25
S.sanguis	10	11	13	12	23
S. salivarius	10	13	15	14	25
Bacillus subtilis	13	14	15	13	22
B. megnetherium	10	11	13	12	24
Lactobacillus acidophillus	12	13	15	14	20
Escherichia coli	10	11	13	12	23
Klebsiella pneumoniae	14	14	16	15	22
Micrococcus luteus	10	11	13	12	21

* tested by well diffusion method
** Solvents did not show any zone of inhibition

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Nutrient dynamics in rhithron zone of Shivalik Himalayan stream Sahastradhara, Dehradun (Uttaranchal)

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Abstract

Sahastradhara hill-stream is a major tributary of river Song, 15 Km. far from Dehradun. It has a great importance as a picnic tourist spot of the region, whereas there is no more industrial and agricultural pollution. Hill streams of the area are the cradle of nutrients especially calcium and magnesium in the form of ions. Anthropogenic factors mainly tourists activities and catchments runoff may influence the index of nutrients in stream water. Nutrients play a vital role into niche restoration maintenance, self-regulation and water quality. Location variation in nutrients concentration of the stream was studied with special reference to correlation with physico-chemical parameters of the stream water. Calcium and Magnesium were observed in higher range in Sahastradhara stream in comparison to other hill-streams. Calcium and Magnesium were found maximum 104.21 mg/l and 68 mg/l respectively in summer season.

Key words: *Nutrient dynamics, Sahastradhara stream, Rhithron zone, Water quality.*

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Introduction

The Himalayas are the cradle of a large number of streams and mighty rivers. Lesser Himalaya consists of a huge part of Uttaranchal. Dehradun, Hardwar & Rishikesh are the main religious and beautiful cities, which are situated in the foothills of Garhwal Himalaya. A hill-stream Sahastradhara, 15 Km. far from Dehradun city is the study site for the accounting of nutrients in natural water and fluctuations at the different locations along with the stream. Adequate understanding of the Himalayan proglacial streams is extremely important for the development of a realistic program for utilizing the potential of water that exist in the form of snow and ice in the area.

The present study reveals to characteristics of the water nutrient chemistry, influenced by tourist's activity & quarrying of the geologically sedimental environments and to determine the nature and degree of anthropogenic impacts on qualitative & quantitative variations occurred in nutrients in relation to physico-chemical parameters of stream.

Materials and methods

The water samples were collected monthly from sampling site Sahastradhara stream from different sampling stations, Site-I, Site-II, Site-III, Site-IV, and Site-V during December, 2003 to May, 2004 in morning period 9:00 A. M. to 10:00 A. M.

The samples for nutrients and physico-chemical parameters were collected and analyzed by using rinsed borosil glassware, with the help of the procedure described by APHA (1995), Trivedi & Goel (1984), Santhanam *et al.* (1989).

Results & Discussion

Sahastradhara stream is flowing throughout a valley of Dehradun mountain chain in foothills of Shivalik Himalaya, enriched with limestone and lignite rocks, which affect the water quality of stream according to the locations. Nutrients concentration and related physico-chemical parameters from selected five sites are depicted in tables 1 & 2.

Sahastradhara stream has the spatio-temporal variations of water temperature, which plays a vital role in all physico-biochemical reactions and self-purification power of aquatic system (Badola & Singh, 1981). Higher value of temperature was found 18 °C in summer and minimum 12 °C in winter season. A direct relationship was established between the water temperature and free carbon dioxide (Hynes, 1970). Turbidity is striking characteristic of the physical status of the water bodies. Although in Sahastradhara stream water is clear because there is no more pollution, siltation was the main source of turbidity in tributaries. Detritus and other non-organic material being added to water mass due to rainfall and tourist activities (Camron, 1996). Maximum turbidity was recorded 7.0 JTU during rainy days and minimum 1.0 JTU in December. The maximum depth of photic zone provides the better biological production for all aquatic organisms.

Total solids were found in the range of 955 mg/l to 1535 mg/l towards summer season, due to the gradual increases in velocity of river which favoured effective sedimentation (Subramanian, 1979). Chemical oxygen demand represents chemically oxidizable organic matter load in water, while biochemical oxygen demand is only biodegradable materials. In the present study high values observed during summer months may be attributed maximum biological activities and high temperature, stimulate the growth of microorganisms (William *et al*., 1993).

The pH of natural water was controlled in a great extent by the interaction of hydroxyl ions arising from the hydrolysis of bicarbonate (Sharma, 1986). The pH of Sahastradhara stream was recorded slightly alkaline (7.2 - 8.1). Hardness is mainly due to percentage of calcium and magnesium salts of bicarbonates, carbonates, sulphates and chlorides, while the value of alkalinity occured due to presence of bicarbonates. The highest concentration of hardness was analyzed 250 mg/l during warm months. A positive relationship between hardness and alkalinity was recorded in river Ganga at Rishikesh (Chopra and Patrick, 1994).

Maximum chloride concentration was recorded (18.46 mg/l) in the month of May and minimum in December (11.36 mg/l). Chloride and hardness showed a positive relationship to one another (Chopra and Patric, 1994). Chloride was found in the form of chloride ion, and one of the major inorganic anion present in natural water.

Calcium and magnesium the dominant cations, and these represent the main weathering products, but significant hydro-chemical differences between the five sampling sites associated with the bedrock geology exist (Jenkins *et al.,* 1995) Calcium is one of the essential nutrients, which plays an important role in biological system. Maximum calcium concentration was recorded (104.208 mg/l) in the month of May and minimum in January (77.154 mg/l). Calcium concentrations were found maximum about 7.5% of the total solids present in the stream water. Positive relationship between, calcium and temperature was also reported by Khanna and Singh (2000) in river Suswa, Dehradun. Magnesium is also an essential element but it is toxic at higher concentration. The amount of magnesium in Sahastradhara was found maximum (68.0 mg/l) in the month of April and minimum (45.0 mg/l) in December.

During the summer season nutrients concentration in hill-streams became more. Miller *et al*.(1997) described the nutrients availability in selected environmental settings of the Potomac River and Cameron, E. M. (1996) showed the similar type of fluctuation in Fraser river of British Columbia. Sodium is one of the most common cations has no adverse effect on human health at lower concentration. Bond, H.B. (1979) described similar nutrients concentration pattern in a stream draining a mountain ecosystem in Utah. Maximum sodium concentration in Sahastradhara was recorded (11.0 mg/l) in the month of May and minimum in January (6.0 mg/l).

Potassium is naturally occurring element, released by the clay minerals, weathering and leaching from growing vegetation and decomposition of organic matter (Berndtsson, 1990). Maximum potassium concentration was recorded (18.0 mg/l) in the month of April and minimum in December (14.0 mg/l). Pande and Mishra (2000) also observed similar results on Sahastradhara hill-stream Dehradun. Relationship between nutrients and other physico-chemical parameters are given in the table-3 and percentages of nutrients among the total solids are given in table-4, during the study period. These high concentrations confirm the location of the calcareous formation associated with the Central Himalaya thrust. Similarly, samples from stream draining the slope of Doon valley, exhibit high concentrations of Mg relative to K and Na. Again this can presumably be attributed to local geological features. In general, the stream at site III with high Ca concentrations also exhibit relatively low K concentrations compared to the other sites.

The present results conclude that significant differences in stream water nutrient concentrations exist among different environmental settings within the five subunits. The environmental setting with the highest potential by more soluble nutrients, fluctuations in nutrient concentrations were the land use and carbonate bedrock that was predominated in the Doon valley especially, at main tourist spot & sulphur springs site III. Ca and Mg are the dominant cations in this alkaline tributary of river Song. Rock weathering is the most important mechanism controlling the water chemistry. The high concentrations of alkali earth metals, high alkalinity and the high (Ca+Mg)/(Na+K) ratio indicate that the water chemistry of the stream is controlled largely by carbonate weathering and partially by run-off process & tourists activities. The spatial variations in TDS are attributed to climatic and lithological control over the ionic concentrations.

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Table- 1: Nutrients parameters (mean values in mg/l) of Sahastradhara stream.

Parameters	Site-I	Site-II	Site-III	Site-IV	Site- V
Chloride	(11.36 – 15.62)	(11.36 – 16.58)	(12.78 – 18.46)	(9.94 – 18.46)	(8.52 – 16.58)
Mean	12.78±1.73	13.73±1.93	15.26±2.1	13.49±3.25	11.6±3.06
Calcium	(80.16–88.17)	(80.16–92.18)	(77.15-104.20)	(79.15-99.19)	(80.16-96.19)
Mean	84.67±3.58	85.67±4.28	91.68±10.13	89.18±8.26	88.43±6.19
Magnesium	(45 - 53)	(55 - 62)	(63.0 – 68.0)	(52.0 - 28.0)	(45.0 – 55.0)
Mean	48.66±3.09	57.33±3.29	64.66±2.36	55.33±2.49	51.0±5.29
Sodium	(6 – 8.5)	(7.0 – 8.2)	(8.0 – 9.5)	(7.0 - 10.0)	(7.5 – 11.0)
	7.375±0.96	7.725±0.506	8.75±0.75	8.87±1.14	9.25±1.35
Potassium	(14 - 16)	(14.5 – 17.0)	(16.0 – 17.5)	(15.5 - 17.5)	(16.0 – 18.0)
	15.13±0.74	15.75±0.90	16.62±0.65	16.5±0.79	17.0±1.35

Table- 2: Physico-chemical parameters (mean values) of Sahastradhara stream.

Parameters	Site- I	Site- II	Site- III	Site- IV	Site- V
Temperature (°C)	(14 - 18)	(13 – 17.5)	(13 - 17)	(13.5 - 18)	(12 - 18)
Mean	15.75±1.14	15.37±1.63	15.0±1.41	15.75±1.6	15.75±2.277
Velocity (m/s)	(0.3 – 0.4)	(0.28 – 0.32)	(0.8 – 1.0)	(0.78 – 0.82)	(0.6 – 0.7)
Mean	0.3±0.14	0.9±0.1	0.35±0.05	0.8±0.02	0.65±0.05
Turbidity (JTU)	(1.0 –5.0)	(2.0 – 5.0)	(3.0- 6.0)	(2.0 - 6.0)	(3.0- 7.0)
Mean	2.75±1.47	3.25±1.30	4.5±1.15	3.75±1.48	4.75±1.48
Total solids (mg/l)	(955 - 1427)	(1090 - 1332)	(1115 - 1443)	(1135 - 1520)	(1148 - 1535)
Mean	1218±183.2	1234.2±89.8	1277.2±122.6	1305.7±166.1	1290.7±146.1
TDS (mg/l)	(840 - 1278)	(895 - 1217)	(1010 - 1322)	(1039 - 1380)	(965 - 1420)
Mean	1093.25±174.9	1094.25±120.5	1140.5±134.6	1189±158.01	1134.25±176.1
TSS (mg/l)	(113 - 149)	(119 - 195)	(105 - 207)	(105 - 140)	(115 - 211)
Mean	124.75±14.39	140.0±28.16	136.75±40.95	116.75±13.8	156.5±41.69
pH	(7.2 – 8.1)	(7.3 – 8.1)	(7.5 – 7.9)	(7.6 – 8.0)	(7.2 – 8.1)
Mean	7.625±0.43	7.6±0.28	7.75±0.15	7.75±1.66	7.6±0.339
Free CO_2 (mg/l)	(1.40 – 1.69)	(1.62 – 1.92)	(1.62 – 2.20)	(1.65 – 1.85)	(1.62 – 2.20)
Mean	1.6525±0.39	1.75±.017	1.825±0.25	1.74±0.09	1.87±0.21
D O (mg/l)	(7.04 – 11.08)	(6.84 – 10.07)	(7.04 – 9.47)	(6.04 – 9.06)	(6.04 – 9.47)
Mean	8.41±1.62	8.46±1.18	8.65±0.95	7.55±0.87	7.49±1.36
BOD (mg/l)	(1.60 – 2.0)	(1.7 – 2.2)	(2.0 – 2.5)	(1.8 – 2.2)	(1.9 – 2.3)
Mean	1.875±0.162	1.98±0.23	2.25±.18	2.0±0.14	2.05±0.15
COD (mg/l)	(2.1 – 3.0)	(2.2 – 2.9)	(2.6 – 3.2)	(2.4 – 3.0)	(2.4 – 2.9)
Mean	2.55±0.32	2.6±0.25	2.9±0.22	2.68±0.22	2.7±0.18
Hardness (mg/l)	(190 - 210)	(185 - 220)	(200 - 250)	(180 - 230)	(185 - 235)
Mean	196.25±8.2	200.0±15.41	222.5±19.2	200.0±18.71	198.75±21.02
Alkalinity (mg/l)	(150 - 480)	(140 - 500)	(170 - 600)	(130 - 570)	(120 - 540)
Mean	250.0±134.7	262.5±140.8	305±172.1	292.5±168.8	317.5±175.2

Table- 3: Correlation (=CORREL) between Nutrients (mean values) and Physicochemical parameters (mean values) of Sahastradhara stream.

Parameters	Chloride	Calcium	Magnesium	Sodium	Potassium
Temperature (°C)	-0.86097	-0.51833	-0.92056	-0.01186	-0.14275
Velocity (m/s)	-0.17595	-0.12077	0.007842	0.179873	0.225839
Turbidity (JTU)	0.012697	0.818834	0.400371	0.92284	0.959357
Total solids (mg/l)	-0.00448	0.788427	0.273292	0.949891	0.906666
T. D. S. (mg/l)	0.133154	0.71132	0.25802	0.764443	0.682478
T. S. S. (mg/l)	-0.35586	0.096981	0.004271	0.35689	0.46296
pH (pH unit)	0.681329	0.761113	0.623067	0.395679	0.345766
Free CO_2 (mg/l)	-0.03224	0.686443	0.396104	0.833271	0.90927
D.O. (mg/l)	0.679888	-0.12231	0.471533	-0.65112	-0.55633
B. O. D. (mg/l)	0.607899	0.912138	0.845587	0.615583	0.694262
C. O. D. (mg/l)	0.595229	0.954861	0.801927	0.654354	0.704159
Hardness (mg/l)	0.814816	0.795954	0.897315	0.312648	0.386789
Alkalinity (mg/l)	-0.04111	0.829565	0.331085	0.97707	0.985243

Table- 4: Percentage of different nutrients among the total solids at different location of Sahastradhara stream at Dehradun.

Nutrients	Site-I	Site-II	Site-III	Site-IV	Site-V
Total solids	100%	100%	100%	100%	100%
Chloride	1.0492%	1.1125%	1.1948%	1.0331%	0.8987%
Calcium	6.951%	6.941%	7.178%	6.830%	6.851%
Magnesium	3.995%	4.645%	5.062%	4.238%	3.951%
Sodium	0.6055%	0.6263%	0.6852%	0.6793%	0.7166%
Potassium	1.242%	1.276%	1.301%	1.264%	1.317%

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The impact of industrial effluent on Growth of *Cicer arietinum*

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Abstract

The present paper deals with the study of Physico-chemical characteristics of a industrial effluents and effluent treated soil.The physico-chemical characteristics suggested that effluent was under the permissible limit as per ISI- guidelines. Therefore, there is no harm to use this water for irrigation purpose. The pot experiments reflected that there was increase in total biomass and chlorophyll content in effluent irrigation plants. The most encouraging results were observed in 60% of effluent than 40% and 100 % . The higher concentration of effluent restricts growth of plants like *Cicer arietinum*.

Key Words : *Cicer arietinum, Metalaid, Industrial effluent, Physico-chemical*

Introduction

Metal toxicity has become a problem in marginal cropland because of the increased metal solubility from acid rain. Industrial activities generate large quantities of water containing chemicals , trace elements , effluent containing alkaline, acid calcium carbonate, sodium , potassium , nitrate , almunium are discharged. For these elements known to be essential in animal human and in plant nutrition. " Micronutrients are more useful and explicit term". The micronutrients important for plant growth, are Cu, Zn, Fe, Mn, Mo, Co, Na, B and U possibly.

Various types of chemicals are used for forming the product in metal aid industry. The main chemicals which are used as a raw materials are aluminium ash, aluminium powder, sodium, Silicofloride, nitrate, pf reagent, wooden dust, fly ash, Saw-dust and ash. The treatment used for industrial wastes are almost the same as that of sewage. All types of treatment such as preliminary treatment, primary treatment , secondary treatment , tertiary treatment are also necessary in case of industrial waste treatment. In industrial waste treatment it is impossible to select a well suited treatment for a particular effluent (organic, inorganic and chemical effluent) because of the fact that the quality of wastewater is uniform as well as predictable and the pollutant present is known.

In the present investigation an attempt has been made to analyse the physico-chemical aspect of metal-aid industrial effluent and their effect on the growth parameter of *Cicer arietinum*.

Material and Methods

The material and methods include the following aspects.

* Location of site
* Sampling
* Water analysis
* Soil analysis
* Plant growth

Sample of water for various examination were collected from metal aid industry located in Hardwar District, Soil sample was collected from agriculture land.

Water samples were collected in plastic cans for analysis of physico-chemical characteristics of various parameters i.e pH, electrical conductivity , total dissolved solid, total hardness, dissolved oxygen, alkalinity , sodium, potassium and were estimated as per methods of APHA (1998) and Trivedy and Goel (1986).

Soil samples were collected from the agricultural field and were analysed for various parameters i.e pH, electrical conductivity, alkalinity, organic matter, carbon present, sodium, potassium and bicarbonate. The soil sample were air dried crusted and passed through 2μm sieve and stored in polythene bags for analysis.

Results and Discussion

The results of the above study is shown in table 1-6. The quality and composition of effluents depends upon the type of industry. According to Bhatnagar (1993) colour of water is usually estimated by visual method. Colour of metallic industrial effluent depends upon the metal used.

Temperature is basically an important factor for its effects on chemical and biological reaction in water . The mean value of temperature recorded was 27 ^{0}C ± 0.82 ^{0}C .Electrical conductivity is an indication of dissolve solid and suspended solids. The mean values of electrical conductivity was 0.255 μ mhos/cm ± 0.008 μ mhos/cm. The ability to transmit an electrical current depends on the concentration of charged ionic species in the water Trivedy and Goel (1986). The mean value of pH of effluent collected from metal aid industry recorded was 8.69 ± 0.660 and this is with in acceptable range for industrial effluent (ISI). Alkalinity of water is its capacity to neutralize a strong acid and is characterised by the presence of hydroxyl (OH^+) ions capable for combining with hydrogen (H^+) ions (Saxena, 1994). The mean value of alkalinity was 126.8 mg/l ± 3.02 mg/l.

In the present study , mean value of total hardness has no known adverse effect. Total hardness of water is the sum of alkaline earth metals cations present in it. Hardness is mainly due to presence of carbonate, bicarbonate, sulphate chloride etc. (Trivedy and Goel, 1986).Mean value of dissolved oxygen in the sample observed was 4.738 mg/l ± 0.607mg/l and biochemical oxygen demand (BOD) was 1.538 mg/l ± 0.1321 mg/l. BOD can be defined as the rate of removal of oxygen by microorganisms in aerobic degradation of the dissolved or even the particulate organic matter in water and it is used as an index of organic pollution in water (Saxena, 1994).

In the present study , the mean value of sodium was 3.85 mg/l ± 0.512 mg/l , potassium is also a naturally occuring element in the present study the mean value of potassium was 20.00 mg/l ± 0.895 mg/l.

Soil pH strongly influence plant nutrient availability and soil productivity. From the evidence available , neither a high pH above 8.4 nor a low pH below 5 is favourable for maximum field of crop (Puruthi, 1970). The mean value of pH was found 7.56 ±0.521. According to Verma (1994) the favourable pH for growth of plants is 7.8. The mean value of electrical conductivity of soil was found to be 0.24 μ mhos/cm ± 0.004 μ mhos/cm.

During present study , the mean value of alkalinity was 50.00mg/l ± 0.982 mg/l. In the present study mean value of carbon present is 0.825 %± 0.013 % and the mean value of organic matter was 1.42 % ± 0.019 %.

The value of exchangable Sodium was found 6.35 mg/l ± 0.434 mg/l. Soil temperature also affects the potassium uptake by plants. Reduced temperature shows down plant growth and rate of potassium uptake (Tisdale *et al.* ,1995) . Tisdale *et al.* (1995) reported that when the content of sodium ion increase the potassium ions may become less as sodium ion can partially substitute for potasium. The value of exchangable potassium was 3.04 mg/l ± 0.1289 mg/l in agricultural soil at the time of study. In the present study the mean value of nitrate was 0.0065 % ± 0.02 %.

The results shows that the germination rate in control was high, where as in 40% and 60 % the germination present was slightly less than control and 100 % concentration also exhibit moderate percent for germination of seeds.The shoot length in control was high than in 60% , 40 % and 100% concentration. The 60 % concentration was more suitable for root length of *Cicer arietinum* in comparison to control, 100 % and 40 % effluent.The reduction in root and shoot length in seeds treatment with effluent might be due to the stress caused by high salinity Kumar *et al.* (1993).

The control irrigated plants biomass was found high during the course of study, therefore the plants of control sites were found healthy whereas higher concentration of effluent retards the biomass. Effect of tailing water irrigation on biomass of *Vigna radiata, Tritienum aestivum, Brassica compestris* etc. was studied by Thukral (1986). The study revealed that with the increase of effluent concentration , biomass of different parts of the plant decreased gradually. The 60% content shows the highest amount of chlorophyll than 40%. The control shows relatively less values of chlorophyll content. The least values were observed for 100 % concentration.

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Table 1: Values of Some selected physico-chemical parameters of effluent of metalaid industry (Values are mean ± SE for Eight observation each)

S.No.	Parameters	Mean Values
1.	Color	Grey
2.	Temperature (°C)	27.0 ± 0.82
3.	Conductivity(m mhos)	0.255 ±0.008
4.	pH	8.69 ±0.660
5.	Alkalinity (mg/l)	126.80 3.02
6.	Hardness (mg/l)	144.0 ±0.915
7.	DO	4.738 ±0.607
8.	BOD	1.538 ±0.132
9.	Sodium (mg/l)	3.85 ±0.512
10.	Potassium(mg/l)	20.0 ±0.895

±= Standard Error

Table 2: Values of Some selected physico-chemical parameters of soil in agricultural field. (Values are mean ± SE for Eight observation each)

S. No.	Parameters	Mean Values
1.	pH	7.56± 0.521
2.	Conductivity (mmhos)	0.24± 0.004
3.	Alkalinity (mg/l)	50.00 ± 0.982
4.	Organic matter (%)	1.42 ±0.019
5.	Organic Carbon (%)	0.825 ±0.019
6.	Sodium (mg/l)	6.35 ±0.434
7.	Potassium (mg/l)	3.04 ±0.129
8.	Nitrate (%)	0.0065 ± 0.02

±= Standard Error

Table 3: Values of germination percentage of plant of *Cicer arietinum*

Concentration	Control	40%	60%	100%
Germination%	8.86 ± 2.65	7.86 ±2.23	7.86 ±1.26	6.46 ± 2.04

Table 4: Values of root length and shoot length of plant *Cicer arietinum* (after 20 days of germination)

S.No.	Concentration	Shoot length(cm)	Root length (cm)
1.	Control	20.0±0.041	14.60±0.083
2.	40%	15.97 ± 0.028	11.0 ± 0.062
3.	60%	18.70 ± 0.032	16.50 ±0.070
4.	100%	14.80 ±0.021	13.1 ±0.036

Table 5: Average Biomass (gm/m ^{2})

S. No.	Concentration	Control	40%	60%	100%
1.	Fresh X_1	5874.02	4529.37	4543.52	4465.67
2.	Dry X_2	612.17	527.76	537.86	428.16

Table 6: Chlorophyll content of *Cicer arietinum*

S.No.	Treatment	Total Chlorophyll (mg/gm)	a fraction of Chlorophyll (mg/gm)	b fraction of chlorophyll (mg/gm)
1.	Control	0.4684	0.3884	0.0800
2.	40%	0.4983	0.4095	0.0888
3.	60%	0.5260	0.4420	0.0840
4.	100%	0.3682	0.3150	0.0532

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Implications of Characteristic Environmental Parameters of Melghat Forest, Dist. Amravati

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Abstract

Melghat forest in Amravati district offers a unique ecological niche for the diversified life forms. The present paper reports the analysis of specific environmental features pertaining to temperature, humidity, rainfall, etc that favors the growth and development of rich vegetation. Also, the soil conditions greatly influenced the biotic components in the Melghat forest.

Key Words: *Dry deciduous forest, Melghat, Environmental features, Edaphic Factor, Soil Analysis.*

Introduction

A tropical forest is a very diverse and complex resource. The diversity arises from very large number of plant and animal populations comprising it, from the geographical variations in composition of species (both plants and animals) resulting from difference in climatic and soil conditions, as well as divergence in physiology and morphology of various species. (Lal, 1988). In these forests, neither water nor temperature is a limiting factor. The tropical rain forests are the most productive of all. They provide 139.4 x 10^3 Kcal energy per year on the global basis. (Leith, 1972).

Melghat forest is one of the characteristic natural habitats of tropical dry deciduous forest in Amravati district, maintaining the biodiversity. Melghat forest is endowed with distinctive climatic conditions conducive for the growth and development of some of the temperate plants. It is especially noteworthy that plants like, *Pinus, Araucaria, Agathis, Cupressus* are found to be luxuriantly growing in this region.The characteristic environmental features in Melghat forest are responsible for the luxuriant growth of vegetation. It also provides an ecological niche for number of ethno medicinal plants. The area is more significant from the view of socio - cultural aspect, as it is inhabited by tribals. Melghat tract is entirely different from the rest of the district from climatological, agronomical and floristic point of view. It consists of metamorphic rocks along the northern border of district.

Melghat is located in Dharni and Chikhaldara Tahsils of Amravati district in the Southern hill ranges of Satpura. The Melghat Sanctuary includes intended Gugamal National park of 361 sq. kms. The area of Melghat Tiger Reserve forms a corridor between forest areas of Madhya Pradesh and Maharashtra ensuring continuity of forests in the satpuras. The area is catchment of five rivers namely Khandu, Khapra, Sipna, Gadga and Dolar, all of which are tributaries of river Tapti.

In Melghat, the work on floristic composition initiated by Mirashi and Salpekar (1975) and was continued further by Dhore (1986) . Very recently Bhogaonkar and Devarkar (1999) conducted the morphotaxonomic studies and also reported new plant taxa viz. *Ceropegia*. Thus, overall perusal reveals that studies in Melghat area mostly concentrated on floristic aspect.

Map of Melghat Forest, District - Amravati, Maharashtra, India

Methodology

To carry out the study of abiotic environmental features of Melghat forest ecosystem, we have adopted simple methods. The abiotic components can be safely classified into – climatic, edaphic and topographic factors.

In order to study the environment and specific features, frequent visits were made to the forest area. At times, the camping was done to understand the non-living factors of environment. During the visits, the variations in the climatic parameters were noted. Also the traverses were made to understand overall constitution of vegetation, to study interdependencies between biotic and abiotic factors.

The weather parameters involving temperature, rainfall, humidity, etc were noted through kind courtesy of the Metrological Department of Forest Office. For this, regular visits were made to the forest and with the cooperation of forest official's readings were noted.

Edaphic factor plays an important role in the growth and development of vegetation. For this study, soil samples from different locations in the study area were collected. It was followed by detailed analysis with respect to the amount of carbonates, nitrates, chlorides, sulphates, phosphates, etc.

Observation

The abiotic environment of an ecosystem is controlled by climatic conditions. The climate determines the availability of water and degree of heat. Thus, it influences the development of soil, the nature of vegetation and the type of biological community. Functionally, it also enhances nutrient cycling, photosynthesis & decomposion of ground vegetation. Hence, the major structural and functional aspects of an ecosystem relate directly and indirectly to climate. Within the Melghat forest, temperature, humidity, light and rainfall show a distinct gradient, and these controls the growth and development of vegetation community.

Light

In atmosphere, humidity, dust, cloud, fog normally interfere with the light after reaching the ground surface. The intensity and duration of light changes from time to time, forms two distinct groups viz. Heliophytes and Sciophytes.

Sciophytes, which are the low light loving group of plants includes *Adiantum, Cheilanthus* (silver fern)*, Selaginella*, few bryophytic members and species of lichens; grow abundantly in the valleys of mountains

The upper tree layer, with the fully exposed emergent trees and their associated epiphytes and animal life, exists in the euphotic layer of the forest. The euphotic layer is the most productive part of the forest, originating much of its biomass and its diversity of animal life. (Richards, 1983).

Temperature

The conspicuous features of the tropical climate are high and uniform temperatures through out the year (Mukherjee, 1996). Temperature determines hotness of a place and it varies considerably with the altitude. In Melghat forest ecosystem, there is a marked difference in day and night temperatures in summer. Maximum temperature for hot season could be up to 43^0C and minimum 8^0C .The higher hills, plateau and valleys become very cool during winter, when the temperature frequency falls below freezing point in December - January.

Semadoh, Jarida, Dhargadh, Raipur, and Harisal were chosen as the centers for observations. Observations indicate that, Jarida is hottest place among the places of observations. It indicates minimum temperature of 8^0C in January while maximum in month of May showing 43^0C. On the other hand, Semadoh is coolest place showing minimum 9^0 C and maximum 39^0C in month of January and June respectively. Hence, due to variations in temperatures, Melghat area shows biodiversity in organisms as thermopriodicity is directly related with floristics.

Rainfall

Based on the amount of mean annual rainfall, the forest can be subdivided into wet, moist, and dry types. Where the rainfall is less then 1500 mm, the moist forms are replaced by dry ones. Rainy season start from June and remains till September and sometimes in October to November. The average rainfall is usually higher on the main ridge of Galvilgarh, which amounts to 1784 mm at Chikhaldara. Some of the valleys perhaps receive rains up to 2500 mm in a year. Thus, there is a wide variation in rainfall from place to place even within a short distance with change in altitude and topography. Among the centers studied, Semadoh receives the highest rain fall and it is followed by Dhargadh, Jarida, Harisal and the Raipur.The rain fall of the hilly region run away quickly and it is a useless form of water. The remaining water is absorbed by the plants and thus has a direct role on the development of vegetation.

Humidity

Low temperature, low wind velocity, low light, increases humidity. High humidity brings cooling effect and decrease temperature. At Semadoh and Dhargadh, the humidity is found to be highest in the month of June - July while the readings of humidity are minimum in the month of January - February. On the other hand, in summer months, humidity decreases due to high temperature, high wind velocity & intense light.

Edaphic Factors

Soils are the resultant of the interactions of several factors: climate, organisms, parent material and topology, all acting through time. (Jenny, 1980). It is the medium in which roots grow, anchor the plants and from where the plants obtain water and nutrients. A soil usually contains at least some clay and its clay content strongly influences its management and productivity (Davies *et al*, 1972).

Among the soil samples analyzed, soil of Semadoh is rich in carbonates, nitrates, and phosphates but deficient in bases while Kolkhas rest house soil samples is rich in bases (Ca, K, Mg, Na, etc.) and deficient in other inorganic contents.

Topography

Melghat is a typical representative of the Central Indian Highlands, which is a part of biographical zone 6E - Deccan Peninsula - Central highlands (Rodger and Panwar, 1988). Topographical factors bring about variations in climate of Melghat and influence vegetation. Height of mountains in Gavilgarh and Chikhaldara region; direction of mountain ranges and steepness of slope affects the developmental pattern of vegetation.

Effect of different altitudes can be better seen on high mountains. With an increase in altitude above mean sea level (From Paratwada), there are changes in the values of temperature, pressure, wind velocity, humidity and intensity of solar radiation.Due to these topographic changes, there is much biodiversity in Melghat valleys indicating presence of ferns, lichens, bryophytes and few members of orchids.

Discussion

The species diversity in an ecosystem is greatly influenced by the climatic variations, soil characteristics and altitudinal features. Although Melghat forest has been categorized as a dry deciduous forest, its typical climatic conditions favor the growth and development of some of the representatives of temperate forests. It exhibits 5 –6 storeyed vertical stratification of the vegetation. The topographical features and light intensity allows the growth of distinct sciophytic life forms particularly diverse species of Filicales. The higher plateaus above 1000 m height are much cooler, where as Semadoh region is the coolest place. The rainfall and humidity ranging between 60 – 70% favors the growth of epiphytic forms like *Vanda* and *Aerides*. The ground vegetation also sprouts well in the month of August – September. In this period, the herbaceous vegetation grows well with its full vigor and diversified forms like *Chlorophytum, Curculigo, Dioscorea, Gloriosa,* etc. and the number of ethno medicinal plants viz. *Andrographis paniculata, Embelia rabes, Nervillea aragoana, Ceropegia*, etc.

The analysis of soil reveals the picture about the presence of organic and inorganic contents at the various locations. The soil sample from Semadoh indicates more of the inorganic substances, which results in the diversity of lower and higher forms. On the other hand, the samples from Kolkhas shows the poor quantities of inorganic substances; showing less profound vegetation as compared to other regions in the Melghat ecosystem.

The altitudinal variations also affect the vegetational scenario in the forest. Indirectly, wind velocity influences the geographical distribution of tropical forests through the associated movement of moist and dry air masses, which broadly determines climate and seasonal changes. Departures from the usual patterns may however occur at regular intervals and bring unusually dry conditions even into the most equable and prehumid of equatorial climates. (Longman and Jenik, 1987).

At the foothill, the forest is thick and dense in the Semadoh – Kolkhas belt as compared to other regions. It is in this region, that Tiger and Leopards are well protected along with Deer, Bison, Sloth beer, etc. The area shows the dominant growth of teak population, followed by *Butea monosperma*. Among the monocots, specifically bamboo species like *Dendrocalamus strictus* is well represented in the forest.

Thus, the environmental conditions in the Melghat forest provides an ecological niche for the rich and diversified vegetation along with wild fauna. Also, it serves as a conservation place for many threatened and rare species of plant taxa.

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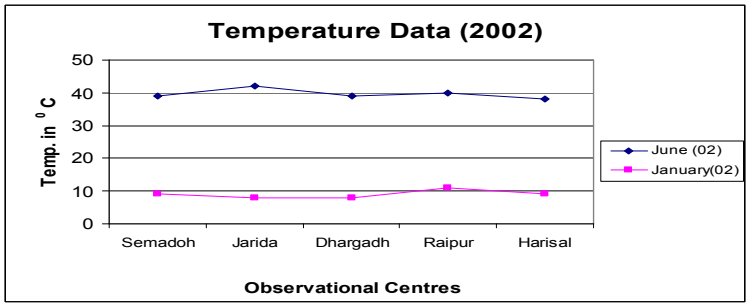
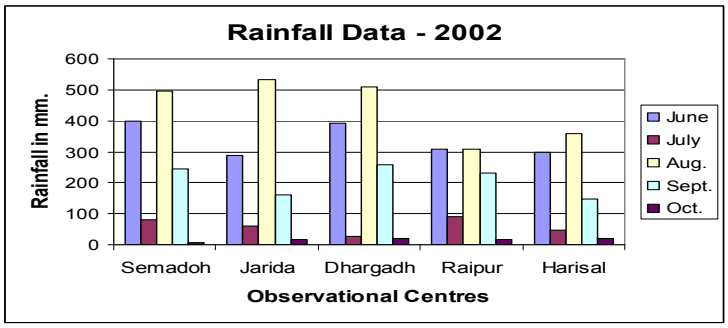
Soil Testing Chart

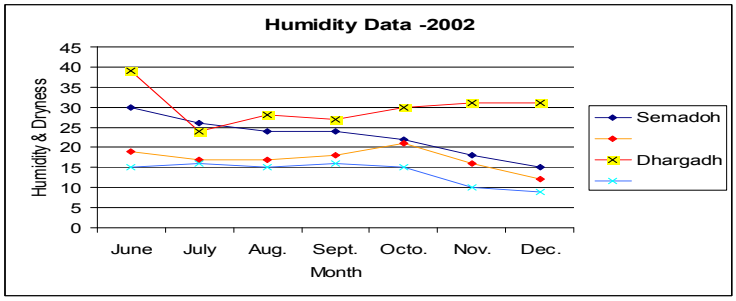
S. No.	Test For	Procedure	Result
1.	Carbonates	Soil sample + Conc. HCL	Effervescence
2.	Nitrates	Prepare Soil: Water (1:5) suspension. Add 0.2 % diphenyl amine prepared in Conc. H_2SO_4. Soil suspension + few drops of diphenyl amine	Blue Colouration
3.	Base Deficiency (Ca,Mg, K,Na etc.)	Soil sample + Solution of Ammonium thicynate + few drops of H_2O_2	Red Colouration
4.	Chlorides	20 ml of water extract + 10 ml of N/10 H_2SO_4 + $AgNO_3$ solution	White PPt
5.	Sulphates	20 ml of water extract + 2.5 ml of Conc. HCL & boil + $BaCl_2$ solution	White PPt.
6.	Phosphates	10 ml of water extract + few drops of conc. HNO_3 + NH_4NO_3 Solution	Yellow colouration

Soil Analysis observation

Soil Sample	Carbonates	Nitrates	Base Deficiency	Chlorides	Sulphates	Phosphates
Ghatang River	++	+	+++	++	++++	+++
Ghatang Campus	+++	++	++	++++	++	+
Kolkhas	+	+++	+	++++	+	++
Semadoh	++++	++++	++++	++	+++	++++


Temperature Data (2002)
Temp. in ^{0}C
50
40
30
20
10
0
Semadoh
Jarida
Dhargadh
Raipur
Harisal
Observational Centres
June (02)
January(02)


Rainfall Data - 2002
Rainfall in mm.
600
500
400
300
200
100
0
Semadoh
Jarida
Dhargadh
Raipur
Harisal
Observational Centres
June
July
Aug.
Sept.
Oct.


Humidity Data -2002
Humidity & Dryness
45
40
35
30
25
20
15
10
5
0
June
July
Aug.
Sept.
Octo.
Nov.
Dec.
Month
Semadoh
Dhargadh

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Influence of Star paper mill effluent on biomass production and yield at harvesting time of different agricultural crops

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Abstract

Influence of Star paper mill effluent of different concentration on biomass and yield production of four agricultural crop i.e. *Solanum melongen*a (Brinjal), *Cicer arietinum* (Black gram), *Glycine max* (Soyabean)and *Lycopersicon esculentum* (Tomato) was investigated in the field condition. Variable behaviour on pattern of seed germination , root length, shoot length , root and shoot ratio was recorded . Similiarly all four crops showed variability with concentration of dose and yield production at harvesting stage.Biomass production was better in control (only tap water) than plot irrigated up to 10% with effluent but was found suitable at 25% and after that it was deleterious for brinjal crop. However effluent was suitable at 5% dose of black gram and after that it showed adverse effect. Adverse effect of effluent on biomass production was recorded at all different concentration used in soyabean crop, but effluent above 50 % concentration showed a positive response for *L. esculentum* crop.Similiarly crop yield in terms of number of fruits / plant and weight of fruits per plant showed variability for their treated dose. Number of fruits and their weight in Brinjal was found better in enhanced trend till 25% and after that deleterious effect was noted while black gram respond positively only at 5% concentration. Similiarly maximum yield was found in soyabean at 5% concentration and above that deleterious effect was recorded. Progressive and positive trend at all concentration in weight of tomato fruit per plant was found.

Introduction

Due to explosion of population , change in attitude of life and development of high degree of scientific researches have yielded rapid growth of industrialization to fulfil the human need in the last two decades of twentieth century. This phenomenon has generated laterally most serious problem concerned with human health and other welfare. Albeit water consumption in the industries has third rank, but many industries are generating effluent not only of high amount but they contain high level of organic components which act as suitable media for growth and multiplication of both virulent and avirulent micro organism. Both are dangerous , because both are concerned in reducing oxygen level resulting adverse effect on aquatic biota. Pathogenic organisms present in the effluent may cause epidemic if surface water is contaminated with these effluent. Besides this several industries are concerned with such type of product having high toxicity level in their effluent due to existence of chemical or heavy metal salts.

Even after proper treatment , effluent should not be discharged in any aquatic system or near by recreation point in order to control outbreak of any kind of epidemic. But as in our condition where maximum number of cities and industries do not posses adequate treatment plants and it is customy to discharge untreated raw sewage either in aquatic reservoir or on land surface. Since this raw sewage contains high amount of organic component and even treated effluent also posses certain amount of organic components. Both may serve the need of nutritional requirement to the plant as fertilizer. Therefore , in order to find out alternative suitable means of safer sewage disposal as well as minimizing the investment in agricultural cost, the investigation was carried out .

In the light of above and in welfare of the society efforts have been made to utilize the effluent for irrigation in several agricultural crops all over the world, based on the reports made by several workers (Dutta and Boissya 1999; Kumar *et al*. 1997). But certain industrial effluent may contain toxic components, which may inhibit the germination of seed or retard the growth of crop plant (Rajannan and Oblisami, 1979; Bishop 1983; Sahai *et al.*1986 and Swaminathan *et al*. 1989). In the present study an effort has been made to find out influence of star paper mill effluent on biomass and yield of certain agricultural crop i.e. *Solanum melongena* (Brinjal), *Cicer arietinum* (Black gram), *Glycine max*(Soyabean) and *Lycopersicon esculentum* (Tomato) at harvesting time.

Materials and Methods

Composite samples were collected from star paper mill, Saharanpur and were brought to laboratory for analysis. The effluent sample was analyzed for various physico-chemical and microbiological parameters as suggested by APHA (1985) and was further used for the treatment of seeds of test crops. Various concentrations of effluent (5%, 10%, 25%, 50%, 75% and 100%) were prepared by using tap water separately. The seeds of uniform size of each crop were selected and surfaces sterilized with 0.1% mercuric chloride for one minute and were washed thoroughly with distilled water to avoid any traces of $HgCl_2$. These surface sterilized seeds were used for the biomass production and yield with different treated/irrigated concentrations of the effluent.

Biomass production and yield under field conditions

For determining the biomass of the crops (*Solanum melogena, Cicer arietinum, Glycine max* and *Lycopersicon esculentum*) seven plots (1-7) each of the size 18 X 18 inch ^{2} were taken. Ten seeds of each crop treated with different concentrations were sown in each plot. The plots (1-7) were irrigated with 0%, 10%, 25%, 50%, 75% and 100% effluent respectively on alternate days. The percentage of seed germination , root length , shoot length , vigour index and biomass were observed after 21 days from the date of sowing. The experiment was conducted four times.

Seven plot of size 18 X 18 inch ^{2} were used for the study of yield production. In each plot ten seeds were sown and all these plots were irrigated with different concentrations i.e. 0%, 5%, 10%, 25%, 50%, 75% and 100% of effluent on alternate days. Biomass production at harvesting stage of different agricultural crops was measured by considering various parameters i.e. root length , shoot length, root/shoot ratio etc. .Production of yield was recorded in terms of number of fruits on seed production on per plant and weight of the fruit or seeds on per plant. Due to variation in growth rate and germination the yield was recorded at different age in different crops i.e. 160 days for *C. arietinum* and for *G.. max,* 180 days for *L. esculentum* and 240 days for *S. melongena*.

Statistical analysis: The data was statistically analyzed (Levin and Rubin, 1995) using standard deviation and correlation factor.

Results

Results of influence of star paper mill effluent on biomass production and yield have been presented in the table 1 & 2 respectively. Under field conditions , at 21 days data showed variable results on percentage of seed germination and on various parameters related with biomass production (Table-1). Maximum percentage of seed germination i.e. 35 at 25% concentration in brinjal while 90 at 10% concentration in blackgram and 60 at 100% (undiluted effluent) in tomato than control (Table-1) . Lower percentage of seed germination was recorded at all the concentrations than compared to control in soyabean.

Maximum root length (0.91 cm) , shoot length (1.52 cm) , vigour index (54.11) and biomass (47.79 mg/plant) in brinjal while root length (8.15 cm) , shoot length (14.68 cm) , vigour index (1230.99) and biomass (826 mg/plant) were recorded at 25% concentration. In case of soyabean maximum value of root length (6.82 cm) , shoot length (13.13 cm) , vigour index (860.27) at 50% concentration but seed germination (85) and biomass (1334 mg/plant) at 5% concentration. In tomato maximum root length (1.35 cm) , shoot length (2.42 cm) , vigour index (175.95) and biomass (82.91) at 100 % concentration of effluent (Table-1).

Findings of biomass production and yield of above different crops are presented in (Table-2). Maximum value for root length , shoot length , vigour index and biomass were found in the same pattern i.e. maximum value at 25% in brinjal at 240 days. But maximum value for root length , shoot length, vigour index and biomass were found in the plot treated with 10% concentration in black gram and soyabean at age of 160 days each (Table-2). Value for all above parameters were found in same pattern of biomass production at 21 days in tomato crop at harvesting time of 180 days old plant in 100% concentration.

Discussion

Data recorded on biomass production at the age of 21 days and biomass and yield at harvesting stage under field condition treated with different concentration of effluent are presented in (Table 1&2). Results revealed that no definite pattern for seed germination and biomass production at 21 days of treated effluent concentration could be established among the different used crops i.e brinjal , blackgram, soyabean and tomato. Conclusion based on findings could be established that star paper mill contains varying amount of nutrient in the form of organic components which serve the purpose of measured parameters up to certain extent in general but specially in brinjal and blackgram (Table 1). Their nutrient support is found limited upto certain limit in term of their concentration. These findings are in accordance to (Rajanan and Oblisami, 1979; Mishra and Sahoo,1989). However Snehlata (1991) found deleterious effect of induced cadmium on enzyme activity which ultimately effect seed germination.Nutritional support of effluent is found effective upto definite concentration , beyond that with increased concentration of effluent showed deleterious effect in brinjal and black gram.These may be perhaps either due to higher concentration of nutrients along with other inorganic chemicals which showed their significant injurious effect either influencing the physiological mechanism of the crop plants. Declined trend of biomass production at higher concentration dose may also be associated due to minimization of porosity of the soil and decomposition of suspended and dissolved solids.

However, stimulatory effect on seed germination and growth in terms of biomass production could not be recorded in soyabean crop as evident by Table 1.Behaviour of tomato plant in response to treated dose was found different from all other test crop plant. All concentrations

used in the study and even in pure effluent, all parameters have been found an enhanced value.

Variabilities among the different test crops responding to the dose of concentration may also be due to genetic nature related with their genetic style. Biomass and yield under field condition of four above mentioned test crops plants showed similar trend in number of brinjal/ plant and yield in terms of weight was found gradually increased from 5 to 25 % concentration and started declining beyond that.

Varied trend of dose was recorded between biomass at 21 days old black gram crop and yield at harvesting stage. Maximum value was found at 10% at 21 days while maximum yield was found at lowest concentration i.e 5% in case of black gram. It may be due to regular irrigation , which could increase the different components in term of organic , inorganic compounds and salts after 21 days upto a level which was available at 10% concentration.

Similar trend was found in soyabean crop, maximum yield has been found at 5% concentrated effluent. It is totally different from the results of 21 days old crops where effluent showed adverse effect . Positive correlation with concentration of effluent and numbers of tomato per plant and yield in term of weight was found in *L. esculentum.*

Thus it can be concluded that albeit at very low concentration (5%) effluent of star paper mill have not shown any adverse effect on germination , biomass and yield but probability of absorption of chemicals during seed germination was there . Moreover transportation and storing in the system of plants and their products could be avoided. Therefore irrigation of the paper effluent in *C. arietinum* and *G. max* at higher concentration should not be recommended. However paper mill indicate that these effluents contains some nutrients, which fulfill the requirement of manures to the germinating crops upto, certain extent. However before recommending these effluents for irrigation more scientific work is needed regarding deposition of chemical components in the products and also their effects on land surface and biota.

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Table 1: Seed germination and biomass production of four agricultural crops at 21 days under field conditions

Crops	Treatments							
	Parameters	0	5	10	25	50	75	100
Brinjal	SG (%)	22.5	27.5	30	35	20	20	17.5
	RL (cm)	0.45	0.44	0.65	0.91	0.58	0.36	0.31
	SL (cm)	0.54	0.53	0.71	1.52	1.10	0.76	0.48
	R/S	0.83	0.83	0.91	0.59	0.52	0.47	0.64
	VI	12.6	15.01	21.95	54.11	22.58	15.56	8.71
	BM (mg/plant)	42.93	26.52	28.5	47.79	20.75	19.62	2.85
Black Gram	SG (%)	80	86.6	90	83.3	83.3	73.3	50
	RL (cm)	7.85	8.53	8.63	8.15	7.74	4.71	4.45
	SL (cm)	15.8	12.49	15.5	14.68	14.53	12.07	9.89
	R/S	0.49	0.68	0.56	0.55	0.53	0.39	0.44
	VI	1271.85	1090.16	1403.68	1230.99	1218.08	889.44	498.95
	BM (mg/plant)	849.25	1128.75	1008.0	826	723.75	498.95	65.5
Soyabean	SG (%)	90	85	80	75	65	55	50
	RL (cm)	4.35	4.68	5.30	6.82	6.82	5.90	2.84
	SL (cm)	12.73	6.07	9.89	10.48	13.13	11.12	8.55
	R/S	0.34	0.77	0.53	0.64	1.92	0.53	0.33
	VI	1150.05	520.63	796.5	792.81	860.27	617.50	430.34
	BM (mg/plant)	1436.5	1334.0	1231.5	1169.0	1039.75	1002.50	462.75
Tomato	SG (%)	20	20	30	47.5	50	52.5	60
	RL (cm)	0.46	0.44	0.64	0.86	0.82	1.25	1.35
	SL (cm)	1.54	2.91	1.41	2.66	2.42	2.09	2.42
	R/S	0.29	0.45	0.21	0.32	0.33	0.51	0.46
	VI	31.26	28.64	63.34	127.21	121.82	128.30	175.95
	BM (mg/plant)	48	26.67	33.10	38.15	79.22	80.32	82.91

Abbreviation

Seed Germination : SG
Root Length : Rl
Shoot Length : SL
Root/Shoot Length : R/S
Vigour Index : VI
Biomass : Bm

Table 2: Biomass and Yield production of four agricultural crops at harvesting time under field conditions

Crops	Treatments							
	Parameter	0	5	10	25	50	75	100
Brinjal (240days)	RL (cm)	2.30	2.50	2.55	5.35	2.35	2.05	1.85
	Sl (cm)	4.85	2.55	4.40	10.25	4.05	3.30	4.95
	R/S	0.47	0.98	0.57	0.52	0.58	0.62	0.37
	No. of B/Plant	1.8	1.8	4.6	4.8	1.6	1.4	1.2
	Yield of B/Plant	200	160	170	200	102	0.233	0.110
	Dry wt. (mg/ Plant)	123.66 $x10^3$	172.5 $x 10^3$	176.8 $x10^3$	251.33 $x10^3$	144.2 $x10^3$	79.2 $x10^3$	54.5 $x10^3$
Black Gram (160days)	RL (cm)	4.55	8.40	7.35	7.30	6.65	5.60	4.95
	Sl (cm)	15.1	21.50	24.25	15.40	17.00	13.30	15.65
	R/S	0.30	0.39	0.30	0.47	0.39	0.42	0.31
	No. of BG/Plant	33.0	50.6	42.6	41.14	40.3	37.8	21.2
	Yield of BG/Plant	7.0	14.0	13.0	11.0	10.7	10.3	3.0
	Dry wt. (mg/ Plant)	$49.^8$ $x10^3$	6^7 $x10^3$	54.8^5 $x10^3$	45.7^5 $x10^3$	$45.^4$ $x10^3$	3^7 $x10^3$	3^2 $x10^3$
Soyabean (160 days)	RL (cm)	7.35	11.75	10.25	10.20	9.50	9.50	8.85
	Sl (cm)	20.25	25.55	18.15	17.70	21.85	12.10	18.60
	R/S	0.36	0.45	0.56	0.57	0.43	0.78	0.47
	No. of Sb/Plant	5.88	27.87	20.85	16.62	14.12	11.5	8.33
	Yield of Sb/Plant	25.0	90.0	75.0	75.0	70.0	40.0	15.5
	Dry wt. (mg/ Plant)	3 x 10^3	10.6 x 10^3	9.3 x 10^3	7.5 x 10^3	6.4 x 10^3	4.5 x 10^3	2.2 x 10^3
Tomato (180 days)	RL (cm)	8.65	5.35	5.50	6.15	6.40	7.80	11.70
	Sl (cm)	29.0	22.10	25.95	21.50	19.05	21.20	26.90
	R/S	0.29	0.24	0.21	0.28	0.33	0.36	0.43
	No. of T/Plant	10.7	8.4	9.83	9.85	10.57	12.0	19.6
	Yield of T/Plant	0.195	0.245	0.494	87.5	93.0	117.85	142.85
	Dry wt. (mg/ Plant)	153.33 $x10^3$	89.28 $x10^3$	130.71 $x10^3$	136 $x10^3$	209.16 $x10^3$	222.4 $x10^3$	335 $x10^3$

Abbreviation

B : Brinjal BG : Black Gram
Sb : Soyabean T : Tomato

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Physico-chemical Analysis of River Panvdhoi at Saharanpur (U.P)

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Abstract

The seasonal physico-chemical and heavy metals concentration of Panvdhoi river Saharanpur has been analysed . Various parameters Viz. temperature, conductivity, turbidity, total solids, total dissolved solids, total suspended solids,pH, BOD, COD, DO, free CO_2, alkalinity ,hardness chloride were observed. In Heavy metals lead, copper, zinc and mercury were observed. Less concentration of these parameters were obtained at Sampling station A,B and C while greater amount were observed on sampling station D and E.

Introduction

Water is most precious commodity of life. It is not only the basic need for sustaining human life but also vital to all the segments of economic development .

Water is being adversely affected ,qualitatively and quantitatively by all kinds of human activities on land , in air and/or in water . According to Bernar (1951) domestic sewage consists of about 99.9% water coming from washing , rinsing ,flushing and other activities. The major part of pollution takes place by industrialization because in the industrial sewage there are a large number of chemicals and heavy metals.

District Saharanpur is situated in the north of Uttar pradesh. Many rivers flows through the Saharanpur Viz. Yamuna , Hindon, Damola, Maskara, Krishna, Kalinadi, Panvdhoi etc.

River Panvdhoi flows through Saharanpur district, it is a stream fed river and a tributary of Hindon. This river originates near Shanklapuri Shiv Mandir of Panwarka, then it goes to Saharanpur. It is about 16 Km. in length and then in Saharanpur it mixes with river Dhamola. Due to industrialization in district Saharanpur main drain carries away some effluent from the factories and also from the residential colonies. This drain carries domestic sewage, which is poured into river panvdhoi. Therefore , it can be well considered that it carries a variety of pollutants of equally different in physico-chemical nature.These effluents changes the physico-chemical characteristics to such an extent that they sometimes lead to high fish mortality.

The location of Saharanpur on Globe is on latitude 29 ^{o} 58' North and longitude 77^{o} 33' east while the height from sea level is 270.50 meter. Present study was carried out on stretch of 16 Km from Shanklapuri Shiv mandir to near Dhamola which is having a width of 1-6 meter and depth of 0 .5 to 1.5 meter.

River Panvdhoi is a small tributary having a length of 16 Kms, It originates from Panwarka and in Saharanpur conflicts into Dhamola. The place where it originates is called Sarkadi Ki Puliya.In this point the width of the river is 1-4 meter and depth is 1.5 meter.

Due to New developing Urban areas however, so far no study has been made to find out the seasonal variation in the ecology of the river Panvdhoi at Saharanpur.Hence the study was conducted to fill up this Lacuna.

Materials and Methods

Sampling Stations of the Study

(A) Shanklapuri Shiv Mandir
(B) Makhraj Ka Pul
(C) Lal Das Ka Baada
(D) Jogyan Pul
(E) Near Dhamola

For ecological study of river Panvdhoi the water samples were collected fortnightly from different sampling stations for a period of two year.

Various physico-chemical parameters and Heavy metals were analyzed following the standards methods of APHA (1998), Trivedi and Goel (1986), Mathur (1982) and Khanna and Bhutiani (2004).

Results and Discussion

The results (average annual values) of the present study are given in table 1-2 . In the present study a difference in the fluctuation of water temperature was observed 15.6 ^{O} C ±4.5 ^{O}C to 25.6 ^{O} C ± 4.0 ^{O} C . The water temperature showed an upward trend from winter season to summer season followed by a downward trend from monsoon season onwards. A more or less similar trend has been observed in the river Yamuna by Chakrabarty *et al*. (1959) and in the Kallayi by John (1976). Same trend of temperature was observed by Khanna (1993) in river Ganga at Haridwar

The annual average value of dissolved oxygen ranged between 10.47 mg/l ± 2.09 mg/l to 1.20 mg/l ± 1.07 mg/l ,Chopra *et al*. (1990) , Gopal and Shah (1993) , Joshi *et al*. (1993) and Sharma (1999) also got the same results and have opined that low temperature in winter increases the oxygen retaining capacity of water and solubility of oxygen in water.A negative relationship has been observed between BOD and DO content. A similar pattern has been reported by Khanna (1993) in river Ganga. The annual average value of biochemical oxygen demand ranged between 2.26 mg/l to 78.10 mg/l.

The annual average value of COD ranged between 4.81 mg/l ± 1.59mg/l to 1156.66 mg/l ± 188.76 mg/l . Similar trend of COD have shown by Khanna and Singh (2000) in river Suswa at Raiwala.

Annual Average value of free CO_2 varied between 1.55 mg/l ±1.61 mg/l to 4.89mg/l ±1.34mg/l . Pahwa and Mehrotra (1966) and Ray *et al*. (1966) have reported that the Ganga river contains maximum free CO_2 in rainy Season at Allahabad.Annual average value of total disssolved solids varied between 105.24 mg/l ± 13.10 mg/l to 787.93 mg/l ± 326.17 mg/l

The annual average values of pH varied between 7.20 ± 0.18 to 8.65 ± 0.40.High value obtained during rainy season may be due to rainy water, runoff of sewage drains etc. It was recorded that pH remains slightly alkaline in nature throughout the study.Das (1961) reported that pH of water has an important behaviour on plankton and microbial production.

The annual average value of alkalinity varied betrween 50.02 mg/l ± 15.76 mg/l to 781.66 mg/l ± 62.11 mg/l. Similar observations was also obtained by Holden and Green (1960) , Talling and Rzoska (1967) and Abidin (1948a) .

The annual average value of total hardness ranged from 95.66 mg/l ± 11.71 mg/l to 280.31 mg/l ± 17.12 mg/l .Mishra and Joshi (2003) observed hardness in river Ganga at Hardwar and found more or less similar trend in their study. The annual average value of Chloride varied between 5.31 mg/l ± 5.26 mg/l to 60.51 mg/l to 2.09 mg/l.Chlorides are present in sewage , sewage effluents and farm drainage . Significant levels of chloride content were showed by many rivers like Yamuna , Sengar *et al*. (1985) and Tungbhadhara , Reddy and Venkateshwarlu (1987).

In the present study heavy metals, lead, copper, Zinc and mercury were taken for observation. The annual average value of heavy metals are given in table 2.The annual average of Lead ranged between 0.0702mg/l ± 0.02291 to 4.9075 mg/l ± 0.6582. The minimum value was found from sampling station A in 2002-2003 and maximum from sampling station E in 2003-2004. The annual average value of copper varied between 0.053 mg/l ± 0.0324 to 1.5945 mg/l ± 0.3729 in which average value of copper was obtained at sampling station A in 2003-2004 and maximum average value at sampling station E in 2002-2003. The annual average value of Zinc ranged between 3. 1651 mg/l ± 0.0528 to 4.871 mg/l ± 0.1750 in which minimum average value of Zinc was obtained from sampling station A in the year 2002-2003 and maximum was recorded at sampling station E in the year 2002-2003. The annual average value of Mercury varied between 0.0000 mg/l ± 0.0000 to 0.0006 mg/l ± 0.0002. The minimum was found as nil in both the years (2002-2004) at sampling station A,B,C and maximum at sampling station E in 2003-2004 (Table- 2). The concentration of these metals at sampling station C,D and E give a highly misleading picture of the degree of metal pollution. Heavy metals get contaminated into aquatic systems as result of various natural activiries (Weathering of soils and rocks from volcanic eruptions) and from a variety of human activities involving the mining , processing or use of metals or substances. Some metals , such as copper and zinc are essential micronutrients, while others such as mercury and lead are not required even in small amount by any organisms. Virtually all metals , including the essential metal micronutrients, are toxic if exposure levels are sufficient high. Andren (1974) reported that about 67 percent of the mercury in the Mississippi river water is associated with suspended sediments.

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Table 1: Average annual value of physico-chemical parameters of river Panvdhoi

Psysico-Chemical Parameters	Sampling Station 'A'		Sampling Station 'B'		Sampling Station 'C'		Sampling Station 'D'		Sampling Station 'E'		Average
	2002-2003	2003-2004	2002-2003	2003-2004	2002-2003	2003-2004	2002-2003	2003-2004	2002-2003	2003-2004	2002-2004
Temperature(°C)	15.6 ± 4.50	16.5 ± 6.30	17.6 ± 4.20	19.3 ± 4.30	20.2 ± 5.20	20.4 ± 5.70	23.4 ± 5.50	23.1 ± 4.40	25.0 ± 4.40	25.6 ± 4.00	20.7 ± 3.50
Conductivity	191.44 ± 127.32	206.70 ± 137.55	191.44 ± 127.18	206.84 ± 137.63	165.56 ± 117.35	166.33 ± 116.22	148.95 ± 110.11	137.71 ± 102.53	142.07 ± 104.39	149.20 ± 105.64	170.62 ± 26.56
Turbidity	57.78 ± 54.54	68.81 ± 70.78	49.58 ± 40.44	44.89 ± 27.63	243.33 ± 30.55	242.20 ± 39.75	533.93 ± 126.08	524.18 ± 85.38	908.46 ± 101.05	901.07 ± 198.83	357.42 ± 341.56
Total Solids (mg/L)	179.53 ± 168.53	210.96 ± 25.71	181.92 ± 169.96	213.17 ± 219.34	186.60 ± 23.33	187.44 ± 28.89	1627.40 ± 647.20	1598.38 ± 629.34	1726.94 ± 651.22	1825.66 ± 748.50	793.80 ± 777.64
T.D.S. (mg/L)	121.67 ± 113.62	141.74 ± 149.86	123.03 ± 114.19	142.78 ± 149.85	105.24 ± 13.10	105.58 ± 13.30	720.46 ± 313.85	787.93 ± 326.17	766.66 ± 351.18	500.00 ± 379.86	351.51 ± 304.54
T.S.S. (mg/L)	57.85 ± 54.94	69.22 ± 70.70	58.88 ± 55.79	70.39 ± 69.73	81.53 ± 10.23	81.85 ± 15.62	905.93 ± 347.60	810.45 ± 343.52	960.26 ± 307.78	965.83 ± 378.07	406.31 ± 14.53
pH	7.32 ± 0.25	7.20 ± 0.13	7.34 ± 0.25	7.24 ± 0.16	7.50 ± 0.09	7.51 ± 0.07	8.42 ± 0.42	8.51 ± 0.40	8.65 ± 0.37	8.65 ± 0.40	7.83 ± 0.63
BOD (mg/L)	2.26 ± 0.32	2.29 ± 0.53	2.54 ± 0.85	2.57 ± 0.74	8.42 ± 2.74	3.80 ± 3.12	281.66 ± 66.58	293.33 ± 73.71	468.33 ± 80.98	475.00 ± 78.10	154.52 ± 203.23
COD (mg/L)	5.69 ± 1.45	4.81 ± 1.59	5.62 ± 0.69	4.95 ± 1.69	28.11 ± 6.56	25.90 ± 6.37	768.33 ± 173.22	878.33 ± 174.73	1075.00 ± 220.17	1156.66 ± 188.76	395.34 ± 504.84
DO(mg/L)	9.55 ± 2.18	9.56 ± 1.99	9.61 ± 1.41	10.47 ± 2.09	7.56 ± 0.89	7.57 ± 1.82	4.66 ± 0.58	4.44 ± 0.69	1.68 ± 1.47	1.20 ± 1.07	6.53 ± 3.41
Free CO2 (mg/L)	2.02 ± 1.95	1.55 ± 1.61	2.56 ± 1.52	2.22 ± 1.56	2.69 ± 1.25	2.59 ± 1.17	3.93 ± 1.36	4.29 ± 1.39	4.74 ± 1.56	4.89 ± 1.34	2.17 ± 1.22
Alkalinity (mg/L)	50.02 ± 15.76	51.93 ± 15.74	50.89 ± 15.94	52.70 ± 15.82	261.17 ± 11.99	244.25 ± 39.71	711.08 ± 3.57	701.05 ± 92.54	781.66 ± 62.11	762.24 ± 112.55	366.70 ± 330.46
Total Hardness (mg/L)	95.66 ± 11.71	97.57 ± 14.10	96.44 ± 12.19	100.56 ± 14.01	221.94 ± 6.96	217.58 ± 7.46	275.83 ± 16.75	275.26 ± 51.77	279.74 ± 17.27	280.31 ± 17.12	194.09 ± 86.04
Chloride (mg/L)	5.51 ± 5.29	5.31 ± 5.26	5.85 ± 5.37	5.74 ± 5.42	34.45 ± 4.33	34.96 ± 6.30	57.16 ± 3.59	44.51 ± 6.15	59.67 ± 3.16	60.51 ± 2.09	31.36 ± 23.95

Table 2 : Average annual value of Heavy metals of river Panvdhoi

Parameters	Sampling Station 'A'		Sampling Station 'B'		Sampling Station 'C'		Sampling Station 'D'		Sampling Station 'E'		Average
	2002-2003	2003-2004	2002-2003	2003-2004	2002-2003	2003-2004	2002-2003	2003-2004	2002-2003	2003-2004	2002-2004
Lead (Pb) (mg/L)	0.0702 ± 0.0076	0.0741 ± 0.0090	0.0711 ± 0.0073	0.0719 ± 0.0087	1.6170 ± 0.3797	1.9533 ± 0.3776	3.3084 ± 0.0776	3.3320 ± 0.1271	4.8452 ± 0.6109	4.9075 ± 0.6582	2.0882 ± 1.9130
Cooper (Cu)(mg/L)	0.0550 ± 0.0291	0.0533 ± 0.0324	0.0626 ± 0.0263	0.0602 ± 0.0332	0.0835 ± 0.0170	0.0811 ± 0.0236	0.8308 ± 0.1756	0.8351 ± 0.1757	1.5945 ± 0.3729	1.5595 ± 0.3328	0.5710 ± 0.6171
Zinc (Zn)(mg/L)	3.1651 ± 0.0528	3.2098 ± 0.0331	3.2109 ± 0.0259	3.2281 ± 0.0304	3.6755 ± 0.2067	3.6913 ± 0.3360	4.2443 ± 0.0732	4.2517 ± 0.1139	4.8695 ± 0.1763	4.871 ± 0.1750	3.8417 ± 0.6772
Mercury (Hg) (mg/L)	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0001 ± 0.0000	0.0003 ± 0.0002	0.0005 ± 0.0006	0.0006 ± 0.0002	0.0001 ± 0.0002

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An assessment of seed germination under the effect of natural dyes

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Abstract

Natural dyes are extracted from leaves, flowers, fruits etc. These substances are natural, hence after the extraction of natural dyes from them they are disposed off in the soil. Even the natural dyes after being used up are disposed off in the soil. Some experiments were conducted in order to show that these dyes during their production and after their use disposed in the soil, they do not spoil the soil quality. On the other hand the waste left after the extraction of dyes serves as manure, hence enriches the soil, Gram & Wheat were taken for experimental purpose, and their morphological characters like shoot length, root length, fresh weight & dry weight were studied by growing them in solutions containing different concentration of natural dyes. These characters were then compared with seed grown in deionised water. Analysis of variance was applied to know whether the difference was significant or insignificant.

Key words : *Natural dyes, Shoot length, Root length, Fresh weight, Dry weight.*

Introduction

The use of natural dye is enjoying a revival more importantly due to the non hazardous effects on skin and environment (Agarwal et al., 1993; Gulati and Turner, 1929; Kumar and Bharti, 1998;Lakhande and Naik, 1997). They do not release harmful chemicals during their production and subsequent use (Encyclopedia Britannica, 1943; Everyman's 1967; Rafai 1989; Rameshwar 2000; Shenai, 1987).

Experiments were conducted using gram and wheat seeds to evaluate the effect of natural dyes on the growth of plants during seed germination. This study has revealed that natural dyes are not harmful to the seed germination and it does not spoils the quality of the soil when it enters into it. The changes and response magnitude of the seedling in the dye solution was compared with each other as well as with the control seedlings.

Analysis of variance was applied to the above experiment, to see the effect of concentration of the dye as well as the time period on the growth of the plant seedling. F coefficient for variance between columns and rows is worked out. F coefficients are compared with their corresponding table values. If it is found that calculated value of coefficient for variance between samples is greater than its table value then difference between values is considered to be significant. If it is found that calculated value of coefficient for variance between samples is lesser than its table value than differ significant.

Materials and Methods

In the present study Gram grains ***(Cicer arietinum)*** & Wheat grains ***(Triticum aestivum)*** were taken for experimental analysis. The seeds were collected from Agriculture College, Indore and natural dyes from Rohini Herbals Pvt. Ltd., Indore. The four natural dyes used for the experimental purpose are namely - Tesu *(Butea monosperma)*, Anar *(Punica granatum)*, Majeeth *(Rubia tinctoria)* and Heena *(Lawsonia alba)*.Seeds were sterilized in 0.01% mercuric chloride ($HgCl_2$) solution for 10 minutes. The seeds were washed 2-3 times with deionised water. The seeds were soaked in a petridish and allowed to germinate under dark condition. Further germination of the seeds has been conducted on wet filter paper in petridishes having various concentrations of dye solution 0.2%, 0.4%, 0.6% and 1%. Simultaneously made a control with dieionised water. Seeds growth in these concentration were sampled and analyzed for 24 hours, 48 hours and 72 hours respectively. Triplicate sets were arranged for each parameter and triplicate readings were taken into consideration and their average values were tabulated accordingly. The changes and responses magnitude of the seedling in the dye solution was compared with each other as well as with the control seedlings.

Results

The average root length, shoot length, fresh weight and dry weight of the wheat and gram seed were examined under morphological parameters as follows :

Shoot length of Wheat

The shoot length increases after every 24 hours. When the dye *'Tesu'* is used the shoot length was about 1.3 cm in deionised water, which decreased to 0.98 cm. in 1% concentration of the dye, in 24 hours. After 48 hours the shoot length was 2.8 cm. in deionised water which reduced to 2.6 cm. In 1% dye concentration. After 72 hours it was 5.2 cm in deionised water which changed to 4.2 cm in 1% dye concentration. The calculated value for F coefficient for row works out to be 3.57, and for column it works out to be 506.06 (Table 1). When the dye *Majeeth* is used the shoot length which was 1.3 cm in deionised water decreased to 1.21 cm in 1% concentration of the dye in 24 hours. The same correlation was observed after 48 hours and 72 hours. The calculated value for F coefficient for row works out to be 3.43, and for column it works out to be 1051.09.

When the dye *Anar* is used the shoot length which was 1.5 cm in deionised water decreased to 1.24 cm in 1% concentration of the dye in 24 hours. The same correlation was observed after 48 hours and 72 hours. The calculated value for F coefficient for row works out to be 3.06, and for column it works out to be 221.86. When the dye *Heena* is used the shoot length which was 1.6 cm in deionised water decreased to 0.85 cm in 1% concentration of the dye in 24 hours. The same correlation was observed after 48 hours and 72 hours. The calculated value for F coefficient for row works out to be 1.34 and for column it works out to be 63.37.

Shoot length of Gram

When the dye *'Tesu'* is used the shoot length was about 1.1 cm in deionised water, which decreased to 0.78 cm. in 1% concentration of the dye, in 24 hours. After 48 hours the shoot length was 2.6 cm. in deionised water which reduced to 2.45 cm. in 1% dye concentration. After 72 hours it was 5.0 cm in deionised water which changed to 4.0 cm in 1% dye concentration. The calculated value for F coefficient for row works out to be 3.37, and for column it works out to be 487.46. (Table. 1).

When the dye *Majeeth* is used the shoot length which was 0.93 cm in deionised water decreased to 0.72 cm in 1% concentration of the dye in 24 hours. The same correlation was observed after 48 hours and 72 hours. The calculated value for F coefficient for row works out to be 3.10, and for column it works out to be 3576.50. When the dye *Anar* is used the shoot length which was 1.26 cm in deionised water decreased to 0.98 cm in 1% concentration of the dye in 24 hours. The same correlation was observed after 48 hours and 72 hours. The calculated value for F coefficient for row works out to be 3.29, and for column it works out to be 341.50. When the dye *Heena* is used the shoot length which was 1.23 cm in deionised water decreased to 0.98 cm in 1% concentration of the dye in 24 hours. The same correlation was observed after 48 hours and 72 hours. The calculated value for F coefficient for row works out to be 3.26 and for column it works out to be 351.89.

Root length of Wheat

When the dye *'Tesu'* is used the root length was about 1.8 cm in deionised water, which decreased to 1.38cm. in 1% concentration of the dye, in 24 hours. After 48 hours the root length was 2.9 cm. In deionised water which reduced to 2.22 cm. in 1% dye concentration. After 72 hours it was 4.3 cm in deionised water which changed to 3.19 cm in 1% dye concentration. The calculated value for F coefficient for row works out to be 2.16, and for column it works out to be 94.34. (Table 1). When the dye *Majeeth* is used the root length which was 2.2cm in deionised water decreased to 2.06 cm in 1% concentration of the dye in 24 hours. The same correlation was observed after 48 hours and 72 hours. The calculated value for F coefficient for row works out to be 3.43, and for column it works out to be 830.20.

When the dye *Anar* is used the root length which was 2.2 cm in deionised water decreased to 1.98 cm in 1% concentration of the dye in 24 hours. The same correlation was observed after 48 hours and 72 hours. The calculated value for F coefficient for row works out to be 3.43, and for column it works out to be 46.61. When the dye *Heena* is used the root length which was 2.26 cm in deionised water decreased to 2.00 cm in 1% concentration of the dye in 24 hours. The same correlation was observed after 48 hours and 72 hours. The calculated value for F coefficient for row works out to be 3.37 and for column it works out to be 335.46.

Root length of Gram

When the dye *'Tesu'* is used the root length was about 2.17 cm in deionised water, which decreased to 2.06 cm. in 1% concentration of the dye, in 24 hours. After 48 hours the root length was 2.83 cm. in deionised water which reduced to 2.00 cm. in 1% dye concentration. After 72 hours it was 5.14 cm in deionised water which changed to 5.00 cm in 1% dye concentration. The calculated value for F coefficient for row works out to be 3.38, and for column it works out to be 508.88 (Table 1).

When the dye *Majeeth* is used the root length which was 2.16 cm in deionised water decreased to 2.00 cm in 1% concentration of the dye in 24 hours. The same correlation was observed after 48 hours and 72 hours. The calculated value for F coefficient for row works out to be 3.26, and for column it works out to be 619.12. When the dye *Anar* is used the root length which was 2.17 cm in deionised water decreased to 2.06cm in 1% concentration of the dye in 24 hours. The same correlation was observed after 48 hours and 72 hours. The calculated value for F coefficient for row works out to be 3.42, and for column it works out to be 460.97.

When the dye *Heena* is used the root length which was 2.20 cm in deionised water decreased to 2.06 cm in 1% concentration of the dye in 24 hours. The same correlation

was observed after 48 hours and 72 hours. The calculated value for F coefficient for row works out to be 3.43 and for column it works out to be 830.20.

Fresh weight of Wheat

In each case the average fresh weight decreased but to a very small extent with the increasing dye concentration. When the dye *'Tesu'* is used the fresh weight was about 0.058 gm.in deionised water which decreased to 0.045 gm. in 1% concentration of the dye, in 24 hours. The same correlation was observed after 48 hours and 72 hours. The calculated value for F coefficient for row works out to be 2.16, and for column it works out to be 94.34. (Table 2). When the dye *Majeeth* is used the fresh weight , which was 0.054 gm. in deionised water, decreased to 0.047 gm. in 1 % concentration of the dye in 24 hours. The same correlation was observed after 48 hours and 72 hours. The calculated value for F coefficient for row works out to be 3.43 , and for column it works out to be 830.20. When the dye *Anar* is used the fresh weight which was 0.072 gm. in deionised water decreased to 0.059 gm. in 1 % concentration of the dye in 24 hours. The same correlation was observed after 48 hours and 72 hours. The calculated value for F coefficient for row works out to be 3.43, and for column it works out to be 46.61. When the dye *Heena* is used the fresh weight , which was 0.073 gm. in deionised water, decreased to 0.068 gm. in 1 % concentration of the dye in 24 hours. The same correlation was observed after 48 hours and 72 hours. The calculated value for F coefficient for row works out to be 3.37, and for column it works out to be 335.46.

Fresh weight of Gram

When the dye *'Tesu'* is used the fresh weight was about 0.32 gm.in deionised water which decreased to 0.26 gm. in 1% concentration of the dye, in 24 hours. The same correlation was observed after 48 hours and 72 hours. The calculated value for F coefficient for row works out to be 2.78, and for column it works out to be 625.53. (Table 2).When the dye *Majeeth* is used the fresh weight , which was 0.36 gm. in deionised water, decreased to 0.25 gm. in 1 % concentration of the dye in 24 hours. The same correlation was observed after 48 hours and 72 hours. The calculated value for F coefficient for row works out to be 3.23 , and for column it works out to be 6.92.

When the dye *Anar* is used the fresh weight which was 0.42 gm. in deionised water decreased to 0.33 gm. in 1 % concentration of the dye in 24 hours. The same correlation was observed after 48 hours and 72 hours. The calculated value for F coefficient for row works out to be 3.15, and for column it works out to be 10.46. When the dye *Heena* is used the fresh weight , which was 0.40 gm. in deionised water, decreased to 0.32 gm. in 1 % concentration of the dye in 24 hours. The same correlation was observed after 48 hours and 72 hours. The calculated value for F coefficient for row works out to be 3.43, and for column it works out to be 830.20.

Dry weight of Wheat

When the dye *'Tesu'* is used the dry weight was about.0.03 gm. in deionised water, which decreased to 0.21 gm. in 1% concentration of the dye, in 24 hours. The same correlation was observed after 48 hours and 72 hours. The calculated value for F coefficient for row works out to be 1.69, and for column it works out to be 170.06. (Table 2). When the dye *Majeeth* is used the dry weight , which was 0.031 gm. in deionised water, decreased to 0.025 gm. in 1 % concentration of the dye in 24 hours. The same correlation was observed after 48 hours and 72 hours. The calculated value for F coefficient for row works out to be 1.79, and for column it works out to be 191.94.

When the dye *Anar* is used the dry weight of root which was 0.042 gm. in deionised water decreased to 0.031 gm. in 1% concentration of the dye in 24 hours. The same correlation was observed after 48 hours and 72 hours. The calculated value for F coefficient for row works out to be 3.36, and for column it works out to be 26.74. When the dye *Heena* is used the dry weight , which was 0.052 gm. in deionised water, decreased to 0.047 gm. in 1 % concentration of the dye in 24hours. The same correlation was observed after 48 hours and 72 hours. The calculated value for F coefficient for row works out to be 1.98 , and for column it works out to be 789.86.

Dry weight of Gram

When the dye *'Tesu'* is used the dry weight was about 0.46 gm. in deionised water, which decreased to 0.03 gm. in 1% concentration of the dye, in 24 hours. The same correlation was observed after 48 hours and 72 hours. The calculated value for F coefficient for row works out to be 2.28, and for column it works out to be 82.59. (Table 2). When the dye *Majeeth* is used the dry weight , which was 0.048 gm. in deionised water, decreased to 0.037 gm. in 1 % concentration of the dye in 24 hours. The same correlation was observed after 48 hours and 72 hours. The calculated value for F coefficient for row works out to be 2.12, and for column it works out to be 248.70. When the dye *Anar* is used the dry weight which was 0.049 gm. in deionised water decreased to 0.038 gm. in 1% concentration of the dye in 24 hours. The same correlation was observed after 48 hours and 72 hours. The calculated value for F coefficient for row works out to be 2.11, and for column it works out to be 412.07. When the dye *Heena* is used the dry weight , which was 0.051 gm. in deionised water, decreased to 0.045 gm. in 1 % concentration of the dye in 24 hours. The same correlation was observed after 48 hours and 72 hours. The calculated value for F coefficient for row works out to be 1.83 , and for column it works out to be 173.83.

Conclusion

It was found that as the time increases, i.e., 24 to 48 hours to 72 hours, there is an increase in all the morphological characters. But as the concentration of the dye solution is increased there is a slight decrease in the growth characteristics, which shows that the increased dye concentration do effect the growth. But the effect is too small or negligible as compared to that of synthetic dyes.

When analysis of variance was applied to the above experiments, to see the effect of concentration of dye as well as time on growth of plants, it was found out that F ratio concerning variance between columns, i.e., concerning growth at different time interval works out to be greater than the table value of F which shows that the difference is significant. The F ratio concerning variance between rows i.e. concerning the growth at different concentration of the dye work out is less than the table value in all cases, which shows that the difference is significant.

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TABLE 1

Effect of Natural Dyes on Shoot Length & Root Length of Wheat & Gram at Different Intervals of Time

Name of the Dye	% Conc.	Shoot Lenghts of Wheat (cms.)			Shoot Lenghts of Gram (cms.)			Root Lengths of Wheat (cms.)			Root Lengths of Gram (cms.)		
		24 hrs.	48 hrs.	72 hrs.	24 hrs.	48 hrs.	72 hrs.	24 hrs.	48 hrs.	72 hrs.	24 hrs.	48 hrs.	72 hrs.
TESU	D. W.	1.3	2.8	5.2	1.1	2.6	5	1.8	2.9	4.3	2.17	2.83	5.14
	0.20	1.22	2.77	4.94	1.02	2.57	4.74	1.76	2.82	4.07	2.16	2.75	5.12
	0.40	1.15	2.72	4.69	0.95	5.52	4.49	1.63	2.61	3.76	2.1	2.61	5.02
	0.60	1.05	2.65	4.45	0.85	2.5	4.25	1.5	2.41	3.47	2.09	2.32	5
	1.00	0.98	2.6	4.2	0.78	2.45	4	1.38	2.22	3.19	2.06	2	4.85
MAJEETH	D. W.	1.43	2.12	3.25	0.93	2.74	4.65	2.2	2.9	5.41	2.16	2.73	5.12
	0.20	1.42	2.11	3.23	0.9	2.72	4.63	2.17	2.85	5.4	2.15	2.65	5.1
	0.40	1.39	2.08	3.16	0.86	2.69	4.56	2.11	2.77	5.35	2.08	2.51	5.09
	0.60	1.35	2.01	3.11	0.81	2.63	4.5	2.09	2.43	5.3	2.05	2.22	5
	1.00	1.3	1.98	2.66	0.72	2.54	4.41	2.06	2.22	5.21	2	2	4.85
ANAR	D. W.	1.5	3.05	5.6	1.26	2.38	4.48	2.2	3.2	4.5	2.17	2.88	5.15
	0.20	1.42	3	5.4	1.25	2.36	4.45	2.16	3	4.48	2.16	2.75	5.15
	0.40	1.36	2.84	4.95	1.1	2.25	4.34	2.1	2.3	4.4	2.09	2.67	5.03
	0.60	1.3	2.79	4.55	1	2.2	4.31	2.04	2.2	4.3	2.08	2.33	4.99
	1.00	1.24	2.7	4.2	0.98	1.35	4.22	1.98	2.09	4.18	2.06	2	4.48
HEENA	D. W.	1.6	2.74	3.66	1.23	2.35	4.43	2.26	3.38	5.48	2.2	2.9	5.41
	0.20	1.2	2.72	3.6	1.22	2.34	4.43	2.25	3.36	5.45	2.17	2.85	5.4
	0.40	1	2.67	3.52	1.2	2.23	4.32	2.1	3.25	5.35	2.11	2.77	5.35
	0.60	0.96	2.6	3.44	1.1	2.2	4.25	2	3.25	5.31	2.09	2.43	5.3
	1.00	0.85	2.55	3.79	0.98	1.35	4.2	1.98	2.35	5.19	2.06	2.22	5.21

TABLE 2

Effect of Natural Dyes on Fresh & Dry Weight of Wheat & Gram at Different Intervals of Time

Name of the Dye	% Conc.	Fresh Weight of Wheat (cms.)			Fresh Weight of Gram (cms.)			Dry Weight of Wheat (cms.)			Dry Weight of Gram (cms.)		
		24 hrs.	48 hrs.	72 hrs.	24 hrs.	48 hrs.	72 hrs.	24 hrs.	48 hrs.	72 hrs.	24 hrs.	48 hrs.	72 hrs.
TESU	D. W.	0.058	0.217	0.47	0.32	0.45	0.53	0.03	0.049	0.19	0.046	0.065	0.19
	0.20	0.05	0.195	0.038	0.31	0.44	0.51	0.027	0.047	0.17	0.041	0.064	0.17
	0.40	0.048	0.164	0.33	0.29	0.43	0.5	0.026	0.046	0.16	0.038	0.062	0.16
	0.60	0.047	0.15	0.28	0.28	0.42	0.48	0.023	0.044	14	0.033	0.06	0.14
	1.00	0.045	0.136	0.22	0.26	0.39	0.47	0.021	0.042	0.13	0.03	0.058	0.11
MAJEETH	D. W.	0.054	0.066	0.22	0.36	0.46	0.76	0.042	0.052	0.086	0.048	0.084	0.26
	0.20	0.051	0.065	0.21	0.35	0.45	0.76	0.041	0.05	0.085	0.046	0.083	0.24
	0.40	0.05	0.064	0.19	0.29	0.41	0.62	0.04	0.048	0.08	0.043	0.081	0.22
	0.60	0.048	0.062	0.18	0.28	0.39	0.42	0.034	0.045	0.075	0.04	0.079	0.21
	1.00	0.047	0.06	0.16	0.25	0.32	0.22	0.031	0.042	0.04	0.037	0.077	0.19
ANAR	D. W.	0.072	0.109	0.184	0.42	0.56	0.84	0.072	0.109	0.184	0.049	0.081	0.29
	0.20	0.065	0.1	0.178	0.4	0.55	0.8	0.065	0.1	0.178	0.047	0.079	0.28
	0.40	0.063	0.085	0.17	0.39	0.51	0.75	0.063	0.085	0.17	0.043	0.078	0.26
	0.60	0.061	0.06	0.165	0.35	0.49	0.55	0.061	0.06	0.165	0.041	0.076	0.24
	1.00	0.059	0.031	0.16	0.33	0.43	0.34	0.059	0.031	0.16	0.038	0.075	0.23
HEENA	D. W.	0.073	0.171	0.32	0.4	0.52	0.82	0.053	0.086	0.32	0.051	0.089	0.22
	0.20	0.072	0.169	0.318	0.38	0.5	0.8	0.051	0.084	0.31	0.048	0.086	0.2
	0.40	0.071	0.168	0.315	0.36	0.49	0.76	0.05	0.083	0.29	0.047	0.085	0.19
	0.60	0.069	0.167	0.311	0.35	0.48	0.54	0.048	0.081	0.28	0.047	0.083	0.17
	1.00	0.068	0.166	0.299	0.32	0.42	0.35	0.047	0.079	0.27	0.045	0.081	0.16

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Modeling the effect of light on phytoplanktonic growth dynamics : A Review

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Introduction

Light plays an important role in the life of organisms including the whole diversity of plants ranging from microscopic phytoplankton to giant trees, because it is the sole source of energy which effects the growth dynamics and structure of most aquatic and terrestrial communities. The unidirectional nature of light gives rise to a vertical gradient of light intensity as a function of depth. Since phototropic organisms absorb light to make a living, this vertical gradient is not static but dynamic. (Reynolds, 1984).

Turbidity and transparency are the major factors in water column, which affects the growth of phytoplankton, because light penetration is controlled by the amount and kind of materials that are dissolved and suspended in the water. Two processes diminish light under water column: absorption and scattering (Kirk, 1994). Absorption and scattering interact in a complex and nonlinear manner to govern the attenuation of light under water .The equation governing the propagation of light underwater, called the radiative transport equations, have no exact solution: but several computer programs have been written to solve the equations by various numerical methods.

Light limited growth models

It's seems that Kok (1952) and Sverdrup (1953) used mathematical models for the first time about five decades ago. There after a number of models were suggested to study the problem and for an excellent discussion on various models, One may refers to Talling (1957), Platt *et al*. (1990), Kirk (1994), Huisman, and Wessing (1994), Huisman (1999),etc.Light- limited growth models use mathematical and numerical techniques to simulate the physical and biological processes that affect the growth dynamics of phytoplankton. A comprehensive light limiting growth modeling approach require the following component:

(a) Physico- chemical and biological data.
(b) Basic equation governing light behavior.

(A) Physico- chemical and biological data.

Physico-chemical and biological parameters plays an important role in population dynamics of phytoplankton. Various parameter that effects the population dynamics of phytoplankton may be broadly classified as light intensity, photoperiod, nutrient availability, Chlorophyll content, transparency, turbidity, temperature, velocity, water column depth. Light intensity, duration, and water column depth are the basic parameter and others are the derived ones.

(B) Basic equations governing light behaviour.

Light downwelling in water column is expressed by two basic exponential equation:

(i) The Beer-Lambert law

(ii) Bouguer's law.

The attenuation of light due to absorption and scattering along the path at a distance S is given by the equation:

$$L(s) = L(0)e^{-\int_0^s K(s)ds} = L(0)e^{-KS}$$

Where K(s) is a function of local parameters of the medium, and Ks =is the opacity or optical thickness.

The light intensity, I, decreases with depth S according to Lambert- Beer's law:

$$I(s) = I_{in}e^{-(kws + k_{bg}s)}$$

Where I_{in} is the incident light intensity, k is the specific light attenuation coefficient of the phytoplankton, and K_{bg} is the total background turbidity due to non- phytoplankton components. The light intensity at the bottom of the water column, I_{out}, is given by I_{out}= I(Z).

Depth integrals are used to calculate depth- integrated production by Monod equation:

$$P(I) = \frac{P_{\max} I}{(P_{\max}/\alpha) + I}$$

Where P_{mex} is the maximum rate of specific production, and is the slope of the P(I) function at I =0 .The advantage of the Monod equation is that it has a simple analytical solution of its depth integral.

Combining the Beer-Lambert's law of absorption and Monod Equation, the following dynamic system (Huisman and Weissing 1994, Weissing and Huisman 1994).

$$\frac{dw}{dx} = \frac{1}{z}\frac{Kw}{(Kw + K_{bg})}\int_{I_{out}}^{I_{in}} \frac{p(I)}{kI} dI - Dw$$

Where P(I) is a function of the local light intensity I. This model predicts that there is a critical value of I_{out}, where we have called the critical light intensity, at which the phytoplankton population should remain stationary. The phytoplankton population should increase as long as I_{out} is above its's critical light intensity, where as the population should decrease as soon as I_{out} is below its critical light intensity. These population dynamics leads to a steady state. A phytoplankton

popupation should grow unite, at steady state, it has reduced the light intensity at the bottom of the water column to its critical light intensity.

The light resource index for phytoplankton growth can be given as (Hamiliton and Schladow, 1997):

$$R_I = \frac{I}{I_{sat}} \exp\left[1 - \frac{I}{I_{sat}}\right]$$

Where I = light irradiance in a stationary water zone(STA-WZ) with its saturation value for reproduction as I_{sat}.

Steele's Equation (1962):

$$F_{Lp} = \frac{I(Z)}{K_{Lp}} e^{1-\frac{I(z)}{K_{Lp}}}$$

where K_{Lp} = the PAR at which phytoplankton growth is optimal [ly/d]. This function can combined with the Beer-Lambert law and integrated over water depth to yield

$$\phi_{Lp} = \frac{2.718282}{K_e H}\left[e^{-\frac{I(0)}{K_{Lp}}e^{-K_e H}} - e^{-\frac{I(0)}{K_{Lp}}}\right]$$

Smith's Function(1980):

$$F_{Lp} = \frac{I(z)}{\sqrt{K^2{}_{Lp} + I(z)^2}}$$

where KLp = the Smith parameter for phytoplankton [ly/d]; that is, the PAR at which growth is 70.7% of the maximum. This function can be combined with the Beer-Lambert law and integrated over water depth to yield. FLp = phytoplankton growth attenuation due to light and KLp = the phytoplankton light parameter.

$$\phi_{Lp} = \frac{1}{k_e H} In\left[\frac{I(0)/K_{Lp} + \sqrt{1+\left(I(0)/K_{Lp}\right)^2}}{\left(I(0)/K_{Lp}\right)e^{-k_e H} + \sqrt{1+\left((I(0)/K_{Lp})e^{-k_e H}\right)^2}}\right]$$

Light intensity and phytoplanktonic modeling

Various types of model are developed in past few decades. Models which are developed for light intensity and its effect on phytoplankton growth are based on some basic assumptions such as Lambert-Beer's law, Steele's equation and Smith's equation for light and its behavior in absorbing and scattering column and Monod equation for the depth integration,

The specific light transmission coefficient, k was given by Bindloss(1976). Reynolds(1984) gave the growth rate models for phytoplankton in presence of light.George and Edwards(1976) gave the model for surface distribution of phytoplankton chlorophyll. Huisman and Weissing (1994. 1995), and Weissing and Huisman (1994) developed an analytically tractable model to analyze the effects of a dynamic light gradient on phytoplankton competition and community structure. Kok (1952), Sverdrup(1953) assume to be the founder of light intensity and its effect on the phytoplanktonic growth dynamics .Cullen (1990) developed a model on the growth and phototosynthesis in phytoplankton.Talling (1957), Platt *et al*.(1990), Kirk (1994) also developed some dynamic model for light and phytoplanktonic population growth.Numerical expressions for approximation for depth integral is also given by Platt *et al*. (1991).Several investigators Talling(1965), Jewson (1977), Reynolds(1984).Chapra(1997) have used the concept of a euphotic depth to calculate phytoplankton carrying capacities under light- limited conditions and also summarized the equation to give the model for phytoplankton and its growth limited by light. Jassby and Platt(1976) formulate a mathematical model for the relationship between light and phytoplankton. Kemp and Mitsch (1979) gave a general model for phytoplankton.Evers (1991) developed a model for light-limited continuous cultures for plankton.

Symbol		Interpretetion	Unit
S	=	Depth of the water column.	m.
z	=	Total depth of water column.	m.
w	=	Biomass of water column.	$g/m_{2.}$
W	=	Total biomass of the water column.	$g/m_{2.}$
I	=	light irradiance.	$J.m^{-2}.s^{-1}$
I_{in}	=	is the incident light intensity,	$J.m^{-2}.s^{-1}$
k	=	is the specific light attenuation coefficient of the phytoplankton.	$m^{-1.}$
K_{bg}	=	is the total background turbidity due to non- phytoplankton components.	$m^{2.} g^{-1}.$
I_{out}	=	is the light intensity at the bottom of the water column.	$J.m^{-2}.s^{-1}$
KLp	=	the Smith parameter for phytoplankton.	ly/d.
FLp	=	phytoplankton growth attenuation due to light.	$m^{-1.}$
K(s)	=	is a function of local parameters of the medium.	–
Lp	=	the phytoplankton light parameter.	–
I_{sat}	=	saturation value for reproduction.	–
P(I)	=	is a functin of the local light intensity.	–
P_{mex}	=	is the maximum rate of specific production.	1/s

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Forest status and land use scenario at Singrauli: A Bird Eye View

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Abstract

Present paper deals with the forest status and land use pattern at Singrauli. Singrauli region once had very dense dry tropical forest, which due to rapid industrialization in recent years got significantly reduced. It is concluded from the study that in general the area under forest and agriculture reduced tremendously while the area under mining has increased markedly.

Key Words *:Forest, Agriculture, Land use pattern, Mining*

Introduction

Since the sixties, the term environment has mostly been used in reference to the human environment; actually every living organism has an environment that is made up of all the physical, chemical and biological condition in which the organism lives.

Indian civilization is distinctive in the sense that it evolved in the forests, not in the city. According to Tagore, 'Forests have nurtured India's mind and India's civilization. Intellectual growth in India did not take place in enclosures made of brick, wood and mortar, but was inspired by the life of the forests in which nature's living forces express themselves in daily variation, creating a diversity of life and sounds, providing the context for the understanding of nature and man. Human understanding in such context could not be restricted to perceiving nature as inert, as an accumulation of dead resources waiting for exploitation. Nature provides light, air food and water through living processes of creative renewal.

This awareness of life in nature as a precondition for man's survival led to the worship of light, air, food and water and they were considered sacred. Indian culture has been cradled by the culture of the forest first in the Vedic period and later during the times of Buddha and Mahavir. Thus, forests in India had remained central to its civilization evolution. The forest teased 'ashrams' (settlements) produced the best scientific research and cultural writings and India thus came to known as an 'Aranya Sanskriti' or a forest culture. Human understanding of the fundamental ecological utility of forest ecosystems and their economic importance led to veneration of trees. This basic dependence on the existence of forests for human survival was the material basis underlying the worship of trees in almost all-human societies. In the Rig Veda, forests are described as Aranyani or mother goddess who takes care of wildlife and ensures the availability of food to man. These ashrams and forests, not urban settlements, were recognised as the highest form of cultural evolution providing society with both intellectual guidance and material sustenance.

This civilization principle became the foundation of forest conservation as a social ethic through millennia. Its erosion began with the spread of colonial methods of management, of forests in India. Teak from the forests of the Western Ghats, Sal from Central and Northern India

and conifers from the Himalayas were felled to meet the timber needs of the British Empire. The results was not merely the destruction of forests but the destruction of a culture that conserved forests.The entire Singrauli region was once covered with dry tropical forest. However, rapid industrialization in recent years, such as quarrying for limestone's establishment of cement and chemical factories, thermal power station, coal mining and construction of reservoir (Plant Sager) have resulted in displacement and rapid build up of human population, deforestation, conversion of natural forest ecosystems into savanna and marginal croplands.

Location

The forest area is hilly as well as plain. The plains are under cultivation in general, and the hills have vegetations. The only hill range extends from Jeer in the North upto Bargawan in the South. The height of the hills is 200 to 400 meters, which form into a plateau near Birdaha. Gopad River form the western boundary of the plan area and all the rivers of the region fall into Gopad in the West, into Rihand in the East and into Sone in the North.In the South Eastern part of Rihand Valley lie the crystalline rocks of Archaean age. Sedimentary rocks of Vindhyan age are found in the northern part of Sone valley. The famous coal mines of Singrauli in this region.

The soil is derived from the Sandstone's, Granites, Schist's Gneiss, Quartzite, and Shale rocks. Different series of soil have derived at various heights depending upon the configuration and it varies from sandy loam to clayey loam.

Forest of East Sidhi forest division geographically lies between latitude $23^0$45' and $24^0$45' North and longitude $81^0$50' and $82^0$50'. East. The area of the division includes Deosar. Chitrangi and Singrauli tehsils of Sidhi district. There are two sub-divisions and four ranges in this division. Geographical area is 5672.83 Sq. Km., within which Reserve forests is 1303.15 Sq. Km. and Protected forest is 916.50 Sq. Km. Total forest area is 2219.65 Sq. Km. Showing Table-1.

Forest Status

There were two forest divisions namely Rewa and Umaria during the Rewa Darbar period. In 1953 four divisions were carved out in which Sidhi was one and in 1962 the Sidhi division was divided into east and west Sidhi. The silvicultural system prevailing in the area up to 1956 was CWR, and SCI introduced during 1956, prescribing the selection girth of Sal, Bija, Tinsa and Shisham as 120 CM. The selection girth of Saja, Tendu, Haldu and Khamar was 90cm. Bamboo was exploited heavily.

Before 1927 there were fourteen reserved forest divisions as per the orders of the Rewa Raj Darbar. During the period of the Rewa Raj forests were Rajas properties. In the year 1935 Rewa Maharaja approved the Rewa Rajya Van Adhiniyam, which was under operation till 1950. In 1948 new state Vindhya Pradesh came into existence, then the Rewa Rajya Van Adhiniyam was abolished and the Indian forest Act 1927 was enforced for the forests of the area. Sidhi forests have now been divided into East and West forest divisions. The total forest area of the Sidhi forest is 4000 Sq. kms. of which 2219.65 belongs to East and 1219.36 belong to West forest division. The protected and reserved forest areas in East and West Sidhi divisions are 916.50 Sq. Kms. and 1303.15 Sq. Kms. and 453.04 Sq. kms. and 766.32 Sq. kms. respectively.

Excluding the areas of Bagdara sanctuary (area 23,104.76 Hect.), the plant area has now 35 reserve forest blocks and 158 protected forest blocks, 43 new protected forest blocks (area 1448.38 Hect.) were notified recently under section 29 of the Indian forest Act, which have for the first time been included in the Plan. An area of 2124.93 hect. was denotified in order to settle the

encroachments upto 1976.

The natural vegetation of the district was mostly arboreal. About 4000 Sq. km. out of the total area of 10546 Sq. km. of the district, are classified under reserved and protected forests. The recorded forest cover, therefore, comes to 37.97% of the total and area. This statistics is no longer true. The exorbitant clearing for agriculture and unregulated grazing have stripped the forest nearly all the plain and much of the lower hills. In the plains the woodland is now almost confined riverine strip.

Description of the forest and species structure

The forests have been classified into following sub-groups as per revised classification of Champion and Seth :

1: Northern Tropical Dry Deciduous Forests, sub-group 5B, Dry Peninsular Sal : 5B/C1c
2: Northern Tropical Dry Deciduous Forests, sub-group 5B, Northern Dry Mixed Deciduous Forest: 5B/C2

In addition, following two Edaphic Sub-Types are also found :

1:	5B/E2	Salai Forests
2:	5B/E9	Dry Bamboo Area

The classification of Champion adopted in forest records mentions about a long strip of moist dry deciduous forest in southern Gopadbanas tahsil showing good coverage of Sal (*Shorea robusta*). Teak (*Tectona grandis*) and Bamboos (*Dendrocalamus spp.*) are the most important species of the district. Timber and fuel are the major products of the division. Bamboos, Tendu leaf, and Harra are the minor forest products of the area.

The main species of the forests of the region is Sal. Natural teak is not present though quite a few successful teak plantations are there. Bamboo in Sal as well as in mixed forests forms the understory over quite a large area but it is in a very degraded condition.

From the management point of view East Sidhi forests have been divided into following two categories

(1) Sal forest
(2) Mixed forest

Sal forest

The forests, which have 20 to 90 percent Sal have been classified as Sal forest. The total area of the Sal forest is 32,205 hectare. Which makes 14 percent of the total forest area. The regeneration of the Sal forest appears to be quite discouraging because of heavy grazing and fire incidences and anthropogenic activities including mining hence the young plants are rarely seen. The significant associates and the species structure are as follows.

Chief associates of top canopy :

Terminalia tomentosa, Diospyros melanoxylon, Boswellia serrata. Lannea grandis, Anogeissus latifolia.

Other Associates of top canopy :
Terminalia arjuna, Terminalia belerica, Eleodendron glaucum, Schleichera oleosa, Pterocarpus marsupium, Dalbergia paniculata, Madhuca indica.

Chief associates of middle story :
Buchanania lanzan, Emblica officinalis, Zizyphus xylopyra, Casearia tomentosa, Ougenia oojeinensis, Cassia fistula, Flacourtia indica, Careya arborea.

Other associates of middle story :
Aeacia catechu, Eugenia heyeana, Soymida febrifuga, Saccopetalum tomentosum, Mallotus philippinensis, Dalbergia lanceolaria, Cochlospermum religiosum, Holarrhena antidysenterica, Wrightia tinctoria, Bauhinia retusa, Grewia tiliaefolia, Kydia calycina, Dendrocalamus strictus .

Chief associates of under story :
Nyctanthus arbortristis, Woodfordia floribunda, Indigofera pulchera, Gardenia turgida, Flemingia spp.

Other associates of under story :
Phoenix acaulis, Carissa opaca, Asparagus racemosus, Randia dumetorum, Grewia hirsuta.

Grass species :
Heteropogan contortus, Eragrostis tenella, Themedi triandra, Bauhinia vahlii, Butea superba, Butea parviflora, Vallaris heynei, Celastrus paniculata, Zizyphus oenoplia, Abrus precatorius, Ventilago calyculata, Smilex zeylanica.

Mixed Forest :

The forests, which have mixed species by 80% of its volume, have been classified mixed forests. The total area in mixed forest is 12,0996 hectare which makes 54.5% of the total forest area. Chief constitute of mixed forest are as follows.

Chief associates of top canopy :
Anogeissus latifolia, Diospyros melanoxylon, Boswellia serrata, Terminalia tomentosa, Lannea grandis, Lagerstroemia parviflora.

Other associates of top canopy :
Terminalia arjuna, Adina cordofolia, Madhuca indica, Pterocarpus marsupium, Shorea robusta, Dalbergia lanceolaria, Terminalia balerica, Albizzia procera, Dalbergia latifolia, Sterculia urens.

Chief associates of middle story :
Buchanania lanzan, Emblica officinalis, Casearia tomentosa, Holarrhena antidysenterica, Wrightia tinctori.

Other associates of middle story :

Semicarpus anacardium, Eleodendron glaucum, Hymenodictyon excelsum, Cassia fistula, Saccopetalum tomentosum, Ehretia laevis, Acacia catechu, Gardenia latifolia, Flacouria indica, Erythrina suberosa, Garuga pinnata, Cordia macleodii, Dendrocalamus strictus.

Chief associates of under story :

Woodfordia floribunda, Nycanthus arbortristis, Carissa opaca, Zizyphus jujuba

Other associates of under story

Helicteres isora

Grass species :

Heteropogan contortus, Apulda varia, Dicanthium annulatum, Bauhinia vahlili, Zyzyphus oenoplea, Abrus precatorius, Smilex macrophylla, Vallaris heynei, Dioscoria diemona, Butea parvifloras.

Land use pattern :

Land use pattern in and around Singrauli coalfields has been worked out. Table - 2 present data for land use pattern for 1986, 1991, 1996 and 2001. The trend has been shown for a total number of fifteen years at a regular interval of five years Fig.1 and Fig.2. It is evident from the data that the area under agriculture and under forest has reduced markedly. Which comes to 19.31% and 35.76% respectively. The area under mining shows an increase from 2.6 Sq. Km. to 9.29 Sq. Km. in the past fifteen years. The built up land has also increased from 4.71 Sq. Km. to 14.73 Sq. Km., wastelands shows a decrease from 10.61 Sq. Km. to 2.96 Sq. Km. may be because of the fact of the plantation on over burden done by the NCL which was nil in 1986 and gone upto 16.5 Sq. Km. in 2001.

It can conclude from the land use pattern scenario that in general the area under forest and agriculture has reduced tremendously while the area under mining has increased markedly.

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Table 1: Showing rangewise forest area in Sidhi district

Range	Reserved forest area	Protected forest area	Total area
Chitrangi	14739.60 ha	9641.78 ha	24381.38 ha.
Bargawan	10158.00 ha.	28661.96 ha.	38819.96 ha.
Waidhan	30062.68 ha.	8090.47 ha.	38153.15 ha.
Mada	36264.82 ha.	6021.75 ha.	42286.57 ha
Sarai	18995.67 ha.	21824.12 ha.	40819.79 ha.
Jiyawan	20093.63 ha.	17410.21 ha.	37503.84 ha.
Total	130314.40 ha	91650.29 ha.	221964.69 ha

Table 2: Land use pattern in Sidhi district

	1986	1991	1996	2001	%
Agriculture land	52.8	49.4	46.00	42.6	19.31
Forest	27.6	24.31	21.02	17.73	35.76
Built-up land	4.71	8.05	11.39	14.73	-212.73
Waste land	10.61	8.06	5.51	2.96	72.10
Mining area	2.6	4.83	7.06	9.29	-257.30
Ash pond	0.3	0.73	1.16	1.59	-430.00
Water bodies	1.38	1.37	1.36	1.35	2.17
Plantation	0.0	2.7	5.4	8.1	810.00
Plantation on OB	0.0	5.5	11.00	16.5	165.00

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Primary production efficiency in different environmental settings of Sahstradhara hill-stream, Dehradun.

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Abstract

An investigation was conducted on primary productivity and water quality of Sahastradhra hill-stream for evaluation of aquatic ecosystem status in different environmental settings along with the stream. The factors such as temperature, pH, carbon dioxide and plankton on which primary productivity depends were studied. It was pointed out that the Gross primary productivity showed a negative relationship with temperature, pH and carbon dioxide.

The present paper deals with the production efficiency of Sahastradhara hill stream, Dehradun and maximum production efficiency of Sahastradhara stream was found 66.66% at sampling site- III in the month of December 2003, while minimum production efficiency was recorded 20.79% at site- IV during May 2004.

Key words: *Production efficiency, Primary productivity, Photosynthesis, Hill-stream ecology.*

Introduction

The rate of production of organic matter per unit time is termed as productivity with the two levels; primary and secondary in producers and consumers respectively. the amount of new organic matter as plant tissue built up by photosynthesis is termed as primary production. Primary productivity is the rate at which the sun's radiation energy is stored by photosynthetic activity of producer organisms. The animal and plant communities inhabiting water bodies are considered as the direct manifestation of the productivity. It is well established that the primary productivity is controlled by several physico-chemical and biotic interactions (Pandey and Mishra,2000).

There are few successive steps of production process; Gross Primary Productivity (GPP) rate of photosynthesis and includes the organic matter used up in the respiration; Net primary productivity (NPP) the rate of storage of organic matter in plant tissues in excess of the respiratory utilization by the producer; Net community productivity (NCP) or community respiration (CR) the rate of organic matter not used by heterotrophs. Production effeciency depends upon net primary productivity. If NPP is relatively high, than production efficiency will be automatically high in the particular ecosystem.

Material and Methods

Five sampling site were selected for the measurement of primary production & efficiency in Sahastradhara river. We choose the *light & dark bottle method* of Gaarder & Gran for estimation of primary productivity. The water samples were collected monthly from five sampling stations of 'Sahastradhara stream' during December 2003 to May 2004 in morning period 9:00 hrs. to 10:00 hrs. The samples for plankton and physico-chemical parameters were collected and analyzed by using rinsed borosil glassware, with the help of the procedure described by APHA (1995), Trivedi & Goel (1984), Santhanam et. al (1989) and Bharti (2004).

Results and Discussion

It is well established that the primary productivity is controlled by several physico-chemical and biotic interactions. The biotic communities inhabiting water bodies are considered as the direct manifestation of the productivity. The maximum gross primary productivity of Sahastradhara stream was observed during winter season. Kar *et al*. (1978) recorded high productivity also in winter season.

Temperature plays a vital role in all physico-biochemical reactions and self-purification power of aquatic system. Temperature fluctuation measurement is useful to determine the trends of bio-chemical and biological activities. Temperature was recorded maximum (17.7ºC ± 0.4) in the month of May and minimum (13.1ºC±0.66) in January. The temperature of water decreases form September and increases from January onward. Badola and Singh (1981) observed similar trend in the river Alaknanda in the Garhwal region. Joshi and Kathait (1998) also reported similar trend in three Tributaries of river Ganga. The higher productivity in the present studies was concomitant with water temperature range from 14ºC to 18ºC. Singh and Swaroop (1980) observed positive correlation with productivity and water temperature. A positive correlation existed between gross primary productively and calcium in Cauvery (Lakshminarayan, 2001). Vashney *et al*. (1983) recorded a positive correlation was between gross primary productivity and dissolved oxygen while the negative correlation between gross primary productivity and temperature and free carbon dioxide. Sumithra (1971) reported a distinct correlation between productivity and alkalinity, we have also find the similar on individual values but there may be a standard error in correlations due to the mean value of parameters during the different months.

In this study it was recorded that the pH was always slightly alkaline. The pH of natural water was controlled in a greater extent by the interaction of hydroxyl ions, resulting form the dissociation of carbonic acid, and form hydroxyl ion arising from the hydrolysis of bicarbonate, was recorded highest (8.02 ± 0.1166) in December and lowest (7.4 ± 0.1414) in the month of April. The higher rate of photosynthesis decreases free carbon dioxide content and increases dissolved oxygen (Denham, 1938) while higher rate of decomposition increases free carbon dioxide. Similar observations were found in Sahastradhara stream during investigating period. Vashney *et al.* (1983) observed negative correlation between productivity and turbidity, total dissolved solids & suspended solids because these factors deceases the light penetration & further affects the rate of photosynthesis in aquatic ecosystem (Khanna, 1993), while negative correlation between GPP and pH, temperature & free carbon dioxide.

The maximum value of free carbon dioxide was observed (2.2 mg/l ±0.155) in May and minimum value in January (1.70 mg/l ± .066) free carbon dioxide and dissolved oxygen showed a negative relationship to one another. The highest rate of photosynthesis decreases free carbon-dioxide content and higher rate of decomposition increases free carbon dioxide.

The maximum net primary productivity was observed (0.335 ± .093) in the month of December and minimum (0.170 ± .04) in the month of May. The maximum gross primary productivity was observed (0.796 ± .123) in the month of January and minimum (0.569 ± .0379) in the month of May. The maximum net community respiration was observed (0.479 ± .0575) in the month of January and minimum (0.399 ± .0102) in the month of April. Net production efficiency shows the positive correlation with dissolved oxygen, while the negative correlation between net production efficiency and carbon dioxide. The maximum net production efficiency was observed (43.79%) in the month of December and minimum (29.88%) in the month of May. Similar trend was observed by Yeragi and Shaikh (2003) on the primary productivity of Tansa River. Kar *et al.* (1978) however, recorded low and high productivity in summer and winter respectively.

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Table-1: Primary productivity (mean values in mg/l) of Sahastradhara stream.

Parameters	Site-I	Site-II	Site-III	Site-IV	Site-V
N.P.P.	(0.200 - 0.355)	(0.200 – 0.255)	(0.140 – 0.500)	(0.105 – 0.320)	(0.200 – 0.330)
Mean	0.271±.069	0.220±.0215	0.336±.108	0.231±.086	0.265±.0522
G.P.P	(0.605 - 0.805)	(0.600 – 0.705)	(0.550 – 1.01)	(0.505 – 0.900)	(0.580 – 0.810)
Mean	0.6925±.074	0.640±.0776	0.716±.1344	0.729±.0975	0.676±.0826
C.R.	(0.405 - 0.450)	(0.400 – 0.450)	(0.390 – 0.480)	(0.400 – 0.580)	(0.380 – 0.480)
Mean	0.420±.0184	0.420±.0635	0.421±.0394	0.498±.156	0.411±.0375
NP.E (%)	(33.05 – 44.09)	(33.33 – 36.17)	(25.45 – 66.66)	(20.79 – 37.03)	(34.48 – 42.55)
Mean	38.77±4.7	34.29±1.101	44.15±15.56	30.485±6.445	38.87±3.069

Table- 2: Planktonic population (mean values) of Sahastradhara stream.

Planktonic diversity	Site-I	Site-II	Site-III	Site-IV	Site-V
Total plankton (n/l)	(700 - 1540)	(725 - 1525)	(693 - 1480)	(700 - 1490)	(730 - 1583)
Mean	1130.25±316.8	1133±316	1101.5±323.9	1063.75±346.9	1163.25±339.4
Phytoplankton (n/l)	(625 - 1380)	(635 - 1380)	(615 - 1345)	(635 - 1340)	(640 - 1410)
Mean	1018.25±286.1	1023.75±291.5	992.5±296.3	951.25±318.2	1037.5±259.5
Zooplankton (n/l)	(75 - 160)	(77 - 145)	(78 - 140)	(65 - 150)	(90 - 173)
Mean	112±31.61	109.25±27.09	109±28.6	112.5±31.72	125.75±36.66

Table-3: Physico-chemical parameters (mean values) of Sahastradhara stream.

Parameters	Site- I	Site- II	Site- III	Site- IV	Site- V
Temperature °C Mean	(14 - 18) 15.75±1.14	(13 – 17.5) 15.37±1.63	(13 - 17) 15.0±1.41	(13.5 - 18) 15.75±1.6	(12 - 18) 15.75±2.277
Velocity (m/s) Mean	(0.3 – 0.4) 0.3±0.14	(0.28 – 0.32) 0.9±0.1	(0.8 – 1.0) 0.35±0.05	(0.78 – 0.82) 0.8±0.02	(0.6 – 0.7) 0.65±0.05
Turbidity (JTU) Mean	(1 – 5) 2.75±1.47	(2.0 – 5.0) 3.25±1.30	(3 - 6) 4.5±1.15	(2 - 6) 3.75±1.48	(3 - 7) 4.75±1.48
Total solids (mg/l) Mean	(955 - 1427) 1218±183.24	(1090 - 1332) 1234.2±89.8	(1115 - 1443) 1277.25±122.6	(1135 - 1520) 1305.7±166.1	(1148 - 1535) 1290.75±146.1
TDS (mg/l) Mean	(840 - 1278) 1093.25±174.9	(895 - 1217) 1094.25±120.5	(1010 - 1322) 1140.5±134.6	(1039 - 1380) 1189±158.01	(965 - 1420) 1134.25±176.1
TSS (mg/l) Mean	(113 - 149) 124.75±14.39	(119 - 195) 140.0±28.16	(105 - 207) 136.75±40.95	(105 - 140) 116.75±13.8	(115 - 211) 156.5±41.69
pH Mean	(7.2 – 8.1) 7.625±0.43	(7.3 – 8.1) 7.6±0.28	(7.5 – 7.9) 7.75±0.15	(7.6 – 8.0) 7.75±1.66	(7.2 – 8.1) 7.6±0.339
Free CO2 (mg/l) Mean	(1.40 – 1.69) 1.6525±0.39	(1.62 – 1.92) 1.75±.017	(1.62 – 2.20) 1.825±0.25	(1.65 – 1.85) 1.74±0.09	(1.62 – 2.20) 1.87±0.21
D. O. (mg/l) Mean	(7.04 – 11.08) 8.41±1.62	(6.84 – 10.07) 8.46±1.18	(7.04 – 9.47) 8.65±0.95	(6.04 – 9.06) 7.55±0.87	(6.04 – 9.47) 7.49±1.36
BOD (mg/l) Mean	(1.60 – 2.0) 1.875±0.162	(1.7 – 2.2) 1.98±0.23	(2.0 – 2.5) 2.25±.18	(1.8 – 2.2) 2.0±0.14	(1.9 – 2.3) 2.05±0.15
COD (mg/l) Mean	(2.1 – 3.0) 2.55±0.32	(2.2 – 2.9) 2.6±0.25	(2.6 – 3.2) 2.9±0.22	(2.4 – 3.0) 2.68±0.22	(2.4 – 2.9) 2.7±0.18
Hardness (mg/l) Mean	(190 - 210) 196.25±8.2	(185 - 220) 200.0±15.41	(200 - 250) 222.5±19.2	(180 - 230) 200.0±18.71	(185 - 235) 198.75±21.02
Alkalinity (mg/l) Mean	(150 - 480) 250.0±134.7	(140 - 500) 262.5±140.8	(170 - 600) 305±172.1	(130 - 570) 292.5±168.8	(120 - 540) 317.5±175.2

Table- 4 :Correlation (=CORREL) between Primary productivity (mean values) and Physico-chemical parameters (mean values) of Sahastradhara stream.

Parameters	Net primary productivity	Gross primary productivity	Community respiration	Net production efficiency
Temperature °C	-0.59945	0.006189	0.311429	-0.57232
Velocity (m/s)	-0.82147	-0.40554	0.387568	-0.78591
Turbidity (JTU)	0.459379	0.237629	-0.09751	0.389256
Total solids (mg/l)	0.086601	0.565255	0.544701	-0.16675
TDS (mg/l)	0.01787	0.761621	0.801179	-0.33031
TSS (mg/l)	0.165469	-0.58282	-0.73453	0.444083
pH	0.409892	0.87509	0.647625	0.023325
Free CO_2(mg/l)	0.335796	-0.03623	-0.24934	0.360837
D O (mg/l)	0.43596	-0.20694	-0.47748	0.522691
BOD (mg/l)	0.715985	0.330189	-0.11921	0.583037
COD (mg/l)	0.757185	0.484589	-0.01968	0.572202
Hardness (mg/l)	0.811178	0.38677	-0.13668	0.659382
Alkalinity (mg/l)	0.380434	0.349649	0.067672	0.259953

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Traditional use of some medicinal plants in the tribal area of Betul district of Madhya Pradesh (India)

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Abstract

District Betul of Madhya Pradesh is situated at the centre of India. It has dense forest. Number of medicinal plants are found here. This district of Madhya pradesh is density populated by the tribes. Gond, Korkoos are the main trible communities. The minimum rain fall of the district is mainly 45 inches per year. The people of this area are mostly suffered from Asthma, Eosinophilia, various skin diseases, malaria, piles, pyarrhea, typhoid diabetes etc. Floristically the area is observed to support diverse flora in prevailing forest ecosystem. *Annoa reticulata* (Anonaceae) Ramphal, *Aegle marmelos* (Rutaceae) Bel, *Zypus rotundifolia* (Rhamnaceae) Jarbery, *Sapinduse merginata* (Sapindaceae) Ritha, *Semicarpus anacardium* (Anacardiaceae) Bhilwa, *Ptecarpus marsupium* (Fabaceae) Beeja, *Cassia fistula* (Caesalpiniaceae) Amaltas, *Acasia nilotica* (Mimosaceae) Babool *Madhuca latifolia* Sapotaceae mahua, *Halarrhena antidysentica* (Apocynaceae) Dhudhi, *Achyranthus aspera* (Amaranth aceae) Latjira *Chlorphytum tuburosum* (Liliaceae) Safed musli, are the well known medicinal plants amongs them. Tribes of this district are using these medicinal plants as traditional medicine. They use these plants to cure many diseases.

Key Words :- *Medicinal plants, Amaranthaceae, Liliaceae.*

Introduction

District Betul of Madhya Pradesh has dense forest, it possessess Sal, Teaks and Bamboo trees. Along with these plants number of medicinal plants are also found here, local resident of the district are mostly, gond, korkoo and baiga. They are surviving their life within these dense forest most of the places where medical facilities are not available they use medicinal plants as they require. During the survey author have found that these people are solving there medical problem by using wild fruits, root and bark of the plants which are found surrounding to there approach. Few peoples are very much expert treating Patients and are called "Baigas". These Baigas collects medicinal plants according to there elders guidance. As mentioned above so many plants are there for e.g. Banana (Musaceae), *Nelumbium sucifera* (Lotus), *Ficus religiosa* (Moraceae), Papaya (Caricaceae), *Annona squamosa* (Annonaceae) tribes who are using as medicine. It is not possible to discuss here about all plants, therefore this paper deals some important plants and there uses to cure various diseases.

Methodology

Survey was conducted (during year 2002-2003) and author interviewed number of expert peoples specially Baigas etc. Number of medicinal plants, roots and bark were collected with the help of these peoples and identified them from standard literature.

Results and Discussion

Plantwise details and their uses are given below :-

1- ***Ageratum conyzoides*** Linn. (Local name Teera) the leaves are styptic and anti-tetanic and are applied to cuts and sores. The whole plant is used as a nervine tonic. Extract of the plant is used as insectiside (Mainly in the field of mosquitoes control). Long stored water extract of the leaves are given to the children to cure bed wetting.

2. Tridex procumbance L. (Family compositae) Local name MONDI. It is common weed used for a variety of medicinal purposes. Apart from these uses local peoples used this plant (powder) to control aquatic population of mosquitoes.

3. Amaranthus virdis Linn. (Syn. *A gracili* Desf.). Local name-Choulai. This plant is used as cooling medicine in snake-bite. Its roots are used as anti fertility agent. Water extract of leaves is used to cure urinary problem.

4. Bombax ceiba Linn. Syn. *B. malabaricum*) Local name Semul. The bark of this plant is used to control abnormal uterine bleeding. Flowers of plants are used to induce fertility in women.

5. Cassia fistula Linn. Local name-Amaltas. Young leaves of the plant are used to cure Amenorrhoea (Genital problem in women).

6. Terminalia arjuna (Roxb.) Local name - Arjun. Twigs of the plant are used to clean mouth and teeth. Bark powder is taken with milk as a cardio-tonic.

7. Chenopodium album Linn. Local name Bathua Bhaji. Paste of the seed of this plant is applied for various skin diseases.

8. Chloropodium borivillanum Family Liliacea-Local name-Safed musli. The roots of this wild plant are commonly used by the tribes of the district as health tonic or sexual tonic this plant has got great importance in traditional medicine. it is also called Anti-cancer plant.

9. Calotropis gigantea Linn. Oleaceae local name-Chameli. The fresh juice of the leaves is used by the tribes to cure ear ache and to remove the corns of the feet.

10. Saraca indica Mimosaceae. L name Ashoka Bark of the tree is used to prevent abortion & irregular mentruation in women.

11. Withania somnifera (Bitter Cherry-Solanaceae L) Name Asgandh. It is common wild herb. Roots of the plant are very much important. As we know Betul is surrounded by hills, here patients suffering from goitre are more than other district due to lack of iodine Baigas are treating them by giving roots of such types of plants.

12. Adhatoda vasica Acanthaceae L. Name Adusa. The roots and leaves are used for those patients which are suffering from chronic bronchitis. Author collected data from Patakhera, Bagdona, and Sallaya villages. These villages receive dust and ash particles from thermal power station which is situated nearby these villages.

13. Aegle marmelos Rutaceae L. name Bel. Whole plant having medicinal value. It is used to cure digestive, stomach ache, diarrhea etc.

Along with these plants various other plants of medicinal use are also found but it is need of today to consume rare plants which are only found in District.

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