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Pollution abatement and environmental preservation

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Abstract

In the recent years there has been a growing concern over the problem of municipal and industrial waste disposal. In India city sewage, distilleries, tanneries, breweries, sugar mill and food processing units are the major source of organic pollution in water resources. Our growing concern about the availability of clean environment/water makes us more conscious to develop effective and beneficial treatment technologies for the liquid wastes. Anaerobic treatment of liquid waste, having high concentration of biodegradable organic matter, is a competent method to overcome this problem. With the aid of anaerobic treatment technology such wastes can be used to extract some useful products/by products and energy, like-biogas. Biogas is a clean and effective substitute of other conventional energy sources, i.e. coal. The paper highlights major issues of anaerobic treatment along-with the cost economics.

Key Words ***Wastewater; Anaerobic Treatment; Biogas***

Introduction

Water is the elixir of life. In our day to day life we are using this vital natural resource for a variety of purposes, like drinking and other domestic uses, irrigation, power generation, industrial cooling and finally for waste disposal. Continuous practice of our society to use water resources as a natural dustbin is creating the greatest problem of this century-The water pollution. Water pollution may be of

different types depending upon the constituents causing pollution, for example, organic pollution is mainly caused by the discharge of organic wastes of wastes containing organic material. Such wastes when enter a water body, dissolved oxygen is consumed in their oxidation or breakdown by microorganisms. The more the oxygen required for oxidation, the greater will be the deoxygenating, which can cause adverse impacts on the existing flora and fauna of the water body. Pollutants in the category of organic pollution generally comes from such sources as : domestic/city sewage, food processing units, distilleries, pulp & paper mill, sugar mill, breweries, dairy, slaughter house, etc. Thewater pollution problems in developing countries, like India, are still at a stage where effects can be abate if action is taken in time. Always, it is easier and advantageous to control pollution at the early stages rather than investing huge capital to protect and purify the water resources at later stages like-Ganga Action Plan.

Waste

Waste is the disposal/discharge of material, residues and energy into the environment. Of these, some are unconvertible raw materials, some are un-recovered final products and some are by products. Thus discharge of waste in the environment creates a problem of environmental pollution. In other words it can be considered that we are loosing by two ways. Firstly, we are loosing our valuable material and secondly we are polluting our environment, thereby our natural resources.

Liquid waste containing biodegradable organic matter can be used to produce some useful products/energy like-methane rich fuel gas commonly termed as Biogas.

Water Pollution Control

On the discharge of untreated organic waste to aquatic environment:-

1. Dissolved oxygen level of the receiving aquatic body diminishes and results into subsequent damage to the aquatic organisms.
2. High turbidity hinders the penetration of sunlight which adversely affects the photosynthetic activity.
3. Floating impurities and foul smell due to the presence of organic matter makes water unsuitable for recreational purposes.
4. Water no longer remains suitable for domestic/irrigation purpose.

Bioaccumulation / Biomagnification / Bioamplification of toxic material takes place which ultimately attack the human population.

Therefore, the control of water pollution is essential and require instant attention and devotion. The most effective way to control water pollution is the treatment of waste water in an efficient and suitable effluent treatment plant before its discharge. The main objective is to minimize harmful constituents to an acceptable level with or without by-product recovery. Various suggested methods are:-

1. Physico-Chemical Methods.
2. Biological Treatment Methods.
3. Production of Green Manure (Composting).

1. Physico-Chemical methods are generally used in separating the heavy materials and to neutralize the acidity. These are-Screening, Sedimentation, Floculation. \ Neutralization etc.
2. The objective of biological treatment is to remove oxygen consuming organic matter by the help of microorganisms, capable in oxidizing the organic matter. Biological treatment is often the most competent method.

These are of two types:-

(i) Aerobic: microorganisms require oxygen to oxidize the organic matter and produce carbon dioxide as a by-product.
(ii) Anaerobic: microorganisms does not require oxygen and produce biogas as a by product.

3 Incineration is the drying of organic wastes and the dried material may be disposed off on land.
4. Liquid organic waste can be utilized to produce green manure by treating with solid wastes (composting). The production of green manure with this method is highly beneficial and the manure produced is always better than the chemical manure.

Anaerobic Treatment of Organic Wastes

Anaerobic digestion with methane recovery is indeed the most rational approach in present times of

energy crisis. This treatment of organic wastes is also known as methanization or methane fermentation. Methane generation from the rotting or organic matter has been known since the 18th century. Volta identified this as marsh gas. The first use of this valuable gas as a fuel was recorded in

1875, when it was used for lightening the street light of a city in England. Due to various advantages (with few drawbacks) this method has gained a paramount interest and widespread acceptability. Several technologies are available in the market to produce biogas from organic wastes. Process design alternatives for anaerobic treatment of organic wastes may be identified as anaerobic filter process, anaerobic single stage process and acid methane segregation process.

Anaerobic filter process:- has been developed to treat strong wastes, having high concentration of organic matter. The reactor contains a solid support, usually plastic matrix or stones. In this process microorganisms grow attached to the support material or as free blocks in the interstices.

Single stage anaerobic process:- is a conventional anaerobic treatment process. This is a combined one step process of all activities (acid formation and methane formation) required to recover methane rich fuel gas from organic waste. In this process only a single reactor is required.

Acid methane segregation process:- is a microbial segregation process where acid producing and methane producing microorganisms are allowed to grow in different reactors under different environmental conditions. This process enhanced the activity of microorganisms to utilize organic compounds more effectively.

Identification of Organic Wastes for Anaerobic Treatment

The liquid waste have high concentration of biodegradable organic material with adequate nutrients and micro-nutrients these are quite suitable for anaerobic treatment and can be utilized to produce biogas. These wastes should be free from toxic substances. In terms of BOD the wastes from distillery, starch, pharmaceutical, city, pulp and paper, slaughter house, tannery, brewery, sugar mill, etc. are highly suitable for the production of biogas with the help of anaerobic treatment. It is essential to know the status of organic waste before adopting the technology.

Process Parameters for Anaerobic Treatment

Every process depends upon several environmental conditions. For the anaerobic treatment

temperature, pH, nutrients and the presence of toxic substances are important.

Temperature

The most suitable temperature range is 30-40^{o}C. In the lower range of the temperature the process remain low due to low activity of the microorganisms, whereas in the higher range it initially touches the peak but after that is slows down due to the sudden fall in the activity and the number of microorganisms. Sudden variations in temperature results in temporary shut of the activity, but a long hold can cause degradation in the treatment process. On the basis of temperature range the process and the microorganisms are of three types i.e. Cryophilic (between 0-25 ^{o}C), conversion rates are slow. Mesophilic (between 30-40 ^{o}C) and Thermophilic (between 50-70 ^{o}C), the conversion rates are high due to high microbial activity. Normally the mesophilic range of temperature is most suitable and cost effective for the anaerobic treatment.

pH

The most suitable pH range for anaerobic treatment is 7.0-7.5, but it can be operated upto 8.0, the experimentation shows that in the higher pH range biogas have increased concentration of methane of the two bacteria, involved in anaerobic treatment, acidogens are capable of performing their activity between 5.0-6.0 pH range whereas 7.0-8.0 is suitable for methanogens.

Nutrients

Various studies showed that Organic waste must be rich in nutrients and micronutrients for better anaerobic treatment. The main nutrients are N and P. In different technologies the rate of nutrients varies as per the COD/BOD loading rate.

Toxic substances
Like other biological process anaerobic treatment may also be affected by the presence of toxic substances. For this process sulphide, ammonia and higher fatty acids are the most consequential.

These compounds always try to inhibit the microorganisms activity which ultimately end in the lowering of BOD/COD reduction and biogas production.

Advantages of Anaerobic Treatment

Anaerobic treatment process has several advantages from other biological processes. Few important are discussed hereunder.

1. This can accept high organic loading since oxygen requirement is nil.
2. This produces a useful by-product, viz., Biogas.
3. This can be operated after a long non-operating gap.
4. Since the reactor is closed no offensive odour exists.
5. Sludge production is low.
6. Possible direct utilization of sludge as a manure.
7. Treated effluent can be used for aquaculture. The main advantage is the production of biogas, which can be used as a clean and environment friendly fuel.

Biogas

Biogas is a composite mixture of methane, carbon dioxide and hydrogen sulphide produced naturally by the decomposition of organic matter. The composition of all the three gases differ from time to time and technology to technology. The main composition is - Methane (CH_4)-50-70%, Hydrogen sulphide (H_2S) - 2-5% and Carbon dioxide (CO_2) - rest. The calorific value of the biogas is approximately 5000 K.cal/NM^3. Biogas is a good substitute of conventional energy sources like wood, coal, kerosene, etc. Biogas production from organic wastes varies from waste to waste. Generally, it ranges from 0.1 M^3 to 0.55 M^3/Kg. of COD reduced.

Benefits from Biogas

There is an assumption to know exactly how much biogas is beneficial to us.

Let us consider a strong organic waste i.e. waste from distillery (Spentwash). 1 M^3 of distillery waste can produce 25-35 NM^3 of biogas.
(The variation is due to technology difference.)

Methane percentage	-70%
Calorific Value	-5000 K.Cal/NM^3
Calorific value of coal	-4500 K.Cal/NM^3
Combustion efficiency of coal -	-75%
Combustion efficiency of gas	-90%
Equivalent coal	-1.33 Kg/NM^3

therefore,

$1M^3$ of distillery waste can save 33-50 Kg of coal. Other than this,saving of transportation cost of coal,

saving of energy in terms of diesel and conservation of environment are indirect benefits.

Conclusion

The foregoing discussion evidently revealed that biogas is highly beneficial. It can reduce the problem of energy crises and environmental pollution. Therefore, it is essential to popularize anaerobic treatment as an obligatory step to all, producing/discharging organic wastes into the water bodies.

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Studies on the sex ration of *Chela untrahi* of Bhadra reservoir, (Karnataka, India)

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Abstract

In the present study 1432 specimens of *Chela untrahi* belonging to various size ranges were examined for sexuality at backwaters of Bhadra reservoir. Dominance of male was noticed in most of the size groups. Significant chi-square values were obtained in fishes of size between 81 and 100 mm during 1998-99 and 81 and 115 mm for 1999-2000. The overall male:female ratio was found to be 1:0.5057 and predominance of male was noticed all through the year.

Key Words: ***Chela untrahi, Sex ratio, Chi-square, Bhadra reservoir.***

Introduction

A good deal of work has been done on the reproductive biology of various fishes. Notable among them are: Hickling 1930, Clark 1934, Keasteven 1942, Alikunhi 1956, Qasim and Qayyum 1961, Raitt 1968 and Bagenal 1978. A knowledge of the sex composition of catches is helpful in understanding whether any differential fishing exists and if solubility what possible bearing it has on the fishable stocks (Kesteven1942). It may indicate differences in the growth rate of the two sexes (Qasim 1966). *Chela untrahi* is included in the sub order-Cyprinoidei under the order-Physostomi and belong to the family-Cyprinidae (Day 1958). Most of the *Chela species* are inhabitants of tropical and subtropical waters. Bhadra reservoir from where specimens were collected for study serves as a source of fishing,

irrigation and for producing electricity. Fishermen and villagers also use it for drinking purpose and pisciculture of locally available fishes and other major carps. The Bhadra reservoir is located at a latitude 13° 45'-00"N and longitude 75°-30'-14" E. No scientific study has been conducted on the sex-ratio of *Chela untrahi* occurring in Bhadra reservoir so far. Hence, the present study was aimed at enhancing the knowledge regarding the sex ratio of *Chela untrahi* of Bhadra reservoir and to enable the formulation of suitable management measures towards rational exploitation and management.

Materials and Methods

The samples of *Chela untrahi* were obtained from the backwaters of Bhadra reservoir at Narasimharajapura near Kalgudda. *Chela untrahi* fishes were collected with the help of fishermen by using monofilaments gillnets of size 16 mm. Random samples were taken for sexuality of which 951 were males and 481 were females. The size (total length) range of species varied between 71 mm & 135 mm. The period of study was from July 1998 to June 2000. Fish samples were collected once in a month.

Results and Discussion

The results showed that male was dominant in most of the size groups. Table 1 represents the sex ratio of *Chela untrahi* in relation to size groups of fish. Significant chi-square values were obtained in size between 81 and 100 mm during 1998-99 and 81 and 115 for 1999-2000. Table 2 and 3 represents data on sex ratio of *Chela untrahi* with respect to different months of year. Predominance of male was noticed all through the year except in August and September 1998 and again August-99 when the ratio was most equal to the hypothetical 1:1 Chi-square (x^2) values indicated that dominance of males in the population was significant during most part of the year and the male : female ratio was found to be 1:0.5057.

It is believed that the following factors might be responsible for sex composition.

(a) Segregation of the sexes through various periods of the year including segregation resulting from sex differences in age and size at maturity,
(b) Gear selectivity in relation to sex differences in morphology and in physiological activity and
(c) Differences in natural and fishing mortality between sexes. Bannet 1962 states "Most studies of sex ratio of the individuals comprising isolated populations of fresh water fishes show more males than females among smaller fishes, but among the older fishes the dominance of females is solubility great as to leave little doubt that the males died off much faster than females".

Table 1 Sex ratio of *Chela untrahi* in different size groups from July 1998 to June 2000.

Year	1998-99					1999-2000				
Size groups (mm)	Males	Females	Total	X^2 Values	Sex ratio	Males	Females	Total	X^2 values	Sex ratio
71-75	1	0	1	1.0000	1:0.000	0	0	0	0	0
76-80	4	1	5	1.8000	1:0.2500	1	0	1	1.0000	0
81-85	37	17	54	7.40274*	1:0.4594	13	2	15	8.0666*	1:0.1538
86-90	135	49	184	40.1956*	1:0.3629	73	8	81	52.1605*	1:0.1069
91-95	136	78	214	15.7196*	1:0.5735	140	37	177	59.9378*	1:0.2642
96-100	127	51	178	32.4494*	1:0.4015	157	71	228	32.4386*	1:0.4522
101-105	35	27	62	1.0322	1:0.7714	71	59	130	1.1077	1:0.8309
106-110	4	13	17	4.7647*	1:3.2500	15	38	53	9.9811*	1:2.5333
111-115	0	3	3	3.0000	0	0	12	12	12.0000*	0
116-120	0	1	1	1.0000	0	2	8	10	3.6000	1:4.0000
121-125	0	0	0	0	0	0	4	4	4.0000	0
126-130	0	0	0	0	0	0	1	1	1.0000	0
131-135	0	0	0	0	0	0	1	1	1.0000	0
Total	479	240	719	79.4450*	1:0.5010	472	241	713	74.8401*	1:0.5106

* Significant at 5% Level

Table 2. Sex ratio of *Chela untrahi* in monthly samples from July 1998 to June 1999.

Months	Males	Females	Total	X^2 values	Sex ratio
July 1998	18	19	35	0.0270	1:1.0555
August	31	29	60	0.0666	1:0.9355
September	30	30	60	0.0000	1:1.00
October	37	23	60	3.2667	1:0.6216
November	59	14	73	27.7397*	1:0.2372
December	42	27	69	3.2608	1:0.6428
January	45	15	60	15.0000*	1:0.3333
February	45	15	60	15.0000*	1:0.3333
March	47	13	60	19.2666*	1:0.2766
April	48	12	60	21.60000*	1:0.2500
May	34	16	50	6.4800*	1:0.4705
June 1999	43	27	70	3.6571	1:0.6279
Total	479	240	719	79.4450*	1:0.5010

* Significant at 5% Level

Data on sex ratio in different sizes showed that males were dominant in size groups other than 106110,

111-115 and 116-120 mm during 1998-99. But an observation during 1999-2000 revealed that the males were dominant in size groups other than 106-110, 111-115, 116-120, 121-125, 126-125, 126-130 and 131-135 mm. Austin 1971 studied the sex ratio in fishes of sizes up to 110 mm. He found that above 110 mm size range females were dominant over males. Similar condition was observed during the study period. Significant chi-square values were obtained with sex ratio in size groups of 81-85, 86-90, 91-95, 96-100, 106-110 and 111-115 mm during 1998-2000. Chi-square test was also applied to monthly samples and it was found that at 0.05 probability levels, significant difference was noticed in all the months except July, October and December 1998, June and August 1999 and June 2000. Joseph K. Manissery *et al*. 1979 studied the sex ratio in *Puntius ticto* in relation to months. According to them, male:female ratio of *Puntius ticto* was 1:0.901 and concluded that there is no significant difference between the observed and the expected values of 1:1 (P=0.05), in the sex ratio of *P.ticto*. However, in the present study there is a significant difference exists in the sex ratio of *Chela untrahi* (1:0.5057).

Table 3. Sex ratio of *Chela untrathi* in monthly samples from July 1999 to June 2000.

Months	Males	Females	Total	X^2 values	Sex ratio
July 1999	16	44	60	13.0666*	1:2.7500
August	30	30	60	0.0000	1:1.0000
September	48	12	60	21.6000*	1:0.2500
October	14	46	60	17.0667*	1:0.2857
November	29	11	40	8.1000*	1:0.3793
December	53	7	60	35.2666*	1:0.1320
January	43	5	48	30.0833*	1:0.1162
February	39	15	54	10.6667*	1:0.3846
March	45	8	53	25.8301*	1:0.1777
April	54	11	65	28.4461*	1:0.2037
May	45	11	56	20.6428*	1:0.2444
June	56	41	97	2.3195	1:0.7321
Total	472	241	713	74.8401*	1:0.5105

*Significant at 5% level.

Sex ratio in *Chela untrahi* at different months and years has been showed that males outnumber females. Similar observation was made by Neelakantan *et al.* 1980-81 in *Lactarius lactarius*. While Vinci 1984 and Azad 1990 studying on *Silonia childreni* and *Anabas testudineus* reported that females outnumbered males. Nevertheless, Bhimasena Rao and Karamchandani 1986 noticed equal population of male and females in *Ompok bimaculatus* from Kulgarhi reservoir (M.P.). However among the

smaller fishes, males constituted the majority (Mc Fadden and Copper 1962, Bailey 1963 and Bhatnagar 1972). Therefore, the observations made in the present study are conformity with the above researchers.

Kesteven 1942 observed the predominance of males in Australian mullet (*Mugil dobula*) which he attributed to differential fishing. This may not be solubility in the case of *Chela untrahi* since no differential fishing has been observed. The apparent variation in the monthly sex ratios may be due to sampling variations. The insignificant differences in the number of individuals of both the sexes during spawning month (June, July, August, September, October, and December) indicated that males and females congregate during the spawning season. Therefore, fish catch should be avoided during aforesaid months.

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Phenol degradation by a bacterium *Pseudomonas putida* in the presence of chromium

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Abstract

Phenol and Phenolic compounds are well known components in aqueous waste of many different pollution generating industries. These compounds must be regarded as hazardous to the environment and are resistant to biological degradation. Degradation of Phenol in the presence of hexavalent chromium was studied using phenol degrading bacteria, *Pseudomonas putida*. The bacteria was able to degrade phenol up to 80% in the absence of chromium but the degradation was increased up to 81.67% in the presence of 25mg/l initial concentration of chromium (VI). The degradation was declined further up to 21.67%, when concentration of Chromium (VI) was applied 50mg/l.

Key Words: ***Phenol degradation, Pseudomonas putida, Hexavalent chromium.***

Introduction

Phenol is a common constituent of effluents from polymeric resin production, oil refining, coking plants, textile, pulp and paper mills and tannery industries. The discharged effluents contain phenolic compounds ranging 6-200 mg/L, however their admissible limit is only 3 mg/L in the receiving water bodies (Jossens 1978). Phenol can be toxic to fish at concentrations of 5 mg/L and gives an objectionable taste to drinking water at far lower concentrations (Throop 1975). The persistence of phenolic compounds in the aquatic and terrestrial environment can be injuries to the health of humans and cause allergic dermatitis, skin irritation, cancer and mutation (Bui Kema *et al.* 1979, Zitomer and

Speece 1993 and Sing and Viraraghavan 1966).

Recent literature on the method of degradation of phenol and their compounds from industrial effluents focus on microbial degradation process. *Pseudomonas putida* has an ability to degrade a wide variety of aromatic compounds. The present study has revealed the potential of phenolic compounds degradation through microbial degrading bacterium *Pseudomonas putida* in the presence or absence of Chromium as the wide spread use of chromium and its compounds by various industries has led to the release of this element into environments. Being mutagenic, carcinogenic and teratogenic, hexavalent chromium is about 100-fold more toxic than the trivalent form (Petilli and Flora 1977).

Materials and Methods

A pure culture of *Pseudomonas putida* was obtained from Institute of Microbial Technology, Chandigarh (UT).The bacterial strain (*Pseudomonas putida*) was maintained on nutrient agar medium, stored at 4 ^{o}C and sub cultured every week. The culture media used to perform the growth experiments were LB (Luri Bertani) media containing peptone 10gm/L, NaCl 10gm/L, yeast extract 5 gm/L, agar 2% and LB (Luria broth) having above composition without agar. The complete growing medium were sterilized in an autoclave at 121 ^{o}C for 30 minutes and subsequently cooled. Phenol solution and chromium were added to the sterilized medium to make the solution of desired concentration. In each experiment the initial pH of the medium was raised to 7.0 by addition of concentrated NaOH before sterilization. The LB (Luria broth) media (25 mL) was dispensed into a sterile 150 ml flask fitted with a cotton plug. Aromatic compound (Phenol) and Chromium (VI) as chromate (K_2CrO_4) were added as sole electron donors for chromium (VI) reduction. Harvested cells of *P. putida* were placed into each experiment before incubation in the dark on a rotator shaker at 140 RPM and at 30 ^{o}C temperature.

The viable cells of *P. putida* were counted by using haemocytometer at the desired time intervals. The cell growth was measured by the optical density (OD at 699 nm) taken at regular intervals. Hexavalent chromium was determined calorimetrically by using spectrophotometer at 540 nm by reaction with diphenylcarbazide in acid solution (APHA 1989). The phenol concentration was determined calorimetrically using a spectrophotometer at 500 nm by reaction with 4-amino-antipyrine in the presence of potassium ferricyanide (APHA 1989).

Results and Discussion

In the culture, *Pseudomonas putida* has oxidized the phenol and used Cr (VI) as an electron acceptor. The oxidation of phenol by *P. putida* has initialized the energy flow of the culture and served as a primary energy source for the strain while Cr (VI) reduction occurred only as result of metabolism

(Shen and Wong 1995). The effect of different concentration of chromium (VI) mixed with bacterial culture (*Pseudomonas putida*) growth has shown in Fig. 1 and observation revealed that growth was inhibited up to incubation period of 6 hrs in the culture media containing chromium (VI). The chromium concentration (50 mg/L) in culture medium has exhibited more inhibitory phenomenon than culture of initial chromium concentration (25 mg/L). At the 24 hrs incubation period, the culture of chromium concentration (25 mg/L) was found growth promoters, where as chromium concentration (50 mg/L) has shown considerable inhibitory effect as increasing the incubation periods.

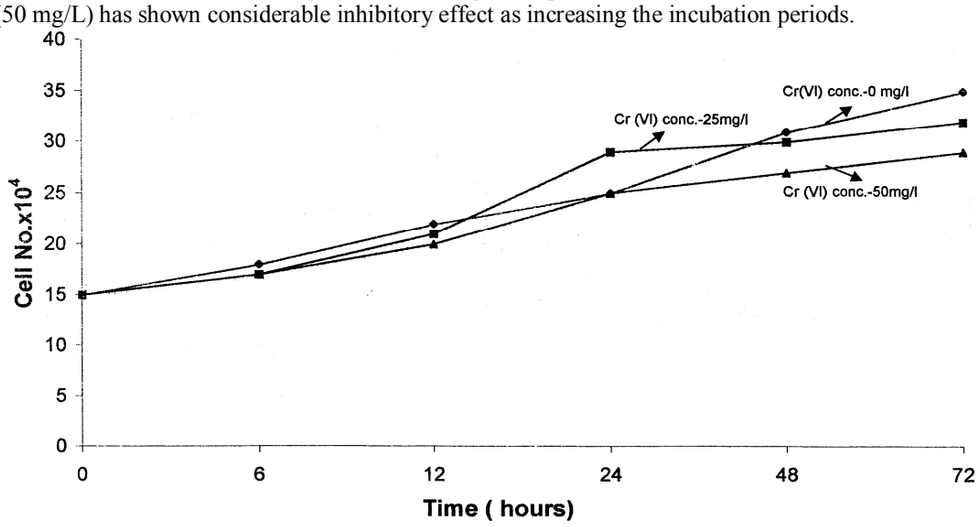

Figure 1. Growth pattern of *Pseudomonas putida* at diferent concentration of Cr (VI)

The sudden change in the growth of *P. putida* at the incubation period of 24 hrs can be explained with changing pH (Fig. 2). In the culture medium, the changing pattern of pH has observed after 12 hours exposure period. This change in pH may be due to the presence of some metabolites released by *P. putida* in the culture (Shen and Wang 1995).

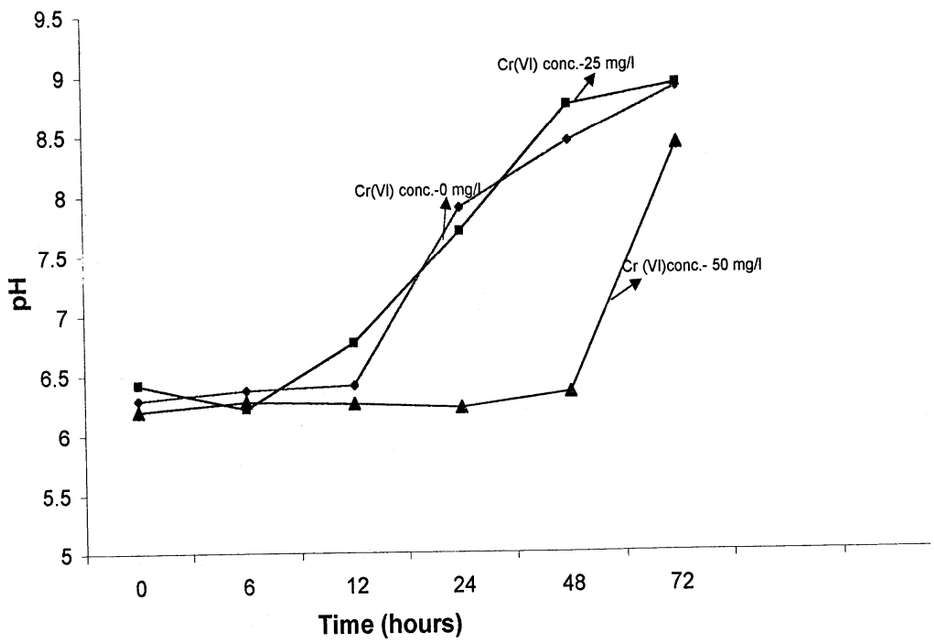

Figure 2. Change in pH at different Cr (VI) concentration with time

In the experiments chromium (VI) reduction occurred in the culture of *P. putida* using phenol as a

carbon source, the results have observed that Cr (VI) reduction was greater in the culture containing Chromium concentration (50 mg/L) (Fig. 3). The Chromium reduction suddenly increased up to 60 percent in the culture containing Chromium con. (25 mg/L) after 12 hrs incubation time. The effect of Cr (VI) and phenol concentrations on Cr (VI) reduction and phenol degradation were also investigated by (Shen and Wang 1995 and Annadurai *et al.* 1999). The phenol degradation patterns have shown in Fig-4 and the results occurred as Chromium (VI) with concentration of 25 mg/L have shown maximum rate of phenol degradation in between 24-48 hours incubation time, while the chromium (VI) conc. (50 mg/L) has suppressed the phenol degradation up to many fold in comparison to control.

When *Pseudomonas putida* was grown in the culture to degrade the phenol, the fluids turned yellow transiently and the yellow material accumulated in the culture was obtained maximum with the maximum phenol degradation (Molin and Nilsson 1985).

In the present study, the results have shown that *Pseudomonas putida* has degraded the phenol compound up to 80% in the absence of Chromium (VI). The degradation level has enhanced up to 81.67% in the presence of 25 mg/L initial concentration of Chromium (VI). The simultaneous Chromium reduction was observed 68% and 70% in initial Chromium concentration used as 25.0 and 50.0 mg/L respectively.

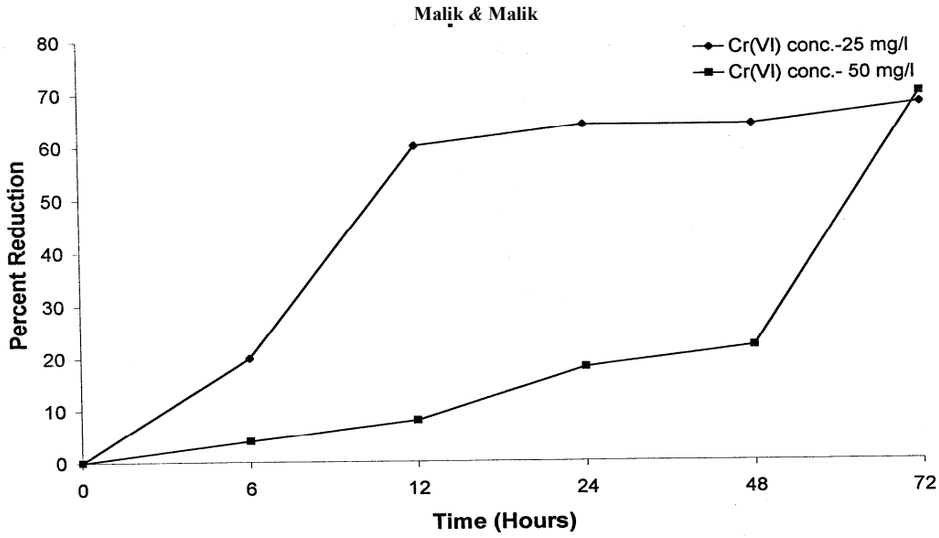

Figure 3. Chromium reduction at different time in presence of phenol

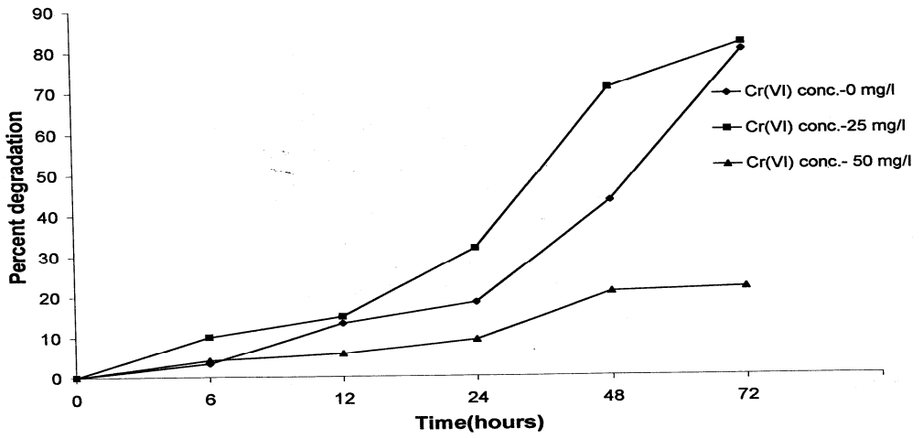

Figure 4. Phenol degradation with different Cr (VI) concentration

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Rearing and feeding of larvae of *Bombyx mori* Linn In laboratory conditions

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Abstract

Lepidoptera larvae are good experimental materials to observe growth phenomenon.In the present study relationship between quality and consumption of leaves and larval rearing have been depicted .

Key Words: ***Lepidoptera, Larvae, Silkworm***

Introduction

Lepidopteran larvae are know as more or less continuous feeders hence, a deficiency in the amount of food required for reaching its full potential will be manifested in various ways (Wouldbaver 1968). Shortening of feeding periods for larvae of different insects have resulted in the prolongation of larval periods and decrease in final body weight (Mc Girimis and Kasting 1969), which in turn may affect reproductive success or resulting adults particularly where adult females do not feed. Shrivastava *et al* 1982 reported extension of larval period up to 2 days and decrease in the fecundity to the extent of 32% Eri silk moth, *Philosamia ricini*.

Material and Methods

Lepidoptera larvae are good experimental materials to observe growth phenomenon. The growth and reproduction are separate phases in the life cycle of Silkmoth. Providing nutritional mulberry leaves to the larvae is an essential component of sericulture solubility, as to get good quality and improved cocoon and Silk thread. The larval feeding especially 4^{th} and 5^{th} in star are very important because the

larva only feed on leaves and grow. The whole phenomenon of larval feeding completes within few days only and one has not to wait for months and years to complete experiment, their smaller size makes them manageable objects and the entire experimentation can be conducted by controlled situation with petridishes, wooden trays and other material.

The growth of silk moth larvae in relation to food consumption and in relation to ecological factors such as light, temperature and humidity have been studied in detail with reference to the growth and production of cocoon solubility as to make the problem more result oriented.

Taxonomic Position of Silkmoth

Mulberry silk worm, *Bombyx mori* is a homometabolous insect and passes through four morphologically stages in its cycle Viz. egg, larva, pupa and adult.

In first stage, the embryo grows and develops into a larva's. The second is a Vegetative Stage, in which the larva takes nutrients i.e. mulberry leaves. Mulberry leaves are the sole food for larvae in commercial sericulture and the quality and quantity of the mulberry leaf feed during rearing decide the success of Silkworm crop. Hence, choice of mulberry leaves suitable for healthy growth of Silk worm is one of the most important factor in sericulture. The 4^{th} is metamorphic stage in which the larva becomes pupa and then in to the adult. The fourth stage of cycle is known as reproductive, stage in which moth mates and the female moth lay eggs producing next generation. It is only the larval stage that the silk worm takes foods, grows enormously and accumulates nutrition for the moth stage, the life cycle of silk moth was under laboratory condition and following stages were studies by Chawky methods the eggs were procured from "Seri Culture Centre" district Raisen, Madhya Pradesh.

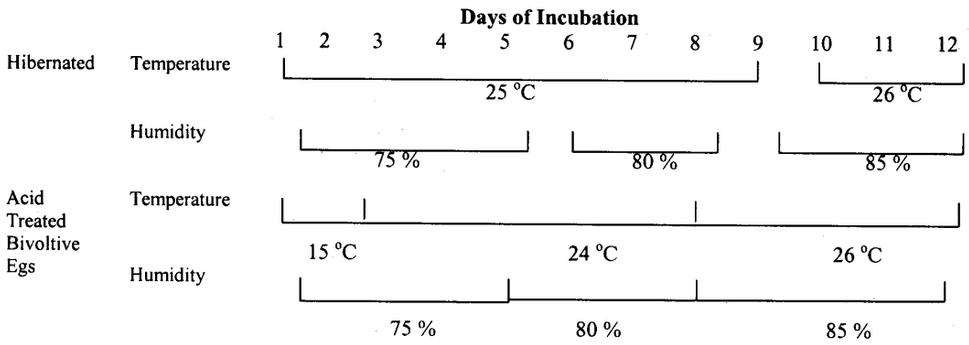
Laboratory culture of Silk moth eggs and larvae

Silkworm eggs are brought from sericulture centre were sterilized by dipping in 2% formaline solution for about 10 minutes and dried in shade before incubation. The incubation period as recorded for bivoltine and hibernating bivoltine eggs in room with temperature 25^{o} C, RH 80% + 5% and keeping the photoperiod L:D 16:8. The data recorded for proper incubation of eggs are given in the table 1. The data show that average incubation period varies between 11-12 days. It was also observed that two days before hatching, the colour of the eggs start changing into lighter shade with a blue point, the very next day colour of eggs changed into blue. This is the pigmentation stage. Eggs were kept in dark room or covered with black paper or cloth. The following technical cares need to be followed as emerged from the experimentation in the present study.

(A) **Maintenance of Temperature**

a. 20-28°C is the optimum range of temperature for Silk worm rearing
b. 25 C is temperature which favored healthy growth of late instar larvae.
c. It was noticed that maximum optimum range of temperature for different instar as mentioned in Table 2 varies from 20 to 28 °C.
d. It was observed that for young larvae upto 3rd instar a slightly higher range of temperature is required where as in last stages i.e. for 4th and 5th instar a little less as shown in the Table 2.

Table 1. Showing range of temperature and humidity required during incubation period days of Incubation



(B) **Humidity** It was noticed that relative humidity needed, for ideal rearing of silk worm larvae ranged between 80 to 90% for younger instar, a slightly higher humidity was needed while for older, less humidity is required as shown is table 2. It was maintained by using Honey well Humido-state in the insectary.

(C) **Light** Silkworm larvae attains maximum growth in dimlight and was found to avoid strong light. The minimum photoperiod of light required for larval rearing was noticed to be 16:14

hours night/day. This was maintained by automatic switch 'On and Off' device available in the insectory. All these conditions were maintained in the insectery established long back at Pest Control Research Laboratory at Vidisha.

(D) **Spacing of worm's in the rearing beds** This is another important aspect of sericulture. Optimum rearing bed over from brushing to the end of larval stage is important to attain full larval growth and yield of good quality cocoon. The data collected for proper spacing have been cited in table 3 with spacing, regular cleaning was also felt necessary. Cleaning was done during 2nd instar, first on the next day of resumption of feeding and the next before the worms prepare for second moult in the 3rd instar also. Two cleaning is sufficient, first after second moult and second before setting for third moult. The larvae reared on good quality leaves were found grown to 10 thousands time more, than the weight of the newly born larvae within 24 to 25 days.

Table 2. Temperature and humidity required during early instar rearing

Particulars	1st Instar	2nd Instar	3rd Instar
Temperature	28 °C	27 °C	26 °C
Humidity	85-90 %	85 %	80 %

Table 3. Showing spacing during rearing of larval Instar of *Bombyx mori*

Age of larvae	Area Required for rearing		Increase in Spacing during Each Instar (times)
	In beginning (Sqft)	At the End (Sqft)	
1st Instar larvae	4	15	3 ½
2nd Instar larvae	15	41	3
3rd Instar larvae	41	105	2 ½
4th Instar larvae	105	210	2
5th Instar larvae	210	400	About 2

Results and Discussion

A detail study was carried out as regards the feeding and rearing of *Bombyx mori* in the insectary maintained at Pest Control Research laboratory of the Institution. It was noticed that mulberry leaf feed during rearing decides the success of silk worm crop. The similar views have been expressed in several manual of Silk worm rearing specially.F.A.O. Bulletin 1988. It has been observed that young larval instar needs more care and attention because they are more susceptible to diseases. Of the total leaf consumed, 6.36% was found to be utilized by early stages i.e. from 1st to 3rd instar larvae. For the proper growth and metamorphosis of the larvae of silk moth, proper feeding is required as mentioned in the table (1 to 5). Besides proper feeding to the larvae, proper spacing in rearing beds and clearing is also needed to be taken care of. Larvae reared, on in crowded condition showed poor growth. Rajan *et al* 1996 have mentioned that rearing of young larval instar of *B.mori* needs special attention. They have mentioned further that not giving proper spacing to the larvae may affects cocoon quantity and yield of fibers. Similar views has been expressed by Saxena 2000.

In the present study relationship between quality and consumption of leaves and larval rearing have been depicted in the tables (4 & 5). It took about 24 to 26 days for completing the larval cycle in *Bombyx mori* under controlled laboratory conditions which are slightly different (< 2 days) as mentioned by Nath *et al* 1990.

Table 4.Contents of Starch and Water in Mulberry leaves

Contents	**Harvesting time**	
	06=00	**18=00**
Sugar	0.490	0.921
Starch	0.707	2.043
Water	82.11	74.01

Table 5.Showing frequency of Bed cleaning during rearing of *Bombyx mori*

Instar	Before moulting	Inter mediate period	After moulting
1st Instar	1	-	-
2nd Instar	1	-	1
3rd Instar	1	1	1
4th Instar	-	1-2	1
5th Instar	-	Once a day	

Acknowledgement

We are highly thank full to Dr. Y.P. Saxena, Dy. Director, Sericulture for permission to use the facilities at Sanchi Farm and to Mr. Soni, Technical Assistant and other persons at Sanchi Sericulture for various facilities.

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Effect of *Catharanthus roseus (L.) (Apocyneaceae)* extract on developmental stages of *Erias favia* stall

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Abstract

Developmental defect in *Erias favia* was investigated due to aqueous extract of *Catharanthus roseus*. The extract caused significant reduction in adult emergence as well as in percentage of egg hatch in *Erias favia.*

Key Words: ***Catharanthus roseus, Growth inhibition, Erias favia toxicity.***

Introduction

Botanical compounds particularly those with acute properties have been used as insecticides for many years (Jacobson and Crossby, 1971 and Rajendran and Gopalan, 1978). Some plants are excellent sources of substances disruptive of growth and behaviour (Kubo *et al*, 1983 and Kaur *et al.* 1989) Kalyansundrum and Das 1985 and Despande *et al.* (1988) reported the larvicidal and enzymatic activity of *Catharanthus roseus* extract on mosquito larvae and on *Spodoptera litura*.

The number of other plants whose extract caused juvenile and anti-juvenile hormone activity in dipteran and lepidopteran larvae (Saxena *et al.*, 1992 and Kubo *et al.* 1983*). Catharanthus roseus* (L)

(Apocynaceae) is sturdy perennial herb with known diverse biological activity. *Catharanthus roseus* showed developmental defects on larval stages of a Cotton pest of lepidoptera, *Erias favia* which is also pest on *Hibiscus esculentus*.

Plant description and Identification

The plant, *Catharanthus roseus* (L.) Apocynaceae was found distributed through out the country. The perennial herb collected from botanical garden at the College campus, after identification in the P.G Department of Botany of the College. A voucher specimen was deposited in the herbarium of the laboratory at No. 15.
The structure of the plant was supported earlier by Rastogi and Mehrotra (1991) to contain Catharanthine Plrytochemical study with the leaves at *Catharanthus roseus* was found to posses "Catharanthine"

2. Material and Methods

2.1 Plant Material

Fresh leaves of *Catharanthus roseus* collected in large quantities were thoroughly washed in tap water, shades dried and powdered (40 to 60 mesh). The powdered materials were extracted with water using the cold percolation methods of Harborne (1984). The extract was concentrated using a vacuum evaporator and the residue was dissolved in acetone to make the desired concentrations.

2.2 Bioassays

Erias favia (Lepidoptera : Noctuidae) was cultured in glass jars capped with muslin cloth and rubber band in the insectary maintained at temp. + 1^{o}C, RH 75% and 14:10 hr. L:D Photoperiod Insects were fed on fresh seeds of *Hibiscus esculentus* ped sooked in drinking water. A piece of Whatman filter paper was kept in each jar for egg laying, eggs and pupae from the laboratory culture stock were used for experimental bioassays.

2.3 Treatment of eggs

The freshly laid eggs (0-12 hr) were treated using in contact method. A film of extract was prepared by spreading 0.5 µl of different concentrations 1.0, 0.5, 0.25 and 0.05% on petridish. The solvent was allowed to evaporate by rotating the peridishes. There were three replicates for each treatment. Percentage corrected mortality was calculated by Abbott's formula (1925).

2.4 Treatment of pupae

Freshly ecdysed pupae (0-24 hr old) were treated with the different concentration of the extract topically by a Hamilton microlitre syringe in 5/ml doses. A control with acetone alone was also run separately. The pest performance parameters studied included the hatching success of eggs pupa period, adult emergence and mortality.

3. Results and Discussion

Hatch was considerably reduced when caped in contact with different concentration at the water extract of *Catharanthus roseus* (Table 1). No egg hatched was recorded at the higher concentration, and at lower concentration it got reduced to 46, 22 and 6% respectively. The delayed pupation and the longevity of adults also found to be 3.1 days against 7.3 days in control as reported by Garcia and Rambold (1984) who observed delayed pupation in *Rhodnius prolixus* by the treatment of Aazadirachtin. The inhibited egg development in female *Locusta migratoria* was also reported by Rambold & Siebr (1980) is quite similar as noticed in the egg of *Erias favia*. Tischler *et al*. (1989) described the effect of ecdysteroid on the growth of the flight muscles in *Manduca sexta*. They have mentioned that growth, development and sexual maturation largely regulated by ecdysome and JH. The results of present study also suggest that *Catharanthus roseus* could be a new success of biopesticidal compound for suppressing best population at an early stage of their development.

Acknowledgement

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Table-1: Effect of water extract of *Cathranthus roseus* on inactive development stages (egg) of *Erias favia* Stall.

Dose in Percent	No. of egg treated	Percent egg Hatching	Incubation Period (in days)	Percent Mortality	Percent Corrected Mortality
1.0	100	-	-	100	100.0
0.5	100	-	-	100	100.0
0.25	100	-	-	100	100.0
0.01	100	6	4-5	90	92.0
0.05	100	22	4-5	72	75.0
0.025	100	46	4-6	54	50.0
Control	100	92	4-6	8	-

0.5 wg. Dose of each concentration was used.
First three concentration caused 100% mortality of the eggs (0-12 hr).

Table -2 : Effect of water extract of *Cathranthus roseus* on inactive development stages (egg) of *Erias favia* on topical application.

Dose mg/pupa	Conc. N (%)	No. of Pupa treated	Percent in death within population (a)	Percent died out in the puparium (b)	Percent mortality at pupal stage (a+b)	Percent corrected mortality	Percent adult emergence	Adult longevity (days)	Pupal period (days)
5	1.0	25	100.0	-	100.0	100	-	-	-
5	0.5	25	90.0	10.0	100.0	100	-	-	-
5	0.25	25	72.3	24.6	97.0	100	3.0	3.7	6.5
5	0.85	25	64.0	26.0	90.0	100	10.0	3.7	6.5
5	Control acetone alone	25	4.0	-	4.0	100	94.0	7.1	4.5

Adult longevity and pupal period is mentioned for living adult only.-

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Solid state fermentation of wheat for the production of cellulase

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Abstract

Solid state fermentation of wheat straw for cellulase production by *Phanerochaete chrysosporium* has been studied. The most optimum moisture level for solid state fermentation was found to be 40% while the best enzyme yield was obtained at an initial pH of 4.5 and incubation temperature of 30 ^{0} C. Supplementation @ 0.2% (W/W) was found to have enhanced the yield of the enzyme by three folds. With all conditions standardized an enzyme yield of 78 IU pergds could be obtained.

Key Words: ***Cellulase ,Phanerochaete chrysosporium, Fungus***

Introduction

Utilization of lignocellulosic wastes is gaining considerable interest in most developing countries due to their availability in abundance. Almost five decades have passed since the pioneering work of Reese on fungal degradation of cellulosic substrates (Mandels and Sternberg, 1976, Esterbrauer *et al*. 1991). In view of relative abundance of wheat straw, its biodegradation has been carried out by several fungi (Zadrazil and Brunnert, 1980: Zafar *et al.* 1989). *Phanerochaete chrysosporium* has been reported to be a potent lignin degrading white rot fungi (Faison and Kirk 1985). In the present investigation an attempt has been made to utilize wheat straw for the production cellulose by solid state fermentation.

Materials and Methods

Organism and cultural conditions

Phanerochaete chrysosporium (HHB 103737 S) was obtained from Prof. Kirk's laboratory of Forest Research Laboratory, Canada. It was grown and maintained on malt extract agar slants and repeated transfers were performed at 30 days intervals. The culture was preserved in refrigerator at 4^0C. The medium for cultivation was prepared according to Kirk *et al.* (1978) with 0.22 g per litre of ammonium tartarate as the nitrogen source. As per the requirements the Erlenmeyer flask of 100 ml capacity was added with 4.5 ml of the basal medium containing 30 mm 2,2- dimethyl succinate to buffer the cultures at 4.3-4.5 and 0.5 ml of fungal mycelium. The fungal mycelium was obtained from a Roux bottle run in batch. Such an inocculums was used to obtain rapid primary growth of the culture (Ulmer *et al*. 1983).

Preparation of Starter culture

Starter culture of the test mould was prepared according to the standard method as described by Tao and Zuohu, (1997). Conidiospores were aseptically harvested from a 15-day old culture slant by suspending in 10 ml sterile distilled water containing 0.01% Tween 80. The conidiophores suspension was suitably diluted to obtain a population of approximately 10^7 per ml One ml culture was used per 100 g substrate for all experimental purposes.

Solid state Fermentation

All fermentations were carried in autoclavable LDPE bags (30*25 cm : Himedia). The bags were perforated at 1.5 cm distance throughout and filled with the test materials. The raw materials viz. wheat straw was ground in Waring blender and 100 g of each were then loodely filled in the perforated autoclavable LDPE bags in triplicate. All the bags were then autoclaved at 15 psi for 30 minutes.

Optimization for moisture content

Moisture levels in solid state fermentation depends upon the nature of substrate, the organism and the type of end product (Ramesh and Lonsane1990). Since the nutrient concentration is inversely proportional to the quantity of water present in the substrate, an increase in the salt concentration resulting in high osmotic potential, will have an adverse effect on the growth and productivity. This preliminary experiment was thus undertaken to optimize the moisture content for each organism and substrate used in this study.

Fifty gram of substrate was transferred into the each three perforated autoclavable LDPE bags (Himedia, India) for testing of each substrate as well as organism. Each of the three bags were added with water at the rate of 25, 50, and 75 ml water. The bags were then autoclaved at 15 psi for 30 minutes. After cooling to room temperature the materials were inoculated with 2.5 ml of starter culture containing 1.0 X 10^7 cells or spores per ml. The bags were then incubated at 28^0 C. The growth of the organism was measured by standard plate count method.

Effect of Nitrogen supplementation

Carbon: Nitrogen ratio is an important factor in determining the growth behaviour and productivity. Thus nitrogen in form of ammonium, nitrate and protein were supplied through addition of ammonium sulphate, urea, sodium nitrate and casein. The test substrate was tested for effect of nitrogen supplementation on enzyme yield. Three concentration viz. 0.2, 0.5, 1.0 and percent (as N) were added to the substrates and were inoculated with the test microorganisms. A control (without N) was also run simultaneously.

Effect

For the optimization of pH the wheat straw was soaked in water of different pH of raw material were 3, 4.5 6.0 and 7.0. The material were then loosely packed in auloclavable LDPE bags and inoculated. Other fermentation conditions were same as for other experiments.

Optimization of incubation temperature

The experimentation for incubation temperature, the inoculated bags were incubated at different temperatures viz. 25^0, 30^0,37^0 and 40^0 C.

Determination of Cellulose activity

Sample extraction and analysis

One gram samples in triplicate were withdrawn aseptically at 5 days intervals and extracted in 10 ml citrate buffer (0.05 M; pH 4.8) using pestle mortar. The content was shaken for 10 min on a rotatory shaker and finally centrifuged. The supernatant was collected and the residue was washed twice and again centrifuged. All the supernatant were finally pooled and cellulase activity determined.

Filter Paper (FPase) Activity

FPase activity was determined using 1.0 cm X 6.0 cm of Whatman No. 1 filter paper strip (in 1 ml of 100 mM sodium citrate buffer, pH 5.0) as substrate and incubating it with 1.0 ml of enzyme extract for 1 hr at 500^{o} C. The reaction was terminated by boiling the contents for 2 min. The released reducing sugar content was measured by Nelson's (1944) using glucose as standard.

Carboxy Methyl Cellulose (CMCase) Acidity

CMCase activity was determined by using the IUPAC method (IUPAC, 1987). One ml of extract was added with 1 ml of Carboxymethyl cellulose (1% prepared in 0.05N; pH 4.8). The contents were incubated at 500^{o} C for 30 min. and finally the reaction was terminated by adding 3 ml of 1 mM sodium carbonate solution. The released reducing sugar was estimated by Nelson's method (1944).
One unit of cellulase activity was CMCase expressed as micromoles of glucose released per min per gram of culture.

Determination of reducing sugars

Two gram samples were extracted in ten ml of 70% aqueous ethanol by finely grinding in pestel mortar. The contents were then centrifuged at 5000 rpm for 10 minutes. The pellets were washed thoroughly in same solution twice and again followed by centrifugation. All the supernatants were pooled and evaporated to dryness using flash evaporated. The contents were re-dissolved in 5 ml of 70% aqueous ethanol and used for estimation of carbohydrates using the standard method according to Nelson (1944).

Results and Discussion

Moisture levels in solid state fermentation depends upon the nature of substrate, the organism and the type of end product (Ramesh and Lonsane, 1990; Smits, *et al.* 1997). The results show that the most optimum moisture level was 40% . Since the nutrient concentration is inversely proportional to the quantity of water present in the substrate, an increase in the salt concentaration resulting in high osmotic potential, will have an adverse effect on the growth and productivity. Our results are in accordance with those of Jha *et al.* (1999) who have also shown 40% as the most optimum initial moisture content for the cellulase production from soyahulls. Zafar *et al.* (1989) and Smits et *al,* 1997 have however reported a minimum moisture of 60% in solid state fermentation. It may however be mentioned that lower initial moisture is always better as it greatly facilitates handling and extraction of the enzyme at pilot scale.

While studying the physiological characters of *Phanerochaete chrysosporium* grown on wheat straw it was seen that the high cellulase yield of 31.5 lU per g dry (FPase) substrate was obtained at an initial pH of 4.5. of pH Further, the temperature optimization experiment indicated that 25^0 C was the most optimum temperature for best cellulase activity.

Effect of supplementation of various nitrogen viz. Ammonium sulphate, sodium nitrate, urea and casein was also studied. The results indicate that all the compounds used showed stimulatory effect on the cellulase activity. Among different nitrogen sources supplemented, urea was found to be the best nitrogen source for cellulase production. Our results are in accordance with that of Nigam *et al.* (1988) who have also shown urea to be the best nitrogen sources in the fermentation of sugarcane bagasse and soyabean huls, respectively.

The over all results indicate that under all conditions standardized, the cellulase activity of 74.9 lU per g dry substrate could be obtained in 6 days and thus concludes that wheat straw can be successfully used for the production of cellulase at pilot scale.

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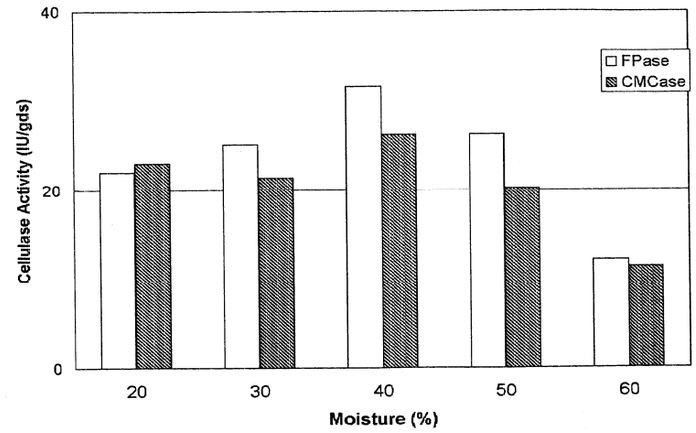

Fig.1 Effect of moisture level on the production of cellulase

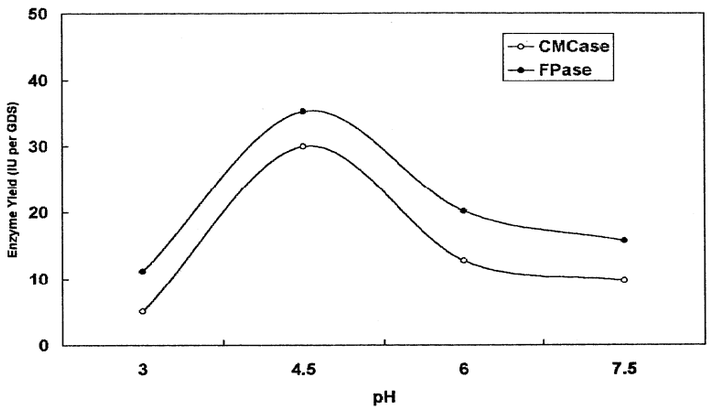

Fig. 2. Effect of pH on the Cellulase Production

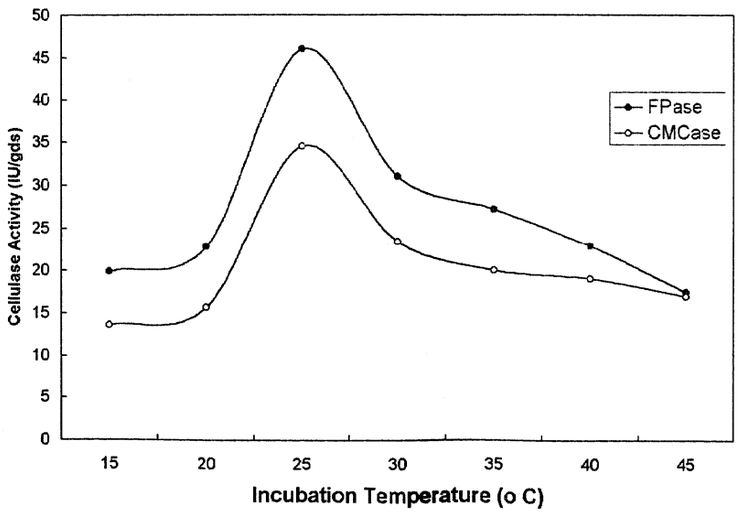

Fig. 3. Effect of Incubation temperature on cellulase activity

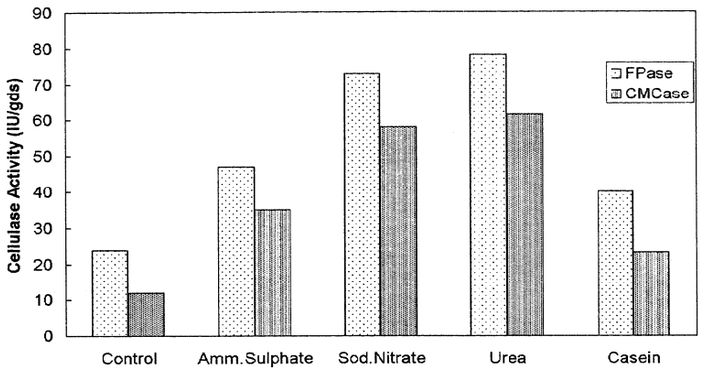

Fig 4. Effect of Nitrogen sources on Cellulase activity

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Effect of air pollution on photosynthesis-A study of its effect on oxygen evolution.

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Abstract

This paper deals with the effect of urban air pollution on oxygen evolution by common tropical avenue tree species growing along three important traffic corridors in the capital city of Delhi. Oxygen evolution was measured using Clark-type Hansatech oxygen electrode (U.K.) A marked reduction in oxygen evolution was observed in five species of tropical avenue trees, viz., *Azadirachta indica A.Juss, Alstonis scholaris R.Br. Ficus religiosa* Linn., *Ficus benghalensis* Linn. and *Morus alba* Linn. growing along three important traffic corridors in the capital city of Delhi. Reduction in oxygen evolution was found to be related to the intensity of air pollution resulting from growing automobile traffic. In respect of oxygen evolution, *Ficus religiosa* was found to be the most sensitive, while *Alstonia scholaris* was relatively tolerant to roadside automobile pollution. The results of this study suggest that sensitivity of oxygen evolution to air pollution can be an important criteria for selecting avenue trees for road side plantation along high traffic corridors in urban areas and for raising green belts in and around industrial complexes.

Key Words: ***Oxygen evolution, Photosystem II, air pollution and avenue trees, sulphur dioxide.***

Introduction

The effect of air pollution on plants is a growing concern. The synergy resulting from industrialization, rapid growth of automobile traffic and economic liberalisation is bound to escalate the intensity and magnitude of urban air pollution in the coming years. Plant performance in terms of functioning of stomata, respiration and photosynthesis has been shown to be highly sensitive to air pollution, affecting

plant growth and yield adversely (Varshney and Garg 1979, Wellbur 1988, Darrall 1989, Peace *et al.* 1995). Although a vast literature exists on the plant performance under pollution stress, studies have been mostly conducted in experimental conditions while the influence of ambient air pollution on plants in field conditions have not received as much attention, even though long-term exposure to low-levels of air pollutants, below prevailing leaves affect plants performance including photosynthesis and thus growth and yield (Roberts *et al*. 1983, Koziol and Whatley 1984, Queiroz 1988). Further, the studies are largely based on crop plants (viz. Zipfel *et al*., 1990 on *Vicia faba* L., Lee *et al*., 1992 on *Phaseolus vulgaris* L. and *Glycine max* L.; Ashenden *et al.* 1955 on *Trifolium repens* L.), while literature on the effect of air pollution on broad-leafed tropical tree species is completely lacking.

The effects of air pollution stress on tree species have been evaluated mostly on the basis of morphological and bio-chemical parameters and to a lesser extent in terms of physiological parameters. Studies on the effect of air pollution on photosynthesis have been mostly restricted to stomatal conductance and CO_2 assimilation rate, enzyme activities, growth, yield and productivity. Information on the effect of air pollution on oxygen evolution capacity of plants is scarce and that too mostly pertains to herbaceous species (viz. Pfanz *et al.* 1987 on *Hordeum vulgare* L.; Ghisi *et al.* 1990 on *Spinacea oleracia* L) and a few studies have been conducted on seedlings (viz. Renuga and Paliwal 1955 on *Harbwickia binata*). Hardly any study exists on oxygen evolving capacity of trees subjected to ambient air pollution stress under field conditions in the urban environment on road-scapes.
This paper attempts to evaluate the effect of urban air pollution on oxygen evolution in common tropical avenue tree species in Delhi.

The study area

Delhi, the capital city of India is located between $76^0\ 50^1$E-$77^0\ 23^1$E and $28^0\ 12^1$N-$28^0\ 53^1$N. It lies in the Subtropical belt and experiences a maximum temperature of 46^0C in summer and minimum of 1^0C in winter. It has a monsoon climate having an average yearly rainfall of 73 mm (1994).

Delhi, the third populous city of India, has a population of 95.2 million and spreads over an area of 1483 sq. km (1991 census). In recent years the city has grown at a phenomenal rate. With the growth of economy and urban frontiers, automobile traffic in the city has greatly increased. The number of industries and automobiles have increased from 29000 and 204078 in 1971 to 93000 and 2198908 in 1993 respectively (Delhi Statistical Handbook 1955). In 1975 Delhi had a human population of 49.01 lakhs, and that of motor vehicles was 2.12 lakh, i.e., one vehicle for every 16 persons, but in 1994 human population grew to 1.01 crore and that a motor vehicles became 24.14 lakh, i.e., for every four persons there was a motor vehicle, which is four times the 1975's value, and the ratio is steadily

coming down. (Hindustan Times 1995). This rapid increase in point and non-point pollution sources has affected air quality significantly.

Study sites

Four field sites were selected. Three sites namely Bikaji Cama Place, AIIMS and Ashram lined with avenue trees were selected representing increasing traffic densities. The fourth site was selected inside the JNU campus. Site 1: JNU lies at the southern periphery of Delhi having a sprawling campus of 700 acres with vast expenses of natural vegetation. JNU, being a well-protected campus with restricted entry, has low traffic density, which peters out almost completely during night, as entry into the campus becomes highly restricted. It was selected to serve as control site.
Site 2: Bikaji Cama Place is an office cum-modern commercial complex in South Delhi on the Ring Road which has a medium heavy traffic for most of the day.
Site 3: AIIMS crossing on Ring Road, carries one of the maximum traffic in Delhi. It is estimated that during peak hour 16,000 passenger car units (PCU) remain in traffic.
Site 4: Ashram is on the eastern section of the Ring Road and carries the maximum traffic going out from Delhi to other states and vice versa. It has a constant high traffic density throughout the day.

Materials and Methods

Plant material: Five commonly growing avenue tree species i.e *Azadirchata indica A.Juss, Alstonia scholaris R.Br., Ficus religiosa L., Ficus benghalensis L. and Morus alba* L., along important traffic corridors were selected for study on the basis of their availability in good number of replicates at the sites. Leaf samples from avenue trees were drawn from lower branches, which were under direct sunlight. Care was taken to select trees of equal height/dimensions. The collected leaves were put in ice-bath and brought to the laboratory as soon as possible.
Instruments: Clark-type Hansatech electrode; CBI-D Hansatech control box; Pen-recorder; A source of light (slide projector in this case) and a constant temperature bath.
Ammonium chloride (NH_4Cl), 5mm used as an uncoupler and Sodium dithionite ($Na_2S_2O_4$).
Solutions: Grinding medium: Grinding medium recommended by Cerovic and Plesnicar (1984) was used. Sorbitol, 340 mM; KCI, 0.4 mM; EDTA, 0.04mM; Hepes-KOH, 2mM at pH 7.6-7.8
Resuspension medium: Sorbitol, 330 mM; EDTA, 2 mM; $MgCl_2$, 1mM; $MnCl_2$, 1 mM; Hepes-KOH, 50 mm at pH.6; BSA, 0.05 percent.

The intactness of the chloroplast was usually more than 80% as estimated by the ferricyanide method (Heber and Santarius, 1970). Subsequently, chlorophyll was determined (according to Maclachlan and

Zelik 1970). For getting a constant chloroplast suspension, the absorbance of the chlorophyll solution was measured at 652 nm., the resultant value was then multiplied by 100/9, to give µg chlorophyll per ml of original suspension. Alternatively, the reciprocal of the absorbance value x 9 approximates to the number of µl of chloroplast suspension required to give 100 µg of chlorophyll. Care was taken, that amount of chlorophyll don't exceed 100 µg/ml in the final reaction mixture which was 2ml. Experiment was conducted keeping the temperature constant at 25^0C. Oxygen evolution was measured using Clark-type Hansatech oxygen electrode (U.K.).

Results

Table:- Changes in oxygen evolution (in µmoles of oxygen/mg chl./hr.) at different sites.

Species	µ moles of oxygen/mg chl./hr. Study Sites			
	JNU (control)	Bikaji Cama	AIIMS	ASHRAM
Azadirachta indica	44.11 (0)	29.47 (33.19)	17.50 (60.33)	14.95 (66.11)
Alstonia scholaris	71.17 (0)	59.44 (16.48)	41.92 (41.10)	34.76 (51.16)
Ficus religiosa	16.17 (0)	15.32 (8.32)	11.46 (31.42)	3.51 (78.99)
Ficus benghalensis	24.23 (0)	-	7.15 (70.49)	6.14 (74.66)
Morus alba	57.50 (0)	29.04 (49.50)	22.17 (61.44)	14.96 (73.98)

All the values are mean of three replicates.
Figures within parentheses indicate percentage reduction over control (i.e. JNU).

The data presented in Table, shows that oxygen evolved was 44, 11, 71. 17, 16, 24.23, and 57.50 µ moles of oxygen/mg chlorophyll/hr in *Azadirachta indica, Alstonia scholaris, Ficus religiosa, Ficus benghalensis* and *Morus alba* respectively, growing at the control site (JNU). Plants growing at the polluted sites showed marked reduction in oxygen evolved. Maximum percentage reduction (78.90%) in O_2 evolution was observed in *Ficus religiosa* at Ashram and the least reduction was also in the same species at Bikaji Cama Place. Reduction in oxygen evolution bears a direct relationship with increasing degree of vehicular pollution load (table) i.e. the maximum reduction in oxygen evolution occurred at Ashram and the least was at Bikaji Cama Place, while total value for the AIIMS were intermediate between the two sites.

All five plant species studied, showed this relationship. Ficus religiosa however shows the highest sensitivity towards automobile pollution, as in this case maximum percentage change (reduction) has taken place at each site relative to site having comparatively lesser vehicular traffic density; while rest of the tree species show a moderate reduction from one site to the other (table). The reduction in oxygen evolution in different species at Ashram was in the following order: *F.religiosa* > *F.benghalensis* > *M.alba* > *A.indica* > *A. scholaris.*

Discussion

Plant not only play an important role in the cleaning of the environment but also at the same time, recharges and renovates the environment. Photosynthesis in the biosphere has been estimated to account for an annual global production of fixed carbon amounting to as much 10^{10} to 10^{11} tonnes; about the same amount of O_2 would be liberated into the biosphere as a bio-product (Kamen 1963). The life sustaining process of photosynthesis and oxygen evolution and the effect of air pollutants on the same, makes in imperative to be studied intensively.

A complex multi-subunit enzyme system called photosystem II (PSII) catalyses H_2O oxidation and donates the resulting electrons to the subsequent reactions that ultimately reduce CO_2 to sugars. Photosystem II can be defined as those part of oxygenic photosynthesis which catalyses the photo-induced transfer of electrons from water to plastoquinone 'PQ' (Hansson and Wydrzynski 1990) i.e.

$$4H + 2PQ + 2H_2O \xrightarrow[PS\ II]{4hv} 2PQH_2 + O_2 + 4H^+$$

The direct effects of CO_2 and sulfite, etc., on the photosystems within thylakoids are not clear. If plants are fumigated with very high concentrations of SO_2 (more than 1 ppm, or 40 μmol m^{-3}), then the oxygen evolution functions of PSII as measured polarographically are inhibited (Wellburn 1972). Similarly, if thylakoid preparations are treated with sulfite, bisulfite, or SO_2 at concentrations greater than mol m^{-3}, there are reductions in equivalent PSII functions (Silvius, Ingle, and Baer 1975). SO_2 oxidation in plant cell forms O^-_2, OH and H_2O_2, which reacts with the chloroplast thylakoid membrane components, leading to photo-oxidation of chloroplast pigments (Shimazaki *et al*. 1980). SO_2 can also affect the CO_2 uptake by plants on three different counts, first by affecting the stomatal physiology, second on account of competitive inhibition with CO_2 for active site on Rubisco and third due to the direct impact of SO_2 on chloroplast organisation and hence on the physiology of photosynthesis (Winner and Mooney 1980). SO_2 has been shown to cause swelling of the thylakoids in *Pinus* and reduction in the number of grana in spruce needles (Malhotra 1976) and in *Pisum* (Wong *et al.* 1977). Similar results have been reported in *Azadirachta indica* exposed to 4 ppm SO_2 which resulted in the

swelling of chloroplasts and dis-organisation of grana and stroma, distended thylakoids and disrupted chloroplast envelopes (Sugahara 1984). Disruption of structure and organisation of thylakoids and grana in the chloroplast adversely affect the PSI and PSII activities (Sugahara 1984). Exposure of plants to SO_2 or HSO_3 results in inhibition of photosynthetic electron transport, which could clearly be a consequence of lipid peroxidation in thylakoids (Covello *et al.* 1989). However bisulphite may also directly act on one or more PSII elements either through reactions involving free radicals or by reacting with disulphide bridges (Covello *et al*. 1989). In addition sulphite competes with orthophosphate for an active phosphorylation site on chloroplast coupling factor particles (Cerovic *et al.* 1982).

Nitrite, though appears to have no individual inhibitory effect (as it may function as an electron acceptor), however in combination with sulphite it may initiate free radical reactions within membranes, which in turn may result in the breakdown of the mechanisms involved in the creation of proton gradients across thylakoid membranes. Similarly ozone is known to cause depression or decrease in apparent photosynthesis, event at low concentration-a 60-day fumigation with 0.15 ppm (294 µg m^{-3}) resulted I a final 25% decrease in apparent photosynthesis and a 30-day fumigation with 0.30 ppm (588 µg m^{-3}) revealed a 67% depression (Miller *et al.* 1969).

Any or all of the above stated factors, in isolation or acting synergistically can bring about reduction or inhibition of oxygen evolution by plants.

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Environmental State of River Ganges in Rishikesh-Haridwar and its Management

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Abstract

The present study deals with the influence of discharge of various drains carrying domestic and industrial wastes on the water quality of river Ganga at different locations of Rishikesh and Haridwar. It is indicated that though the quality of river water deteriorates at these locations, the river still has an excellence purifying ability. The condition of water quality is not much alarming. There is a need of monitoring of water quality from different depths at 5-6 different points of water current across the river width throughout the year. Various methods for the proper management of river water have been suggested.

Key Words: ***Ganga, Rishikesh, Quality, Management***

Introduction

The river Ganga is most important of holy river of India. More than 80% people of our country worship it since time immemorial. Like other Northern Indian rivers, Ganga also originates from Himalayan glaciers. i.e. Gomukha, before Devprayag, it is known as Bhagirathi. A large number of tributaries join the river and loose their identity during its course. Important tributaries such as Alaknanda in hills and even Yamuna in plains lose their identity at Devprayag and Allahabad

respectively. Tributaries have important role in maintaining the quantity of water. Ganga has an important impact on the economy of Northern India and has been considered as lifeline of the country especially for the states of Uttarpradesh, Bihar and West-Bengal.

Ganga covers about 225 Km from Gomukha to Bay of Bengal. A number of important cities are located on the bank of river and are getting water supply not only for domestic purpose but for Industrial uses also. Besides, it has been a major source of irrigation for the agricultural land and for recharging of the ground water at certain areas. A very limited amount of freshwater is available on the earth at global level for human activity. Of the total available water, 93.96% is confined to Ocean, 4.2% to underground, 0.2% to total inland surface including rivers, lakes and other reservoirs. A very small percentage of water i.e. 0.0001% is available in rivers.
Albeit large restrictions have been made by ancient Rishis to protect the Ganga from contaminants and pollutants but there is a sorry state. It is pardox that the people who worship it are putting a river, which is a part of cultural heritage of the country, to ecological assault. Among all the fourteen major rivers of the country, Ganga is being considered as most polluted river. Environmental health of river has not been deteriorated suddenly. There is information that about 3,70000 people died by consumption of Ganga water due to water born diseases such as diarrhoea, dysentery, cholera, typhoid and hepatitis from 1898 to 1907 (Jonthan *et al,* 1984).

Keeping in view of religious and economic significance of the river, it becomes more imperative to maintain the environmental health of Ganga. Therefore it is necessary to find out major sources of pollution and their impact on water quality and also to provide remedial measures in Indian context of Rishikesh-Haridwar region.

Major resources of pollution at Rishikesh-Haridwar and their characteristics:

Major drains carrying domestic sewage and industrial waste and evacuating them at different locations at Rishikesh and Haridwar were as follows

Domestic drains	**Industrial drains**
1. Swargashram drains	1. Doon Distillary drain
2. Sarswati nala drain	2. IDPL drain
3. Kangra mandir drain	3. BHEL drain
4. Naisotadrain	
5. Lalta Rao drain	

Various physico-chemical and microbiological parameters of the discharge of different drains entering river Ganga and different locations of the river water were analysed using standard techniques (APHA 1986). Annual average data of characteristic features of various wastewater based on the present study has been presented in table 1. The study showed that wastewater contains high amount of organic load that ultimately results in higher BOD, COD and bacterial population. Maximum BOD was found to be 5244.00 mg/1 in Doon distillery while high profile of COD was recorded to be 170 mg/1 at Kangra mandir drain. Bacterial population was found very high in IDPL and Sarswati drain followed by BHEL drain. Both BHEL and Sarswati drains carry high amount of faecal matter, which is evident by disposed faecal waste and excreta at the point of discharge of drain into Ganga. DO in the effluent was negligible and some time it was nil. All the above parameters indicated that these drains caused severe deterioration of water quality of Ganga wherever they discharged their waste.

Further it was observed that all organic pollution load parameters viz. BOD, COD, MPN and SPC were tremendously enhanced in the rainy season. Increased values of these parameters are mainly due to addition of garbage. This garbage reaches into the river through stream water and soil erosion. Stream water also contains high amount of surface dust which is rich source of both organic nutrients and aerobic microbial flora which caused depletion of DO due to utilization of oxygen during decomposition of organic matter and enhances the value of BOD, MPN and SPC. This trend was recorded in all drains uniformly. Besides this, during summer and rains, large number of pilgrims visit Haridwar and Rishikesh which results peak of human activity and generation of large quantity of solid waste, besides addition of detergent, human excreta discharge which ultimately reach into Ganga. A number of sewers and a few Nalas open into Ganga from various Ashrams from Har Ki Pauri to Avadhoot mandal.

Impact of domestic and industrial drains on water quality of Ganga.

It was found that in main stream of Ganga as well as in its tributaries from Gangotri to Rishikesh, the DO was better in winter and there was a slight depletion in summer. BOD, MPN and SPC also showed the same pattern. There was no significant difference in these parameters in Ganga and its tributaries. But the picture of water quality from Rishikesh to Ganga was different due to large number of out falls starting from Rishikesh to Haridwar. The discharge of domestic waste as well as industrial waste in Ganga results in deterioration of water quality upto certain extent downstream depending on the volume of waste and organic matter, volume and flow rate of the river as well as the season and other factors.

The data showed maximum deterioration of water quality during rainy season and an evidence of influence of drains on water quality has also been well established under seasonal variation. It is

obvious that DO, BOD, COD, MPN and SPC during rains were 8.0 mg/1, 5.7 mg/1, 16.77 mg/1 and 20.5 x 10^2, 26 x 10^3 respectively at Muni Ki Reti. Decreased level of DO i.e. 6.4 mg/1 and enhanced values of BOD (42.25 mg/1), COD (120 mg/1), MPN (82.5 X 10^2 and SPC (266 x 10^3) are evidence of the influence of Sarswati drains at Triveni ghat. Most deterioration of water quality was found at IDPL mixing zone at Shyampur Khadri in Rishikesh. It was perhaps due to high volume of effluent discharge into river Ganga and due to large surface area of river current which results in comparatively slower flow rate, shallow depth that could not dilute the discharge of effluents rapidly.

It was established that these drains were deteriorating the Ganga water quality but as the sampling was done from nearer to mixing point and few meter down stream and not from the different depths and opposite to the bank of river and 1 to 2 Km down stream, therefore the exact impact on water quality as whole spectrum cannot be ruled out. Further is was evident that river purifies the water downstream up to certain extent at Haridwar which is around 25 Km down from Rishikesh. Annual average values of various parameters of the water samples collected from Har Ki Pauri indicated that there was excellence recovery in DO (8.1 mg/1), BOD(4.0 mg/1), COD(20.0 mg/1), MPN(10 x 10^2) and SPC (30 x 10^3) as compared to Triveni ghat and IDPL mixing zone. Water quality improved up to level of site at Muni Ke Reti (Table 2).

It seems that during the course of flow dilution of both effluents and river water, occurred. Simultaneously there was a degradation of organic component and enhancement of DO due to mixing and absorbance of O_2 from atmosphere and by release of O_2 by various aquatic plants including algal genera and others. Further it appears that river quality of Ganga would be definitely better towards bottom of the river and opposite bank of the river as it is very difficult for the pollutants to move to opposite bank and to settle at bottom in any stream-current. However, exceptionally high current of wind may facilitate the movement of pollutants toward opposite bank on the river but their impact will be negligible.

Various physico-chemical and bacteriological features of different sites of river Ganga and Haridwar have also been reported by Shankar 1987, Khanna 1993, Chopra and Rehman 1992 a, b, and Chopra and Patrick, 1994,2000. The efforts to make a suitable management programme of domestic sewage as well as industrial effluent with the treatment by aquatic plants under laboratory condition was made by Shankar *et al*. 1989 and Sharma *et al* 1999). They have found a drastic improvement in various parameters of sewage after treatment. Shankar *et al* (1989) observed that certain industrial effluents are a better source for seed germination and plant growth of some agricultural crops and it may provide another source of wastewater management in Indian context after doing more detailed study.

Conclusion

With these findings, it is concluded that water quality as far as bathing is concerned, was not solubility deteriorated. But it does not mean that precaution should not be taken for protection of river Ganga.

The population explosion, change in mode of life, urbanization, industrialization and human activities of course these will cause severe risk on ecological system of river water. To protect the people and to prevent any kind of outbreak of epidemics, there should-be publicity that people should avoid consuming the river water as it may contain traces of raw sewage and chances of presence of human pathogen can also not be ignored.

Management Programme

1. It is obvious that direct discharge of raw sewage or industrial effluents is cause of deterioration of water quality at discharging point. Though purification occurs after a distance of 10-15 Km up to certain extent but the chances of presence of human pathogens remain there. Therefore at any cost, direct discharge of wastes should be prevented.

2. Both domestic sewage and industrial effluents should be properly monitored and treated primarily and secondarily for important parameters. Further the waste should be treated in oxidation ponds. This will facilitate for decomposition of remaining organic components and will allow growing large number of algal genera and other aquatic plants and will generate the organic manure.

3. Due to large volume and load of water, percolation of water may occur which may cause another serious threat for underground water especially if wastewater contains heavy metals or toxic substances, which are not degradable. Besides this, the movement of underground water occurs as columns march very slowly. Once contamination takes place, it would not be only difficult but impossible to eradicate contaminants. The refore other different designing of oxidation ponds should be done to protect the ground water.

4. Before discharge of treated sewage into the river, volume of sewage discharged per cubic meter/second should also be considered on basis of flow rate and volume of river. During winter season discharge of treated sewage should not be permitted as water volume and flow rate of Ganga are highly reduced. Recommendation regarding discharge of treated sewage indicates that for safe dilution, river water should be eight times more than sewage and this criterion should be strictly followed.

5. The treated water should also be tested for its effects on germination of various agricultural crops, biomass production and ultimately on yield. Both biomasses as well as yield should be properly monitored for deposition of heavy metals and chemicals to prevent any kind of human health hazard.

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Table 1:- Annual average values of Physico-chemical and Bacteriological parameters of some domestic and industrial drains responsible for Ganga pollution.

Parameters	DRAINS						
	SN	ID	DD	KM	NS	LR	BH
Temp.(^{0}C)	27.5	25.5	38	21.8	22.0	20.0	35.0
Turbidity (NTU)	109.6	102.31	380.0	52.3	62.26	62.37	160.11
pH	7.26	6.59	3.8	7.82	7.63	7.36	7.62
Conductivity (mv)	0.580	0.467	0.858	0.315	0.288	0.322	0.620
Hardness (mg/1)	189.0	180.0	352	190.0	188.0	250.0	298.0
Alkalinity (mg/1)	252.5	104.0	251.0	108.0	140.0	195.0	212.0
DO (mg/1)	1.20	2.36	Nil	4.61	1.50	3.96	Nil
BOD (mg/1)	142.63	176.0	5244.0	36.21	82.61	93.8	193.21
COD (mg/1)	267.15	278.6	15252.0	170.61	212.11	198.27	242.16
Chlorides (mg/1)	38.5	48.5	210.0	21.8	28.0	28.0	34.64
Sulphates (mg/1)	14.6	21.58	23.5	12.0	8.0	12.0	12.5
SPC/ml x 10^3	446.0	380.0	350.0	42.0	160.0	210.0	580.0
MPN/100 ml x 10^2	240.0	223.0	220..	93.0	193.0	110.0	210.0

SN:Sarswati Nullah, ID:IDPL, DD:Doon Distillary, KM:Kangra Mandir, NS:Nai Sota, LR:Lalta Rao, BH:BHEL

Table 2:- Annual average values of Physico-chemical and Bacteriological parameters at few sites of river Ganga.

Parameters	Sites					
	MuniKiReti	Trivenighat	Pashulok Barrage	IDPL	NealDhara	HariKiPauri
Temp. (^{0}C)	16.84	19.80	18.5	22.0	20.0	21.5
pH	7.7	8.13	7.5	7.6	7.4	7.5
Total solids (mg/1)	462.8	950.6	695.0	596.0	284.0	470.0
CO_2 (mg/1)	0.20	0.29	0.62	0.37	0.78	0.56
Chloride (mg/1)	3.5	18.8	8.07	15.6	10.08	3.50
DO (mg/1)	8.5	6.10	9.0	4.7	8.0	8.1
BOD (mg/1)	7.3	47.10	8.60	116	8.60	4.0
COD (mg/1)	19.50	100.0	17.0	195	38.0	20.0
SPC/ml x 10^3	20.0	280.0	135	280.0	70.0	30.0
MPN/100 ml x 10^2	8.4	16.6	7.0	60.0	11.0	10.0

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Ethanomedicinal uses of some important plants of Jhajjar district, Haryana, India

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Abstract

A large, number of rural people are still dependent for much of their therapeutic needs on the plants of their vicinity. The present paper incorporates the result of ethanomedicinal uses of widely use indigenous medicinal plants. Information on 30 plants along with medicinal application are given in the paper.

Key Words: ***Ethanomedicinal, medicinal plants, rural people, Jhajjar district, Haryana.***

Introduction

The curative properties of the plants have been of main interest to mankind since time immemorial. According to the report of World Health Organisation (WHO 1978) over 80% of the world's population rely on traditional systems of medicines, largely plant based, to meet primary health care needs. Traditional medicines refer to the indigenous systems of healthcare. In Asian countries traditional system of medicines has been an important part of the National Healthcare System. India's medical heritage is centuries old and more than millions of people depend upon traditional health system. Even after the induction of 200 years of modern system of medicines 90% of the population of rural India take the help of Local Village Health Practitioners (LVHP) for the treatment of various diseases (Yadav and Patil-2001).

Over 7500 species of plants are estimated to be used by 4635 communities for human and veterinary health care (Tewari 1999). Most of the countries worldwide have brought out herbals material medica of centuries old traditional medicines. In India Rigveda, which is considered to be the oldest available

record dating back to 4000-5000 B.C recounts some medicinal plants. Atharvaveda, another religious book of the Hindus, has described about 2000 plants having medicinal properties. Sushruta Samhita (1000 B.C) further records the medicinal virtues of 700 plants. Chark. Watts, Kirtikar and Basu, Chopra, Nadkarni etc. have described the medicinal importance of plants from time to time. Indian Material Medica accounts for the nearly 3500 species. About 1000 plants have been used in the Indian system of medicine. However, systematic work on traditional medicines gained momentum with the publication of Chopra's book on Indigenous Drugs of India in 1933. In India, ethnobotanical studies with a good scientific base have appeared in last 1-2 decades, leading to the publication of a number of valuable regionals accounts of medicinal plants. (Handa *et al*. 1951; Jain 1964, 1967; Shabnam 1964; Shah and Kapoor 1974; Jain and Dam 1979; Vartak 1983; Aminuddin & Khan 1994; Girach *et al*. 1994; Maikhuri *et al*. 1998; Dhiman and Khanna 2001).

Geology and Geography

The Haryana state is one of the northwestern states of India adjoining Delhi, the capital of the country. The Jhajjar District headquarter is situated at 28 ^{0} 36 north latitude and 76 ^{0} 42 east longitude. The climate of the district is dry with an intensely hot summer and a cold winter. Only during the three monsoon months of July, August and September does moist air of oceanic origin penetrate into this district to make the weather comparatively milder. From October to June the weather is dry except for a few showers received from western cyclones.

Jhajjar possesses rich alluvial soil, the surface soil, being loamy and slightly on the alkaline side. Sandy tracks occur in some part of the district.

Vegetation

On account of the pressure of population and extensive cultivation very little vegetation has been left of the natural forests. These, where present, are of the open evergreen scrub or thorn type.

The people

The total area of district Jhajjar is 1834 sq kms and the population is 8,87392. The natives of the district Jhajjar are known as Haryanavis and the language spoken by them is Haryanavi, a dialect of Hindi.

Materials and Methods

The study involved fieldwork, interviews, study of specimens and comparison from literature. Extensive field trips during different seasons of the year were made in the area since 1998 to 2002. The

plant specimens were collected and the therapeutic uses and vernaculars of the plants were recorded through interviews with the peasants, shepherds, local medicinal practioners elderly persons.

Results

It was found that traditional medicine man called Shyana (Knowledgeable person) and Vaidji still have a very strong hold in the rural population. There has been little made to explore the possibilities to get the knowledge from these medicine men. The results of the study from the Jhajjar district have been given in the Table 1.

Discussion

Haryanavi folk medicine is an art practised mainly by elderly persons who are said to be capable of healing various diseases, viz, asthma, diabetes, jaundice, kidney stones, leprosy, liver troubles, piles, rheumatism, etc. the treatment is known to majority of people but for the serious ailments Shyana or Vaidji is considered competent.

There are common beliefs of the inhabitants regarding various types of ailments, however. sometimes variations in the remedial measures are also observed. Most of the informants consulted were consistent about the information regarding use of the plants as medicine. However, some of the informants differed in their reports on the way to use the same plant. In most of the cases the plant parts are taken as raw or in the form of juice or decoction for internal administration, while applied as juice or paste in external applications. Usually a single plant makes the remedy but use of combination of plants is also practised.

The people practising Haryanavis folk medicine have strong faith in their own recipes and common people have often observed the positive effects of their medicinal preparations. Still the people prefer to be treated for really serious ailments by doctors in the government hospitals or dispensaries, while plant remedies are employed in emergencies and for routine maladies. Yet the acceptability of these remedies is quite high among 80% of the Haryanavi population of the district.

It obviously requires painstaking scientific research of test the validity of these putative remedies. Since there is no systematic schooling for transmitting knowledge of these plant remedies from one generation to the next, it is believed that with the passing of one more generation, little of this traditional knowledge will survive. In the meanwhile, it is believed that this information should be recorded before it is lost with the passing of another generation.

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Table 1:- Showing the Botanical name, vernacular name, part(s) used, mode of administration, quantity, diseases and dosage.

S. No.	Botanical Name	Vernacular Name	Parts (s) used	Mode of Administration	Quantity	Diseases	Dosage
1.	Acacia arabica	Kikar	Stem barked	Powder, Decoction Roasted As such	10 gm 10 ml. 10 gm	Gum problem Gum problem, mouth ulcer Urinary problem, strength Pyorrhea, mouth was	Twice daily for 1 month Twice daily until cure Twice daily for 15 days Twice daily
2.	*Achyranthes aspera*	Chirchita	Whole plant Leaf Leaf Root	Decoction Juice Paste Extract	10 ml. 10 ml. 10 gm. 2 gm.	Diarrhea Skin eruptions Piles & bites wasps & bees Menstrual disorder	Twice daily for 3 days Twice daily until cure. Twice daily until cure Twice daily for 1 month
3.	*Adhatoda vasica*	Bansa	Flower Root Leaf	Powder Powder Powder	10 gm. 10 gm. 10 gm.	Chest Infection & T.B. Asthma Asthma	Twice daily for 15 day Twice daily for 1 month. For 1 month.
4.	*Aegle marmelos*	Bel	Ripe fruit Ripe fruit Root Bark	 Decoction Syrup Powder	1 cup 1 cup 20 gm.	Digestive Stimulant Piles & constipation Fever & heart palpitation	Once daily for 15 days. Once daily for 15 days As require.

5.	*Albezzia lebbek*	Siris	Seed Leaves Whole plant	Powder As such Decoction	10 gm. 4-5 leaves 10 ml.	Purification of blood, acne, improved vision. Locally Bandage for snake & scorpion bite. Snake & scorpion bite.	Twice daily for 1 month Twice daily for 15 days. Twice daily for 15 days
6.	*Aloe vera*	Gvarpatha	Whole Plant Pulp	Extract Paste	2 gm. 10 gm.	Jaundice & common cold For easy lactation	Twice daily for 15 days. Twice daily for 7 days.
7.	*Amaranthus spinosus*	Cholai	Root Leaves	Docoction As such	10 ml. 5-6 leaves	Colic pain Constipation	As required Twice daily for 3 days.
8.	*Argemone maxicana*	Satyanashi	Leaves	Paste	10 gm.	Skin disease	Twice daily until cure.

9.	*Azadiracht a indica*	Neem	Leaf stalks Young plants Leaves Stem bark	As such Sweet Juice Boiled in water As such Paste	6 5 ml 2-leaves. 10 gm.	Swellings of gum Fever antihelmenthatic, Jaundice Skin infections Snake bite. Boils, open source, bruised joints	Twice daily brushing. Twice daily for 7 days.
			Seed	Oil	5 ml.	Intestinal worms Headache Rheumatism	Daily bath until cure. Twice daily 7 days. Twice daily for 7 days.
10.	*Butea monosperma*	Palas	Flower Seeds Flower Leaves Gum	Decoction Paste Roasted	10 ml. 10 g 10 gm	Wormicide, sore eyes Pimples & acne Impotency, seminal strength	Twice daily for 7 days. Twice daily until cure. Twice daily for 15 days.

11.	*Calotropis*	Aak	Stem Bark Stem Leaf	Powder Juice As such warmed	2 gm. 10 ml. 4-5 leave	Asthmatic cough Applied in swelling & painful joints, Insect bite Ulcers & Pustules.	Twice daily 7 days Twice daily until cure. Twice daily for 3 days.
12.	*Cassia fistula*	Amaltas	Stem Bark Leaf	Powder As such	20 gm 4-5 leaves	Pustules Suppuration Pustules Suppuration	Twice daily for 5 days. Twice daily for 5 days.
13.	*Citrullus colycynthis*	Gudumba	Root Fruit	Powder Pulp Oil	10 gm 10 gm 10 ml.	Rheumatism, appetizer diarrhea, Pimples Hair growth & premature graying	Twice daily 7 days. Twice daily 7 days Twice daily 3 months.
14.	*Datura stramonium*	Dhatura	Leaves	Extract Apply as such	2-3 gm. 2-3 leaves	Cough, back ache, Swellings on hand & feet	Twice daily for 7 days. Twice daily for 7 days.
15.	*Desmostachya bipinnata*	Dabh	Root	Decoction	20 ml.	Renal calculi, strangury, janundice & heat stroke	Twice daily for 21 days.

16.	*Eugenia jambolana*	Jamun	Stem bark Leaves Fruits Seeds	Powder As such, Juice As such Powder	10 gm 2 leaves 10 ml. 100 gm. 20 gm.	Eczema, Menstrual disorder, dysentery Diabetes Mouth sore, Bad odor Appetizer, liver tonic. Diabetes, urinary disorder.	Twice daily until cure. Twice daily until cure Twice daily for 3 days. Twice daily for 15 days. Twice daily until cure.
17.	*Ficus glomerata*	Gular	Leaves Stem bark Root Fruit	Decoction Juice Decoction Powder	10 ml. 10 ml. 10 ml. 10 gm.	Externally on fissures, piles rhinitis, internally for diabetes Skin diseases Mumps & backache Vomiting, Flatulence, Gum problem, diabetes.	Twice daily until cure Twice daily for 7 days. Twice daily for 7 days. Twice daily 15 days. Twice daily until cure

18.	*Nerium odorum*	Kaner	Root Leaves	Paste Boiled in water	10 gm. 4-5 leaves	Ulcers on genitals, ring worm, Water bath in leprosy	Twice daily for 7 days Twice daily until cure
19.	*Nicotiana tobaccum*		Whole plant	Powder	10 gm.	For caries of teeth & toothache, padiculli, bite of wasp.	Twice daily for 3 days.
20.	Ricinus	Arandi	Leaves Root Seeds	Warmed and mustard oil Paste Oil	4-5 leaves 10 gm. 5 ml.	Rheumatic joints, inflammation Abortion Constipation, Renal colic	Twice daily for 7 days Once daily for 5 days Once daily as required.
21.	*Saccharum munja*	Munj	Root Fiber	Powder Rope tied around waist	10 gm.	Urinary problem Urinary disorder, mark of holiness	Twice daily for 7 days For 45 days.
22.	*Saccharum officinarum*	Inkh.	Stem	Chewed as such	1 full stem	Disorder of bile, heat stroke	Twice daily for 7 days.
23.	*Salvadora persica*	Jal	Leaves Fruit	Warmed & mustard oil Ripe fruit	4-5 leaves 25 gm.	Skin disease, Piles Piles	Twice daily for 7 days. Twice daily for 7 days.

24.	*Solanum nigrum*	Makoi	Leaves Root Fruit	As such warm Powder Syrup	2-3 leaves 10 gm. 20 ml.	Boils Fever, Skin disease Liver tonic, Tooth ache	Twice daily for 5 days. Twice daily for 7 days. Twice daily for 15 days.
25.	*Tamarix articulata*	Farash	Fruit Stem bark	Powder Decoction	10 gm. 10 ml.	Applied to injuries to stop decay, toothache and gum decay, skin ailments Pedicullai (External applied)	Twice daily for 7 days. Twice daily for 7 days.
26.	*Terminalia arjuna*	Arjan	Stem bark	Powder Paste	10 gm.	Heart Diseases Diabetes Bone Fracture	Twice daily until cure Twice daily for 15 days.
27.	*Tinospora cordifolia*	Giloe	Stem Leaves	Paste Extract Paste	10 gm. 5 gm. 10gm.	Fever Jaundice, urinary trouble Boils	Twice daily for 7 days. Twice daily until cure. Twice daily for 7 days.

28.	*Tribulus terrestris*	Bhakri	Whole Plant Fruit	Decoction Powder	20 ml. 20 gm.	Painful macturition Renal stones Old age weakness, headache seminal strength	Twice daily for 21 days. Twice daily 45 days.
29.	*Trigonella foenum-graecum*	Methi	Seeds Leaves Flowers	Powder Paste Powder	20 gm. 10 gm. 10 gm.	Dyspepsia, Rheumatism, Migraine, Asthma, Bronchitis Tumors Dysentery, Diarrhea	Twice daily until cure. Twice daily for 7 days. Twice daily for 7 days.
30.	*Withania somnifera*	Guga	Stem bark Root	Powder Powder/ Paste	10 gm. 10 gm.	Fever, Cough Asthma, Migraine	Twice daily for 7 days Twice daily until cure

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Aeromycoflora of Gurukul Kangri and Yogi Pharmacy, Haridwar

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Abstract

The study of aeromycoflora of Gurukul Kangri and Yogi Pharmacy was carried out by gravity petri dish method in the year 1994 and 1998 respectively. A total of 12 fungal forms belonging to 8 genera were isolated from Gurukul Kangri and 17 fungal forms belonging to 11 genera were trapped from the air of Yogi Pharmacy. The dominant species were *Aspergillus niger, A. fumigatus, A. flavus, Cladosporium cladosporioides, Penicillium cyclopium, Epicoccum nigrum* rest of the fungi were of sporadic occurrence. In the diurnal cycle the fungi showed an evening tendency. The role of environmental factors i.e. relative humidity and temperature in affecting the densities of fungal population taken into consideration.

Key Words: ***Aeromycoflora, Cladosporium, Aspergillus***

Introduction

The air has the inherent property to sustain the life on earth besides majority of plant and human pathogens are air borne. The air is the basic amenity of our life and contain both viable and nonviable particulates. The microflora of air chiefly consists of fungi, yeast, bacteria, viruses etc. Aerobiological and indoor or intramural aerobiology. The study of airborne microbial contamination in a closed system like buildings hospitals, glass houses pharmaceutical industrial environment etc. is known as indoor aerobiology as against the outdoor aerobiology which is concerned with the survey of biological material in open space like fields and forests.

The presence of fungi in the air depend on the time of the day, season and geographical location. The number and type of fungi in the air is important for medical purposes because fungal spores provoke allergic response. The information regarding the changes in concentration and composition of allergens facilitate forecasting and treatment of allergic manifestations.

The Indian Acharyas and Rishis were well aware of different properties of herbs in curing various

diseases. Hardwar and Rishikesh are among the places where various sages and ayurvedic practioners have been formulating different ayurvedic preparations. Gurukul Kangri and Yogi Pharmacy are well known and reputed ayurvedic pharmacies of Hardwar. Both the pharmacies are important for the production of ayurvedic drugs which serve the mankind. The present study i.e. aeromycoflora of Gurukul Kangri and Yogi Pharmacy was under taken with a view to isolate and identify the fungi present in air which may affect the ayurvedic preparations of these pharmacies.

Materials and Methods

Aeromycoflora of Gurukul Kangri Pharmacy and Yogi Pharmacy were studied by using gravity petri dish method in February – March 1994 and September – December 1998. respectively. Four petridishes containing Martin's Rose Bengal Agar medium were exposed in Asav Department (Fermentation unit) of Gurukul Kangri Pharmacy in the morning and evening separately for five minutes at two feet height from the ground level both for intramural (inside) as well as extramural (outside) studies. In Yogi Pharmacy four samplings were conducted in four different sections i.e. raw material storage section, asav storage section, furnance section of asav preparation and packing section. The exposed plates were incubated at 25^0C and the number of fungal colonies appeared were counted and identified. Relative humidity and temperature were recorded by placing hygrometer and thermometer at sampling site.

Results

1 Gurukul Kangri Pharmacy:

A. Components:

The spore content of air was rich both qualitatively and quantitatively. A list of fungal spore types and the percentage contribution to total aeromycoflora is given in table 1. A total of 12 fungal forms belonging to 8 genera were trapped. *Cladosporium* formed the main bulk of the total aeromycoflora which was represented by its two species viz. *Cladosporium cladosporioides* and *C. herbarum*. *C. cladosporioides* were found to occur in maximum number. *Alternaria* was the next abundant genus followed by white sterile form. *Penicillium* was represented by two of its species viz. *P. cyclopium* and *P. chrysogenum* contributing 9.97% and 0.70% respectively of total aeromycoflora. *Curvularia species* contributed 3.92% of total aeromycoflora. *Epicoccum* was represented by one species i.e. *E. nigrum* which contributed 3.57% of total aeromycoflora. The fungal species having less than 2% contribution

comprises of *Rhizopus sp. P. chrysogenum, Aspergillus niger* and *Trichothecium sp*. The dominant species above 75% frequency of occurrence were *Cladosporium cladosporioides* and *Alternaria sp. Penicillium chrysogenum, Epicoccum nigrum* and white sterile form showed 50-75% frequency of occurrence (Table 2). Rest of fungi were of sporadic occurrence.

B. Diurnal and seasonal periodicities:

The fungal content of the air at a particular sampling time varied between 7.0 and 66.0 propagules per 100 cm^3 (Table 3 A). Minimum number of propagules were trapped in first sampling at evening (inside) and maximum in second sampling at evening (outside) of room no. 2. In the diurnal cycle, fungi showed an evening tendency in all the samples except in the Ist sampling when it was obtained at morning (inside). In all the samplings morning gave minimum counts. On the basis of statistical analysis (Table-3B) aeromycoflora varied insignificantly.

2. Yogi Pharmacy:

A. Components:

The spore content of air Yogi Pharmacy was richer qualitatively than Gurukul Kangri Pharmacy. A total of 17 types of fungal species belonging to 11 genera were trapped from the air (Table-4). The most abundant fungus was *Asprigillus niger* which contributed 16.83% followed by *Aspergillus fumigatus* (14.71%) and *Aspergillus flavus* (13.89%). The fungal species having less than 2% contribution comparised of *Aspergillus sp*. (i), *Drechslera sp. Helminthosporium sp. Higrospora sp.* and *Penicillium sp*. (iii). Besides these white sterile forms and unidentified fungal spores were also trapped. The dominant fungal species above 60% frequency were *Aspergillus niger, A. flavus, A. fumigatus* and *Cladosporium sp*. (Table 5). Rest of fungi were of sporadic occurrence.

B. Diurnal and seasonal periodicities:

The fungal content of the air at particular sampling time varied between 4.19 and 32.50 propagules per 100 cm^3 (Table-6). Minimum number of propagules were trapped on 19.12.98 in the morning (inside) in IV sampling and the maximum number on 9.11.98 in evening (outside) in sampling III.

Discussion

The dominant fungal forms of air were *Cladosporium, Alternaria, Aspergilli* and *Penicillia. Cladosporium* is an ubiquitous fungus and its dominance in fungal aerospora has been reported from

different part of the country (Dixit and Gupta 1081, Yasmeen and Saxena 1992). During the course of present investigation, the total number of *Cladosporium* colonies were more in dry weather and decreased with the increase in humidity and decrease in temperature. *Alternaria* was isolated in abundance from air samplings of Gurukul Kangri Pharmacy. Pady (1957) and Rati and Ramallingam (1976) also found this fungus very close in percentage to *Cladosporium. Aspergillus species* were found to be present in the aeromycoflora throughout the period of investigation. Noble and Clayton (1963) investigated the fungal flora of air of hospital ward and found *A. fumigatus* was the dominant type of spore. Verma and Chile (1992) reported this fungus contributing 35.64% of the total fungal spores collected from the intramural environment in the allergy ward of medical college of Jabalpur city.

In the diurnal cycle highest quantities of fungi were trapped in the evening time and minimum during the morning. These findings are in confirmity with those of Mishra and Kamal (1971) and Sharma and Gupta (1978). The morning periods in winter months are commonly calm and the fungi most of which are wind dessiminated are not disturbed during this period. The undisturbed environmental conditions accounted for low fungal content of air in the morning. In the day time the fungal spores dry up and even gentle breeze disseminates the spores. The dissemination of spores results in the increased spore number in the evening time and this was the reason that the peak was observed in the evening.

During survey of aeromycoflora of Yogi Pharmacy, maximum aeromycoflora was recorded on 9.11.98 in furnance section and least on 19.12.98 in the packing section. At the time of sampling only one furnance was working, the environmental conditions i.e. temperature and humidity was found to be congenial for microbial growth. Moreover, in this section there is a wide open door and non-cemented floor, thus fungal spores are easily disseminated in the atmosphere from the soil. In the packing section, there is cemented floor and every possible effort is made to keep it clean and free from microbes by using ultraviolet light. The maximum number of colonies were recorded in the month of November due to moderate temperature and humidity as also reported by Verma and Srivastava (1966). Our data showed winter maxima and this trend is in confirmity with earlier reports from India (Sreeramulu and Ramalingam 1966, Ramalingam 1971).

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Table 1:- Percentage contribution of different fungi to total aeromycoflora of Gurukul Kangri Pharmacy, Hardwar (Feb. – Mar. 1994).

Fungal Species	**% Contribution**
Alternaria sp.	12.66
Aspergillus niger	1.05
Aspergillus sp.	2.05
Cladosporium cladosporioides	34.25
C.herbarum	15.13
Curvularia sp.	3.92
Epicoccum nigrum	3.57
Penicillium chrysogenum	0.70
P.cylopium	9.97
Rhizopus sp.	0.17
Trichothecium sp.	1.58
White sterile form	11.02
Unidentified	3.34

Aeromycoflora of Gurukul Kangri

Table 2:- Frequency (%) of different aeromycoflora of Gurukul Kangri Pharmacy, Hardwar (Feb.-Mar. 1994)

Fungal Species	**Frequency (%)**		
	I 9.2.94	**II 28.2.94**	**III 19.3.94**
Alternaria sp.	57.89	90.00	95.00
Aspergillus niger	26.31	20.00	45.00
Aspergillus sp.	31.57	10.00	05.00
Cladosporium cladosporioides	94.73	75.00	85.00
C. herbarum	05.26	55.00	45.00
Curvularia sp.	--	30.00	30.00
Epicoccum nigrum	15.78	75.00	50.00
Penicillium chrysogenum	5.26	20.00	25.00
P. cyclopium	84.21	55.00	70.00
Rhizopus sp.	15.8	--	--
Trichothecium sp.	10.52	40.00	20.00
White sterile form	36.84	45.00	95.00
Unidentified	26.31	40.00	--

Table 3A:- Diurnal Variation in the Density of total Aeromycoflora per 100 cm^3 of Gurukul Kangri Pharmacy, Hardwar (Feb.-Mar. 1994).

Sampling Time	Sampling number		
	I 9.2.94	II 28.2.94	III 19.3.94
Morning (Outside)	11.10	21.93	15.59
Morning (Inside)	19.80	13.09	20.16
Morning (Onside)	10.20	65.99	63.69
Morning (Inside)	6.72	29.90	23.25

Table 3B:- Two Analysis of Variance Table

Source of Variation	DF	Sum of Squares	Mean Square	F
Among means of treatment A	3	1049.19	349.73	1.58
Among means of treatment B	2	1870.81	935.40	4.25
Residual	6	1320.33	220.05	

A = Time Interval
B = Diurnal Cycle
DF = Degree of Freedom
Insignificant at 0.05 level

Table No 4:- Percentage Contribution of different Fungi to total aeromycoflora of Yogi Pharmacy, Hardwar (Sep. to Dec. 1998).

Sl. No.	**Name of Fungi**	**% Contribution**
1.	*Alternaria sp.*	2.57
2.	*Aspergillus flavus*	13.89
3.	*Aspergillus fumigatus*	14.71
4.	*Aspergillus niger*	16.83
5.	*Aspergillus sp. (i)*	0.55
6.	*Cladosporium sp.*	6.53
7.	*Curvularia lunata*	6.34
8.	*Drechslera sp.*	1.28
9.	*Fusarium sp.*	3.67
10.	*Helminthosporium sp.*	1.10
11.	*Mucor sp.*	6.25
12.	*Nigrospora sp.*	1.01
13.	*Penicillium sp. (i)*	12.60
14.	*Penicillium sp. (ii)*	3.49
15.	*Penicillium sp. (iii)*	0.36
16.	*Rhizopus sp.*	2.48
17.	White sterile form	2.20
18.	Unidentified	4.04

Table No. 5:- Frequency % of Different Aeromycoflora of Yogi Pharmacy, Hardwar (Sep.-Dec. 1998).

Sl. No.	Name of Fungus	Frequency (%)			
		Sep.	Oct.	Nov.	Dec.
		16.9.98	4.10.98	9.11.98	19.12.98
1.	*Alternaria sp.*	--	40	55	15
2.	*Aspergillus flavus*	60	30	85	35
3.	*Aspergillus fumigatus*	90	45	90	35
4.	*Aspergillus niger*	95	45	95	10
5.	*Aspergillus sp. (i)*	10	15	--	--
6.	*Cladosporium sp.*	35	25	55	70
7.	*Curvularia lunata*	--	45	80	25
8.	*Drechslera sp.*	--	40	20	--
9.	*Fusarium sp.*	25	40	55	10
10.	*Helminthosporium sp.*	--	35	--	30
11.	*Mucor sp.*	75	55	10	--
12.	*Nigrospora sp.*	--	20	30	--
13.	*Penicillium sp. (i)*	90	55	35	20
14.	*Penicillium sp. (i)*	15	35	40	10
15.	*Penicillium sp. (iii)*	--	25	5	--
16.	*Rhizopus sp.*	65	--	30	--
17.	White sterile form	10	35	25	15
18.	Unidentified	55	45	25	30

--: Absent

Table No. 6:- Diurnal Varitation in the Density of total Aeromycoflora Per 100 cm^3 of Yogi Pharmacy, Hardwar (Sep.-Dec. 1998).

Sl. No.	Sampling Time	Sampling Numbers, Months and Date			
		I	II	III	IV
		Sep.	Oct.	Nov.	Dec.
		16.9.98	4.10.98	9.11.98	19.12.98
1.	Morning (Inside)	14.26	11.74	24.32	4.19
2.	Morning (Onside)	11.32	11.11	28.73	5.45
3.	Morning (Inside)	13.84	13.42	19.50	4.82
4.	Morning (Onside)	15.72	10.69	32.50	6.29

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Environment condition around transmission towers not fit for livelihood

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Abstract

Influence of radio frequency (RF) and mircowave radiation on human body is studied. According to Rai (1992) radio and T.V. transmission towers of Varanasi, which are located in thickly populated area, are causing health hazards problems to the people. Theoretical analysis shows that a transmission tower of 10 kW is expected to cause harmful effects on the people living upto about 300 m. For low power transmitters the distance is smaller. The radiation is more hazardous if a high voltage power transmission line is also passing over the area, as the combined effect of the two radiations may cause cancer risk to the people (Tenferde 1996).

Key Words: ***Radio frequency, transmission, transmitter***

Introduction

In addition to many types of air pollution produced by man an invisible pollution is also coming up. This is electromagnetic pollution which is at its peak near radio and T.V. transmission towers, various military and medical appliances, electrical appliances used in homes, power transmission lines and mobile cellphones. Rai (1992) has given a statistical observation of many diseases occuring to the people living around the T.V. transmission tower of Varanasi. He has also stated that the occurring diseases reduces with increasing of distance from the tower. Here we try to explore the mechanism responsible for this effect on human. Variation of the effect with distance is also explored.

The Mechanism

Radio and T.V. transmission towers transmit R.F. radiation i.e. electric and magnetic fields of radio frequency propagating in the atmosphere. Intensity of these fields is very high near the source (i.e. tower) and reduces as inverse square of the distance. This electric field induces potential difference across the tissues of human body. Higher is the environmental electric field, higher would be the potential difference induced across the tissues. This induced potential difference disturbs the normal functioning of the body and results in many diseases.

Variation of Electric Field with Distance

The value of electric field E_0 at a distance of r from a transmitter of power P is given by the eqn. (Grifths 1999)

$$\frac{P}{4\pi r^2} = \frac{1}{2}\varepsilon_0 E^2 c \quad \text{or} \quad E = \frac{1}{r}\sqrt{\frac{P}{2\pi\varepsilon_0 c}} = \frac{7.746}{r}\sqrt{P}$$

where ε_0 is permittivity of free space and c is speed of light (or radiation). For 10 kW transmitter we get E_0=774.6/r. Thus the field value varies inversely as distance. Table 1 gives the field values at different distances from the transmitter. Table 2 gives the values of potential difference created across a body tissue for these distances, given by ΔU=1.5a E_0, where a is radius of tissue (Bery 1988).

Table:- 1 Field values at different distances from the transmitter

Distance from the tower (m)	100	200	300	400	500	600	700	800	900	1000
Electric Field (V/m)	7.746	3.873	2.582	1.936	1.549	1.291	1.106	0.968	0.860	0.774

Table:-2 The variation of Potential difference across the tissue from the transmission tower of Varanasi.

Distance from the tower (m)	100	200	300	400	500	600	700	800	900	1000
Potential difference (V) X 10^{-6}	43.57	21.785	14.253	10.89	8.713	7.261	6.221	5.445	4.837	4.353

Variation of electric field with distance from transmitter is given in table 1. The tissues inside the body would come across somewhat less field as the penetration of the field depends upon frequency of radiation and depth inside the skin. Field at a distance z inside the boundary of the body is given by

$E_z = E_0 e^{-z/\delta}$

where δ is the skin depth (the distance at which the field is reduced to $1/e$ of its value at the boundary) which again depends on frequency of radiation. For biological materials it is given by $\delta = 1/wq$

where $q = [\mu \varepsilon(\sqrt{(1+p^2)}-1)/2]^{1/2}$, $p = \sigma/w\varepsilon$

w is radian frequency of radiation, ε is permittivity, μ the permeabilily and σ is the conductivity of tissue material.

The variation of electric field with distance inside the body for two frequencies of transmission of Varanasi T.V. is given in Table 3 for tissues of high water content. Table 4 gives these variation for tissues of low water content.

Table:-3 The variation of electric field when it penetrate inside muscle, skin and tissue high water content.

Frequency of E.M. Wave (MHz)	Skin depth (m) x 10^{-2}	Distance (m)	External electric field E_0 (V/m)	Induced Electric Field inside the muscles, skin and tissues				
				1mm (V/m)	2mm (V/m)	3mm (V/m)	4mm (V/m)	5mm (V/m)
41	11.2	100	7.746	7.677	7.608	7.541	7.474	7.407
	11.2	500	1.549	1.535	1.521	1.508	1.494	1.481
	11.2	1000	0.774	0.767	0.760	0.753	0.746	0.740
202	4.79	100	7.746	7.586	7.429	7.275	7.125	6.978
	4.79	500	1.549	1.517	1.485	1.455	7.424	1.395
	4.79	1000	0.774	0.758	0.742	0.727	0.712	0.697

Table:- 4 The variation of electric field when it penetrate inside the bone, fat and tissue with low water content.

Frequency of E.M. Wave (MHz)	Skin depth (m) x 10_{-2}	Distance from tower (m)	External electric field E_0 (V/m)	Induced Electric Field inside the bone, fat and tissues				
				1mm (V/m)	2mm (V/m)	3mm (V/m)	4mm (V/m)	5mm (V/m)
41	118	100	7.746	7.739	7.732	7.726	7.719	7.713
	118	500	1.549	1.547	1.546	1.545	1.543	1.542
	118	100	0.774	0.773	0.7727	0.7721	0.771	0.770
202	39.2	100	7.746	7.726	7.706	7.275686	7.667	7.647
	39.2	500	1.549	1.545	1.541	1.537	7.533	7.529
	39.2	100	0.774	0.772	0.770	0.768	0.766	0.764

Discussion

The analysis shows that a permanent potential difference is created across the tissues of the body because of the radiation. This results in many types of diseases. If the potential difference is higher, it is more hazardous, which is more evident nearer to the transmitter.

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Effect of refinery effluent on seed germination seedling growth at nursery stage of *Vigna radiata*

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Abstract

The present investigation deals with the effect of refinery effluent on germination, shoot/root length, leaf, pods and seed yield of *Vigna radiata*. The seeds were grown in pots and treated with various concentrations of refinery effluent. Concentrations 0.5 and 1.0% and above were found to be deleterious while treated effluent with 0.01, 0.05 and 0.1% concentrations were found to be suitable for irrigation in comparison to ground water. A field experiment was also laid down and observations were interpreted that treated effluents can be effectively used for irrigation.

Key Words: ***Effluent, Refinery,Germination***

Introduction

Petroleum refinery unavoidably generates a large volumes of oil sludge, organics like n-alkanes-paraffins, olefins, aromatics, asphaltics, Phenols and Polynuclear aromatic hydrocarbons (Atlas 1981, Grob 1983) which have both lethal and Sub lethal effects on a wide variety of marine organism (Chet and Mitchell 1973), reduced photosynthetic rate in algae (Parker and Menzel 1974), reduced resistance to environmental stress in crabs (Krebs and Burns 1977) accumulation of hydrocarbons in fatty tissues of fishes which get transferred to higher trophic levels including humans (Shailubhai 1986) . Therefore, the concern over chronic hydrocarbon inputs in environment is ecologically mendatory and disposal of oil sludges and waste hydrocarbons is a major challenge prevailing in the petroleum industry.

Many prior attempts had been made to assess the characteristics of petroleum refinery wastes (Kale *et al.* 1981) and all reports suggest the researchers for regular assessment of this waste in order to obtain

judicious data before effluents are used for irrigation, the deliberately cause deleterious effect in agroecosystems (Shailubhai 1986).

Study area and Methodology

Mathura oil refinery is located near Bad (Mathura District) in Uttar Pradesh processing about 15 lakhs tonnes of crude oil. The oil refinery discharges its pretreated effuents into Yamuna river through a 13.5 km long drain which is constructed with bricks and high slanting sides to avoid ground seepage of effluents. At about 0.5 km away from outlet of the drain, a pumping station has been installed which continuously transfer effluents to the irrigation canal distributing effluent and water to agricultural fields.

Experimental Layout

An experiment on Moong was conducted in the experimental field developed for this purpose, adjacent to the drain carrying treated effluent on Delhi-Agra Highway No. 2 one experiment on Moong was also conducted in pots at the experimental Net House of Botany Deptt. Raja Balwant Singh College, Agra. The study was conducted in a split plot design where main plot treatments effluent discharged from the refinery.

Design of the experiment	**Split plot**
Main plot treatment :	Irrigants (i) Ground water (ii) Treated effluent
Concentrations :	0.01% 0.05% 0.1%
Replications :	Three
Seed rate :	20 kg/ha
Fertilizer :	N10 P30 K35
Date of sowing :	22.4.2000
Irrigations (Four) :	8.05.2000 22.5.2000 08.6.2000 20.6.2000
Samplings :	30.40 and 50 DAS

The following growth, characteristics were studied :

0. Germination
1. Shoot length (cm) per plant
2. Root length (cm) per plant
3. Root nodule number per plant
4. Leaf number per plant
5. Shoot fresh weight (g) per plant
6. Shoot dry weight (g) per plant

Crops and Inputs

As mentioned earlier Moong *Vigna radiata* was selected for these studies. It was based on the fact that these crops are grown locally by the farmers and leguminous crops maintain the seed fertility. In field experiment each plot was irrigated with 2,500 liters of irrigant each time calculated in accordance with the size of the plot and local requirements. A 90^0 v-notch weir box was used for measuring the flow using the following formula.

$Q= 1417\ H^{2.5}$

where Q=discharge, 1/s and H height of irrigant over the apex of the notch cm.

Analytical Techniques

Irrigant and soil samples were analysed according to Standard Methods 1985 and Ghosh *et al*. 1983 respectively. Analysis for heavy metal content was done with the help of Atomic Absorption Spectro photometer.

Statistical Analysis

All the data for growth was analysed statistically according to panse Sukhtme 1985.

Results and Discussion

Most of the growth characteristics, studied at different intervals, exhibited a favourable response to the treated effluent as compared with ground water (Table 1-6). The application of the treated effluent favoured the vegetative growth of the plants, observed at 35, 42, 49 and 56 days after sowing. The respective leaf number per plant was 25.2, 13.0, 16.1 and 13.6% and shoot dry weight per plant was 33.3, 26.7, 38.7 and 27.1% more than ground water application.

The irrigation of Moong treated effluent enhanced the vegetative growth of the plants as compared with ground water. This luxuriant growth resulted in the improvement of all the characteristics

determining the reproductive growth in gram contrary to the 1% above in a similar pattern.
The decrease in leaf No. per plant was observed at 0.5, 1.0 and 1.5% refinery effluent and found that leaf number and shoot dry weight also decreased at this concentration.

The leaf number and shoot dry weight increased by 13.9 and 14.2% at 40 and 14.9 and 17.8% at day 50 respectively. Most of the interactions between irrigant and Moong were not significant (Table 1-6). Contrary to the growth, irrigation with treated effluent decreased seed yield in Moong which was 9.4% lower in comparison to the ground water. It would not be out of place to mention that the percent decrease in plant dry weight of gram due to the ill effect of effluent irrigation was only 3.3% in comparison with ground water above 0.1%. This shows that the plant dry weight in not adversely affected to the same extent as the other two concentration. All the interaction values between irrigant and concentration were not significant for plant growth attributing parameters.

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Table:- 1 : Effect of treated effluent (TE) and ground water (GW) on shoot length (cm) per plant at three concentrations at three stages of growth.

(Mean of three replicates)

	Days after sowing								
	30			40			50		
Concentration	TE	GW	Mean	TE	GW	Mean	TE	GW	Mean
0.01	28.65	26.11	27.38	39.10	36.88	37.99	43.55	39.44	
0.05	27.77	27.66	27.72	39.00	37.89	38.44	41.50		
0.1	31.07	27.22	29.14	44.30	41.55	42.93	47.22	42.06	
							44.64		
							54.77	49.00	
							51.89		
Mean	29.16	26.99		40.80	38.77		48.51	43.50	

CD at 5%

	30	40	50
Irrigants	1.10	0.68	3.03
Concentration	N.S.	1.05	0.82
Irrigants X Concentration	N.S.	N.S.	N.S.
Concentration X irrigants	N.S.	N.S	N.S.

N.S. – Not significant

Table:- 2 : Effect of treated effluent (TE) and ground water (GW) on shoot length (cm) per plant at three concentrations at three stages of growth.

(Mean of three replicates)

Concentration	Days after sowing								
	30			40			50		
	TE	GW	Mean	TE	GW	Mean	TE	GW	Mean
0.01	13.33	13.22	13.27	17.89	15.67	16.78	22.22	19.33	20.77
0.05	1277	13.33	13.05	20.85	23.77	22.31	25.78	21.89	23.83
0.1	14.78	14.22	14.50	23.85	20.22	20.03	31.33	27.99	29.66
Mean	13.83	13.58		20.86	19.88		26.44	23.07	

CD at 5%

	30	40	50
Irrigants	N.S.	N.S.	2.56
Concentration	N.S.	N.S.	1.26
Irrigants X Concentration	N.S.	N.S.	N.S.
Concentration X irrigants	N.S.	N.S	N.S.

N.S. – Not significant

Table:- 3 : Effect of treated effluent (TE) and ground water (GW) on shoot length (cm) per plant at three concentrations at three stages of growth.

(Mean of three replicates)

	Days after sowing								
	30			40			50		
Concentration	TE	GW	Mean	TE	GW	Mean	TE	GW	Mean
0.01	8.00	9.00	8.50	18.55	16.00	17.28	19.55	18.22	18.89
0.05	9.00	10.78	9.89	21.00	18.89	19.94	22.17	19.33	20.75
0.1	13.78	8.89	11.28	25.20	22.66	23.93	26.89	25.44	26.16
Mean	10.22	9.55		21.58	19.18		22.87	20.99	

CD at 5%

	30	40	50
Irrigants	N.S.	1.21	1.65
Concentration	0.93	1.02	1.26
Irrigants X Concentration	2.00	N.S.	N.S.
Concentration X irrigants	1.62	N.S	N.S.

N.S. – Not significant

Table:- 4 : Effect of treated effluent (TE) and ground water (GW) on shoot length (cm) per plant at three concentrations at three stages of growth.

(Mean of three replicates)

	Days after sowing								
	30			40			50		
Concentration	TE	GW	Mean	TE	GW	Mean	TE	GW	Mean
0.01	13.67	14.67	14.17	18.11	16.33	17.22	20.55	19.22	
0.05	14.33	13.22	13.78	19.00	16.44	17.72	19.89		
0.1	16.00	15.44	15.72	21.11	18.33	19.72	24.22	20.55	
							22.38		
							28.00	23.55	
							25.78		
Mean	14.67	14.44		19.40	17.03		24.26	21.10	

CD at 5%

	30	40	50
Irrigants	N.S.	2.03	1.42
Concentration	0.98	0.86	1.12
Irrigants X Concentration	N.S.	N.S.	N.S.
Concentration X irrigants	N.S.	N.S	N.S.

N.S. – Not significant

Table:- 5 : Effect of treated effluent (TE) and ground water (GW) on shoot length (cm) per plant at three concentrations at three stages of growth.

(Mean of three replicates)

	Days after sowing								
	30			40			50		
Concentration	TE	GW	Mean	TE	GW	Mean	TE	GW	Mean
0.01	10.22	10.55	10.39	18.86	17.33	18.00	23.96	20.94	22.45
0.05	10.06	9.22	9.62	19.55	16.88	18.22	27.33	23.18	25.26
0.1	10.22	10.44	10.33	22.66	22.66	22.66	33.77	29.32	31.54
Mean	10.17	10.17		20.29	18.95		28.35	24.47	

CD at 5%

	30	40	50
Irrigants	N.S.	1.25	2.37
Concentration	N.S.	0.60	0.73
Irrigants X Concentration	N.S.	1.25	N.S.
Concentration X irrigants	N.S.	1.04	N.S.

N.S. – Not significant

Table:- 6 : Effect of treated effluent (TE) and ground water (GW) on shoot length (cm) per plant at three concentrations at three stages of growth.

(Mean of three replicates)

Concentration	Days after sowing								
	30			40			50		
	TE	GW	Mean	TE	GW	Mean	TE	GW	Mean
0.01	3.59	3.48	3.53	6.21	5.87	6.04	8.25	6.95	7.60
0.05	3.35	3.08	3.21	6.51	5.75	6.13	9.32	7.86	8.59
0.1	10.69	3.48	3.44	7.70	6.23	6.96	11.50	9.88	10.69
Mean	3.45	3.34		6.81	5.95		9.69	8.22	

CD at 5%

	30	40	50
Irrigants	N.S.	0.77	0.76
Concentration	N.S.	0.20	0.45
Irrigants X Concentration	N.S.	0.54	N.S.
Concentration X irrigants	N.S.	0.35	N.S.

N.S. – Not significant

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Kinetics of oxidative decarboxylation of L-citrulline by permanganate

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Abstract

Potassium permanganate is a good oxidizing againt L-citrulline has an – SH group which is rapidly oxidized by potassium permanganate. In the present study it was observed that two equivalent of permanaganate were consumed by five equivalent of L-citrulline. Beside this an attempt to correlate the rate of oxidation with acid concentration, with various Hypothesis for the mechanism of acid catalysis were also observed.

Key Words: ***Permanaganate, L-citrulline, oxidatived decarboxylation***

Introduction

Oxidative decarboxylation of L-cirtulline by permanganate in sulfuric acid medium has been found to be first order in both oxidant and substrate concentrations. Various hypotheses for the mechanism of acid catalysis have been tested. The energy and entropy of activation have been calculated as 12.76 and 7.13 kJ mol-l and -41.69 and -25.55 J mol^{-1} K^{-1} for two stages of the reaction, respectively. A mechanism is proposed, which is in agreement with the experimental data.

Potassium permanganate has been found to be a good oxidising agent and the kinetics of oxidation of various organic compounds have been studied by previous workers Ghosh and Ghosh (1955), Marcus (1994), Ghosh (1999), Swaminathan and Harris (1996), Mohanty *et al.* (1985) However, careful survey of the literature reveals that oxidative decarboxylation of amino acids by permanganate has received little attention Iyun and Onu (1998), Goto and Krishimoto (1989), Mallamma *et al.* (2001) The present paper deals with the kinetic studies of the oxidative decarboxylation of L-citrulline by potassium permanganate in sulfuric acid medium.

L-citrulline has an – SH group, which is rapidly oxidized by potassium permanganate. The objective of the present investigation was to study the oxidative decarboxylation, which is a relatively much slower process when compared to the oxidation of –SH group to $–SO_3H$ group. The amount of potassium permanganate required for the oxidation of the thio 1 group to sulfonic acid group was determined by adding permanganate solution to solution of L-citrulline to give a pink colour (in excess) and titrating the excess of permanganate against previously standardized hypo solution.

Experiment

L-citrulline, potassium permanganate and other chemicals used were BDHAR'/SM'GR' grade. Doubly distilled water was used to prepare all solutions. The reaction vessels were coated with black paint to exclude any photochemical effect.

Solutions of sulfuric acid were standardized against previously standardized sodium hydroxide solution. Potassium permanganate solution was prepared by the method of Vogel (1964)

The requisite amounts of L-citrulline and sulfuric acid were taken in the reaction flask and kept in a thermostat at the desired temperature within $+0.1^0$C. The flask of potassium permanganate was also kept in the thermostat. Requisite volume of permanganate was then rapidly mixed. The kinetics of the reaction was followed by estimating unreacted permanganate iodometrically.

Results and Discussion

Stoichiometry of the reaction was studied. It was observed that two equivalents of permanganate were consumed by five equivalents of L-citrulline. Formation of ammonium ions and carbon dioxide was confirmed by usual tests. 2-Sulfoacetaldehyde was detected as the reaction product. The induced reduction of mercuric chloride by the reaction mixture indicates the participation of free radicals Drummond *et al.* (1953)

When the concentrations of L-citrulline and sulfuric acid were in excess, the fading of permanganate followed a first order rate law. The pseudo-first order rate constants, k_1 and k_2, are listed in Table I.

Table I Variation of L-citrulline and permanganate concentrations

$_C(H_2SO_4)$=2.0 mol dm-^{2}		Temperature=303 ^{0}K	
c($KMnO_4$) x 10^4 (mol dm-^{2})	c(L-citrulline) x 10^4 (mol dm-^{2})	k_1 (10-^{4} s-^{1})	k_2 (10-^{4} s-^{1})
4.0	2.50	18.07	18.11
5.0	3.75	1811	23.89
6.0	5.00	18.06	29.68
7.0	6.25	18.12	35.10
8.0	7.50	18.14	40.30

Table II Variation of sulfuric acid concentration

c(L-citrulline) = 10^{-4} mol dm^{-4}	C($KMnO_4$) = 10^{-2}ol dm^{-2}	Temperature = 303
c(H_2SO_4) mol dm^{-2}	K_1 (10^{-4} s^{-1})	k_2 (10^{-4} s^{-1})
0.75	14.91	29.61
1.0	18.11	37.09
1.25	20.93	48.37
1.50	25.13	60.37
1.75	29.43	76.78
2.00	33.27	80.81

The variation of permanganate concentration has practically no effect on the rate constants, confirming that the order with respect to permanganate is unity.
The plot of log k vs. Log [L-citrulline] was found to be linear and the slope was unity indicating that the order on the reaction with respect to the substrate L-citrulline is one. There is no kinetic evidence for intermediate complex formation between substrate and permanganate. The rate has been found to increase with the increasing concentration of sulfuric acid. The pseudo-first order rate constants are listed in Table II.
Further in an attempt to correlate the rate of oxidation with acid concentration, various hypotheses for the mechanism of acid catalysis were tested. In this case, either of two Zucker-Hammett plots (1939), are linear indicating that the reaction is acid catalyzed, however, none of these plots produces the ideal slope of unity. In view of these departures of ideal slope values, applicability of Bunnett's hypothesis (1961) and the Bunnett-Olsen l.f.e.r (1966)], were tested. The values of –H0 and log a H O corresponding to acid concentrations have been taken from Paul and Long (1957)] and Bunnett (1961) respectively.
The values of Bunnett parameters ώ, ώ* and Φ were found to be -11.6, 3.2 and 0.94, respectively.
Primary salt effect was not observed, but a linear plot of log k against ionic strength was obtained at higher concentrations of added neutral salts. This indicated that the reaction involves at least a neutral molecule in the rate determining step.

Activation parameters

The reaction was studied at different temperatures to evaluate the activation parameters, The results are summarized in Table III.

Table III Activation parameters

c(L-citrulline) = 10^{-2}mol dm^{-2} c($KMnO_4$) = 10^{-4} mol dm^{-2}; c(H_2SO_4) = 2.0 mol dm^{-2}				
Stage	Δ H (k cal mol^{-1})	Δ E (kJ mol^{-1})	Δ S (J mol^{-1} K^{-1})	pZ (dm^2 mol^{-2} s^{-1})
First	6.528	7.131	-41.69	2.79 x 10^2
Second	12.157	12.76	-24.55	5.072 x 10^3

The information gained from the experimental data leads to the following probable mechanism, which explains the observed results well.

$$H_3N^+CHRCOO^- + H^+ \overset{K_1}{\leftrightarrow} H_3N^+CHRCOOH \quad (1)$$

$$H^+ + MnO_4^- \overset{K_2}{\leftrightarrow} HMnO_4 \quad (2)$$

$$H_3N^+CHRCOOH + HMnO_4 + H_2O \overset{K_1,\ slow}{\rightarrow} H_3N^+CHRCOO^- + HMnO_4^{--} + H_3O^+ \quad (3)$$

$$H_3N^+CHRCOO \overset{fast}{\rightarrow} H_3N^+CHR + CO_2 \quad (4)$$

$$H_3N^+CHR + HMnO_4^{--} + H_2O \overset{fast}{\rightarrow} H_2N^+ \leftrightarrow CHR + HMnO_4^{2-} + H_3O^+ \quad (5)$$

$$H^+ + HMnO_4^{2-} \overset{K_3}{\leftrightarrow} H_2MnO_4^- \quad (6)$$

$$2H_2MnO_4^- \overset{K_4}{\leftrightarrow} 4OH^- + MnO_4^{2-} + Mn^{3+} \quad (7)$$

$$H_2N^+ == CHR + H_2O \overset{fast}{\rightarrow} RCHO + H^+ + NH_3 \quad (8)$$

where R == for L-citrulline.

The concentration of $HMnO_4$ was determined from the equation (9) as

$$K_2 == \frac{[HMnO_4]}{[H+][MnO_4^{--}]free}$$

Free [MnO_2^{--}] can be calculated as
Free [MnO_4^{--}] == initial [MnO_4^{--}] – [$HMnO_4$] formed (10)
It will lead to the inclusion of a K_2 term in the numerator of the rate law.
The rate expression for this mechanism has been derived as

$$\frac{d[MnO_4^{--}]}{dt} == \frac{k_1 K_1 K_2 [H_3N^+CHRCOO^{--}] [H^+]^2 [MnO_4^{--}] [H_2O]}{1+ K_2 [H^+]} \quad (11)$$

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Bio medical waste management in Jammu city

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Abstract

Ironically waste was not a problem for the society when man was primitive and uncivilized. The proliferation of modern concept of consumerism supplemented with culture of disposables has aggravated the waste problem. These biomedical wastes along with the municipal wastes commonly exceed the carrying capacity of biosphere to reabsorb and recycle.

The present paper deals with the status of Bio medical waste management in Jammu city. 42 government and private health institutions have been identified which generate about 3917 kg/day @ 1.52 Kg/bed/day contributing 26% to the municipal solid waste. The paper seeks to demonstrate the waste collection, segregation, treatment and disposal of the wastes in the otherwise unplanned city of temples.

Key Words *Bio-medical waste, Carrying capacity, Incineration, P.V.C, Dioxin & Furans, Judicious.*

Introduction

Bio-medical waste has recently emerged as an issue of major concern not only in hospitals, nursing homes and slaughter houses but also to the legislation, media and to the most of the general public ‘Bio medical waste' means any waste, which is generated during diagnosis, treatment or immunization of human beings or animals or in research activities pertaining thereto or in production or testing of biologicals (gazette of India, 1998). All the health care institutions generate a cocktail of waste stream which serve as a paradise of infection in one form or the other. It is quite surprising that the institutions promoting the community health are least concerned, the proper disposal of their wastes thereby exposing the community vulnerable to diseases.

Keeping in view the deteriorating health scenario in last two decades, the ministry of environment and forests, government of Indian issued draft rules called 'Bio-medical Waste (Management and Handling) Rules 1995, which were finally amended and formulated in 1997. These shall be obligatory to all those health institutions providing treatment to a minimum of one thousand

patients per month. The four schedules of draft mainly deal with segregation, packing, transportation, storage, treatment and disposal viz :-

1. Categorization of biomedical wastes and their disposal options.
2. Containers and colour coding for disposal of biomedical wastes.
3. Labels for biomedical waste containers.
4. Standards for the treatment and disposal of biomedical wastes.

Aims and Objectives

1. Determination of Point of generation of biomedical wastes.
2. Quantification of biomedical wastes.
3. Classification of biomedical wastes.
4. Characterization of biomedical wastes.
5. Segregation and disinfection of biomedical wastes.
6. Disposal of biomedical wastes.
7. Management of biomedical wastes.

Materials and methods

The waste quantification was done by on the spot collection and weighing of biomedical wastes of each institution per day for a period of five months taking reading twice for each point in the study. The questionaire approach was also applied to ascertain the awareness among the masses thereby involving attendants, patients, sweepers, doctors, superindent, C.M.Os and ministry of health.

Results and Discussion

Forty-two health institutions serve as points of generation of biomedical wastes, which is generated at the tune of 3917 Kg/bed/day i.e., 1.52 Kg/bed/day at each institution, thus contributing to 26% of the total municipal solid waste of the city. These wastes include human anatomical blood and body fluid, animal and slaughter house wastes, microbiological wastes, surgical sharps, discarded medicines, liquid wastes, incineration ash, and chemical wastes etc. W.H.O has classified wastes in accordance to their pathogenecity and toxicity which are to be segregated accordingly prior being subjected to the recommended treatments. These include general pathological, radioactive, chemical, infectious and pharmaceutical wastes.

Segregation is the prime impetus to the biomedical waste management which is totally being ignored in the present pretext except for two institutions which follow the colour code

recommendations classified in extraordinary gazette notification of the ministry of environment and Forests, GOI Oct. 1997. yellow, orange, blue and black containers labeled with the waste category have been installed at the required locations for the exclusive collection of highly infectious, animal and slaughter house, waste sharps and disposables. The highly infectious wastes as surgical, anatomical and laboratory wastes are subjected to incineration and the rest collected along with municipal solid wastes and disposed in open which render to a complex of hygienic problems.

The next comes treatment, which is to be followed in accordance with the time schedule in schedule VI for the requistie facilities like incinerator, autoclave, microwave systems etc. of the 42, only four have installed incinerators of varied capacity and efficiency, but the lack of technical know-how for their operation has imposed a question mark on its effciency. The segregated wastes are then subjected to incineration without following the norms as a result of inefficient performance, they aggravate the problem in terms of land as well as air pollution. The incineration ash is directly mixed with the hospital wastes which finally finds its way in municipal solid waste dumping sites. The incinerators emit chlorinated Dioxins and Furans with more than 210 molecular variations, 17 of which are extremely toxic even in nano gram concentrations (Lal, 2000). These are highly persistent and pervasive nonvolatile and fat soluble which accumulate in food chain. Mercury, Cadmium and Arsenic in the biomedical wastes are highly volatile and vapourise in the incinerator and get absorbed in physical and biological structures. Despite the ban on P.V.C. particularly in the incinerators, majority of waste incinerated include drip sets, gloves, surgical pads, syringes etc., which add to the air pollution. Moreover the stack height of the incinerators does not follow the recommendations.

The transportation of biomedical wastes is again a ignorant practice followed by the municipal authorities. It is not carried out in the specified vehicles. The medical waste is carried in open wagons along with municipal wastes and dumped at a common site.

Conclusion

The present biomedical management system suffers from many loopholes form the environment, legislative, management and technological points. The wastes generated from these institutions are vaguely diposed off without any knowledge about their hazardous impacts. The key to hospital waste management is segregation of waste at source. However it is not practiced in most of the hospitals across the country. Though the rules have specified colour codes for each categoric waste, but are not applied practically, as a result the mixing of wastes takes place at primary levels, secondly, the transportation is not carried out in specified vehicles and, thirdly and most dreadly, all hospital waste is dumped along with municipal solid wastes at a common dumping site.

The lack of awareness about biomedical waste management is due to certain reasons which include lack of proper training, education and motivation, financial crunch and above all the harsh fact-treatment of waste is not profitable to enterprise and to medical fraternity.

To attain a proficiency in biomedical waste management sector, it is the right time to make right choices where the health costs are not ignored. Establishment of sound waste management policies, improvement of internal waste collection infrastructure, installation of additional waste treatment facilities, awareness among the masses, quality assurance and strengthening of stringent laws (The Hindu, Survey of Environment) are few recommendations for judicious and efficient biomedical waste management.

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The authors are thankful to Director, Health Services (Jammu and Kashmir Government), and concerned staff of all the health institutions of Jammu city for their kind cooperation.

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BIOMEDICAL WASTE MANAGEMENT IN JAMMU - SOME FACTS

i. Total number of hospitals & nursing homes present = 42

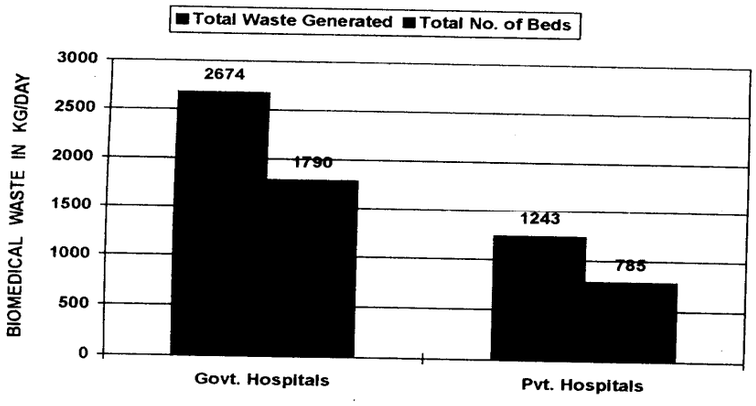
ii. Total waste generated from hospitals/nursing homes = 3917 (kg/day)

- Waste generated from Govt. Hospitals = 2674 (kg/day) @ 1.5 kg/bed/day
- Waste generated from Private Hospitals= 1243 (kg/day) @ 1.4 kg/bed/day

iii. Percentage of biomedical waste incinerated = 66%

iv. Percentage of biomedical waste dumped = 34%

v. Approximate efficiency of incinerators performed = 35%



TOTAL AMOUNT OF BIOMEDICAL WASTE GENERATED IN JAMMU CITY

TABLE - I

BIOMEDICAL WASTE QUANTIFICATION

Name of the hospital/ nursing home	Location	No. of beds	No. of dustbins provided	Presence of color coding system for waste collection	No. of sanitation staff	Presence of incinerator	Mode of waste disposal	Amount of biomedical waste generated per day
Govt. Medical College and Hospital	Bakshi Nagar	850	90	Yes	162	+	Incineration	1275 Kg
SMGS Hospital	Shalamar	500	65	No	80	+	Incineration	750 Kg
Govt. Hospital Gandhi Nagar	Gandhi Nagar	300	40	No	25	-	Into dustbin provided	450 Kg
Govt. Chest Disease Hospital	Bakshi Nagar	35	20	No	15	+	Incineration	52 Kg
Govt. Ayurvedic Hospital	Amphalla	50	10	No	20	-	Into community bins	60 Kg
Govt. Mental Hospital	Amphalla	20	6	No	10	-	—do—	35 Kg
Govt. Sub Distt.	Sarwal	20	9	No	5	-	—do—	30 Kg
Govt. Leprosy Hospital	Gangyal	15	8	No	5	-	—do—	22 Kg
Acharya Shri Chander Hospital	Sidhra	250	40	No	6	+	—do—	375 Kg

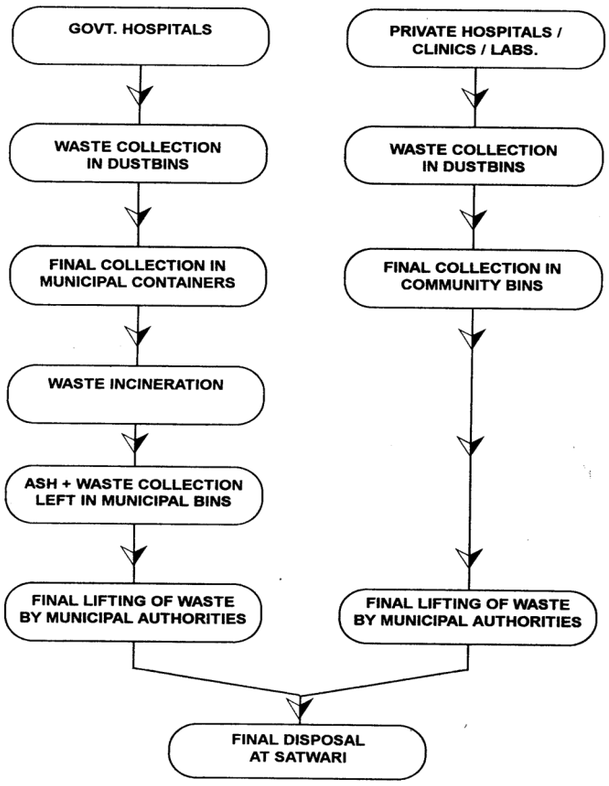
Name of the hospital/ nursing home	Location	No. of beds	No. of dustbins provided	Presence of color coding system for waste collection	No. of sanitation staff	Presence of incinerator	Mode of waste disposal	Amount of biomedical waste generated per day
KHN Memorial Hospital	Rail Head Complex	100	10	No	30	.	Into community bins	240 Kg
Bee-Enn Charitable Hosp.	Talab Tillo	50	30	No	15	.	Into community bins	80 Kg
G.B. Pant Hospital	Shastri Nagar	40	20	No	8	.	—do—	60 Kg
Military Hospital	Satwari	30	10	No	6	.	—do—	45 Kg
Sanjeevani Nursing Home	Gandhi Nagar	10	20	No	4	.	—do—	15 Kg
Medicare Nursing Home	Gandhi Nagar	10	18	No	4	.	—do—	15 Kg
Aastha Nursing Home	Amphalla	12	8	No	4	.	—do—	18 Kg
Shafa Nursing Home	Shastri Nagar	12	10	No	4	.	—do—	18 Kg
Mother and Child Nursing Home	Talab Tillo	10	8	No	4	.	—do—	15 Kg
Upkar Nursing Home	Trikuta Nagar	8	10	No	2	.	Into community bins	12 Kg

Name of the hospital/ nursing home	Location	No. of beds	No. of dustbins provided	Presence of color coding system for waste collection	No. of sanitation staff	Presence of incinerator	Mode of waste disposal	Amount of biomedical waste generated per day
Lajwanti Trust Hospital	Greater Kailash	8	10	No	2	-	—do—	12 Kg
Jeevan Jyoti Nursing Home	Shakuntala Complex	10	12	No	3	-	—do—	15 Kg
Ankur Nursing Home	Trikuta Nagar	10	10	No	2	-	—do—	12 Kg
Triveni Nursing Home	Trikuta	10	6	No	2	-	—do—	15 Kg
Kapur Nursing Home	Shakti Nagar	8	6	No	2	-	—do—	12 Kg
Makkar Nursing Home	Bakshi Nagar	10	6	No	3	-	—do—	15 Kg
Dubey Nursing Home	Canal Road	8	6	No	2	-	—do—	12 Kg
Navjeevan Nursing Home	Near Telephone Exchange Road	8	6	No	2	-	—do—	12 Kg

KEY : + PRESENT
- ABSENT

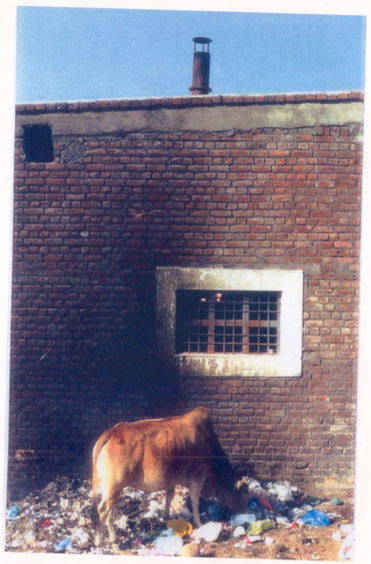
PROCESS FLOW DIAGRAM

BIOMEDICAL WASTE MANAGEMENT



Waste storage in open in backyard of SMGS Hospital

Open burning at Municipal waste disposal site at Satwari



Single chamber incinerator at ASCM Medical college (Only 7 meters), & animal feeding on dumped Biomedical waste

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Waste management strategy of a fertilizer plant

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Key Words : Fertilizer, Management, Effluent, Pollution

Abstract

The paper presents the study to understand evaluate and examine the different pollution abatement strategies of Indian Farmer's Fertilizer Cooperative Ltd. It also includes the identification, types and means of various pollution hazards and to sutdy the abatement strategy of different pollutants.

Introduction

Indian Farmer's Fertilizer Cooperative Ltd. (IFFCO) is one of the fastest growing fertilizer industry of India. At present its four plants are operating in the country. IFFCO was established on 3rd November 1967. The plant is situated at a distance of 28 km. South-West of Bareilly on Bareilly Aonla road in Uttar Pradesh.

The total capacity of Aonla Unit including both phases is 8, 91,000 MTPA for Ammonia and 14,52,000 MTPA for Urea (EMIAU 2000).India uses about 16 kg. per hectare of fertilizer while the world average is 55 Kg. per hectare (Sharma and Kaur 1997). A typical fertilizer unit in India produces 300 tons per day of ammonia, 300 tons per day of Urea, 1100 tons per day complex fertilizer and 130 tons per day of Methanol (Mahajan 1985). According to eminent soil chemist, Dr. H.H. Koepf, modern agriculture can honestly claim two notable crops "disease and pests" but now a third factor " Poison" (as NO_2,NO_3etc.) can be frequently added. Therefore due to high level of toxicity proper management and disposal of effluent is necessary. The Knitting of productionwith environmental protection is the unique feature of Aonla unit. This new technique has eased out various problems of environmental management. The technology of the plant is based on recycle and reuse of the effluent to achieve Zero effluent discharge from plant.

Considering these problems study has been made as Environment Management Strategy and results are presented in paper.

Materials and Method

Management of environment confers utilization of resources prudently so that waste generation is minimized. The environment management at IFFCO aims for abatement of pollution at the source itself.

The various plants and sectors which are running at IFFCO Aonla unit with their capacity are as follows:-

Plants	Capacity
1. Ammonia plant (2no.)	2* 1350 MTPD
2. Urea plant (4No.)	4* 1100 MTPD
3. Utilities	
(a) Steam Generation service boiler	1* 1500 MT/hr.
(b) Gas turbine Generator (2No.)	2*25 MW (ISO)
(c) Water treatment plant	6*140 M^3/hr.
(d) Inert gas Generation	600 Nm^3/hr.
(e) Ammonia storage tank	4* 10,000 MT
4. Centralized effluent treatment plant	
(a) Cooling tower blow down treatment	480 m^3/hr.
(b) Ammonia bearing occasional waste treatment	120 m^3/hr.
5. Urea bagging plant	8 slats of 250 MT/ hr./slat

The study has been made to examine the various abatement strategies of pollution at IFFCO Aonla unit with the following objectives:-

1. To identify various pollution hazards.
2. To identify the types and means of pollution i.e. sources of pollution
3. To study the abatement strategy of different pollutants.
4. To study the environment strategy at IFFCO Aonla.
5. To develop an alternative strategy in existing system. and
6. To ensure awareness among factory employees about the environmental pollution.

Liquid Waste Management at IFFCO Aonla

To achieve zero effluent from Ammonia plant based on Halder Tapsone Technology has process condensate stripper, Turbine condensate, Boiler blow down, Disc oil separator.

The urea plant is based on Snam Progetti technology having waste water treatment section

(A) **Process condensate stripping section:** This section treats process condensate from two separators and excess condensate from CO_2 removal section. The condensate stripping removes a substantial part of NH_3, CO_2 & Methanol from condensate before the treated condensate is passed to demineralised plant (Fig 1)

Both NH_3 & Methanol together with CO_2 enters the process condensate according to following reactions:-

$$\text{(i) } NH_3 + H_20 = NH_4^+ + OH^-$$
$$\text{(ii) } CO_2 + H_2O = HCO_3 + H^+$$
$$\text{(iii) } 2HCO_3^- = 2CO_3 + H_2$$
$$\text{(iv) } NH_3 + HCO_3^- = NH_2\,COO + H_2O$$

In the reforming section methanol & ammonia will undergo chemical reaction and end up as N_2, H_2 & CO_2. The stripped condensate is finally cooled to 45°C before sent to deminerelised plant.

(B) **Treatment of turbine condensate:** Turbine condensate which comes from condenser is contaminated with small quantity of dissolved and undissolved solids. It is treated in condensate polishing section which consists of:-

(i) **Activated carbon filter section:-** Two no. of activated carbon filter are provided for removal of methanol, oil, grease, diethylamine and other undissolved & organic matter. Regeneration of carbon filter is done once in every 48 hrs.

(ii) **Mixed bed unit :-**Two no of mixed bed unit are provided for treating return con densate. Cation and anion (mainly Na^+, K^+, Ca^{++} etc.) are removed in this unit.

(C) **Treatment of Boiler blow down:-** The boiler blow down in flashed in a blow down vessel, where flashed saturated low pressure steam is separated from steam condensate.

(D) **Treatment of oily water:-** Here the spilled oil is collectd through underground PVC pipes to oily water basin where oil and water forms two phases with oily layer at top. Here oil is skimmed off with the help fo Disc oil seperator and is transferred to slope oil tank. Waste water is pumped to neutralization pit.

(E) Treatment of ammonia and urea bearing water in urea plant:- The exhaust solution from stripping column containing mainly Urea os fed to deep hydrolyser operating at 36 ata pressure

On hydrolysis urea is broken down into NH_3 & CO_2.

$$NH_2.\ CO.\ NH_2 \xrightarrow{H_2O} 2NH_3 + CO_2$$

The hydrolyzed solution is fed to distillation tower where ammonia & carbon dioxide is distilled out by low pressure steam. The treated water is used as cooling tower make up.

(F) Treatment of acidic and alkaline waste:- Ammonia and water treatment plants are having ion exchangers. The water which comes from cation exchangers contains lot of free mineral acids, salts of corresponding acids viz. HCl, H_2CO_4, H_2CO_3, NaCl, $CaCl_2$ etc. Similarly, the water which comes through anion exchanger contains sodium salts of weak and strong acid viz. NaCl, Na_2SO_4, and Na_2SiO_3. To neutralize acid waste 5% HCI solution is used neutralization pits are connected to centralized effluent treatment plant.

$$2\ ReH + CaSO_4 \longrightarrow Re_2Ca + H_2SO_4$$
$$ReH + NaCl \longrightarrow ReNa + HCL$$
$$Re_2Ca + 2HCl \longrightarrow 2ReH + CaCl_2$$
$$ReNa + HCl \longrightarrow ReH + NaCl$$

Formation of sodium salts of weak & strong acid in anion exchanger:-

$$ReOH + HCl \longrightarrow ReCl + H_2O$$
$$2ReOH + H_2SO_4 \longrightarrow Re_2SO_4 + 2H_2O$$
$$2ReOH + H_2CO_3 \longrightarrow Re_2CO_3 + 2H_2O$$
$$ReCl + NaOH \longrightarrow ReOH + NaCl$$
$$Re_2SO_4 + 2\ NaOH \longrightarrow 2\ ReOH + Na_2SO_4$$
$$Re_2SiO_3 + 2NaOH \longrightarrow 2ReOH + Na_2SiO_3$$

(G) Treatment of cooling tower blow down & occasional waste by centralized effluent treatment plant:-

Ammonia and urea plant are having separate cooling towers which uses chromate based corrosion inhibitors. The chromated cooling tower blow down is treated in effluent treatment plant which is designed to:-

(i) Remove Hexavalent chromium from cooling tower blow down:

Cooling tower blow down contains following contaminants-

Ca as Ca CO_3	144 ppm
Mg as Mg CO_3	96 ppm
Na as Na_2 CO_3	1448 ppm
SiO_2 as SiO_2	120 ppm
Cr as Cr^{+6}	14-16 ppm
Free chlorine as Cl_2	1.0 ppm

Impurities are treated in chromate reduction plant measured amount of conc. H_2SO_4 & ferrous sulphate at suitable conc. is dosed in to blow down water (H_2SO_4 is added to control the blow down pH in the range of 2-3.5. Because this process progresses rapidly at low pH & reaction end point is more distinct at low pH.

Finally in chromate reduction pond the hexavalent chromium reduces to trivalent chromium.

The effluent is then collected in precipitation pond. In this pond, alkali (lime) is added to elevate the pH to 9.0, where trivalent chromium and iron is precipitated out as hydroxide of corresponding metal.

Reduction pond:

$$Na_2Cr_2O_7 + 6FeSO_4 + 7H_2SO_4 \longrightarrow Cr_2(SO_4)_3 + 3Fe_2(SO_4)_3 + Na_2SO_4 + 7H_2O$$

Precipitation pond:

$$Cr_2(SO_4)_3 + 3Ca(OH)_2 \longrightarrow 2Cr(OH)_3 + 3CaSO_4$$

$$Fe(SO_4)_3 + 3Ca(OH)_2 \longrightarrow 3Fe(OH)_3 + 3CaSO_4$$

Chemical consumption

Ferrous Sulphate	1614 Kg/day
Lime	1625 Kg/ day
98% Conc. H_2SO_4	1222 Kg/day

Used for flow of 480 m^3/hr. of cooling tower blow down to chromate treatment plant. Now the precipitated liquid is transferred to clariflocculator where the solids can be agglomerated in to fast settling particles by adding coagulating agent i.e. Alum. The clear water is taken to guard pond and sludge separated in centrifuge is dumped in sludge pits.

(ii) Treatment of occasional waste from Ammonia & urea plant:- During normal

operating conditions, there is zero effluent generated from urea plant except floor washing. But during abnormal condition ammonia bearing waste from urea or ammonia plant is collected in to contaminated effluent from demineralising plant and lime solution is added at controlled rate to maintain pH about 11. The effluent after filteration is sent for stripping of free ammonia. The air stripped effluent is further heated and residual ammonia is further removed by steam stripping with low pressure steam stripper. The treated effluent is sent to " **Treated effluent lagoon** " These ponds are quite safe from environmental angles as they are double line PCC with polyethylene sheets.

(G) Treatment of sewage waste:- Two no. of oxidation ponds are installed to treat sewage from township. In this aeration is carried out to ensure the dissolved oxygen content of waste water. The water thus obtained is used for irrigation purpose.

Air Pollution Management at IFFCO Aonla

(i) Analysis of Gaseous Pollutants:- There are 5 primary pollutants which together contribute more than 90% of global air pollution these are (i) Carbon monoxide (CO)(ii) Nitrogenoxides $(NO)_x$(iii) Hydrocarbons $(HC)_x$(iv) Sulphuroxides $(SO)_x$ (v) Particulates.

At, IFFCO, the concentration of sulphur being negligible in natural gas obtained from Bombay high basin the SO_2 concentration. in flue gases remains in traces.

To assess concentration of pollutants IFFCO Aonla, separately incorporated SO_2 & $(NO)_x$ analyzer, apart from this CO, O_2 analyser and High volume air sampler are also incorporated. The stack height of steam generation service boiler flue gas stack is kept at 120m for efficient dispersion of plume.

(1) Dedusting system at urea prilling tower:- The air loaded with urea sublimate from prilling tower enters the dedusting system at point A, and escapes the plant at point B with clear air quality. (Fig.2)

The urea dedusting containing gas is scrubbed by lean urea solution which is circulated by pumps. The scrubbing liquid enters the scrubber and is distributed by means of nozzles to become drops with a large absorption surface. This at the same time produces a pressure gain causing at suction connection (A) of the scrubber a suction pressure which sucks off exactly whereby the desired absorption surface is obtained. After escapes at point B into atmosphere containing 5ppm of urea dust. The liquid is collected in a reservoir thus, urea solution can be recovered & extracted at point F. Process condensate water is fed in at point E.

Land Management at IFFCO Aonla

Land management includes both the soil development and solid waste management

(i) Soil development and afforestation:- Initially the soil of the land of IFFCO was highly alkaline in nature with higher content of clay and barren for agricultural purpose but after treating the soil with pyrite along with Gypsum and finally made for plantation. They use 336 acres of total land out of 1273 acres for plantation. IFFCO Aonla developed their social forestry farm. As a result at present there is 80 m wide green belt around the factory and 250 m towards township & additional afforestation is in progress with about 1.5lac tree plantation.

(ii) Solid waste disposal & management:-

(a) Solid waste from plant:- One of the solid waste from plant is hexavalent chromium which after treatment is dumped in to sludge pit which is safe from environmental point of view.

(b) Solid waste from township:- Solid waste collected from township is dumped into low line area to maintain the level of the land.

Noise pollution management at IFFCO Aonla

In IFFCO to control the pollution through noise there is a regular checking of heavy machines such as pumps, motors, compressor and structure support of different machines. There is also a regular checking of vibrations and knocking through machines. To avoid noise pollution there is regular maintenance of producing sources such as greasing, oiling of machines etc.

Control Methods as described by Gupta & Singh (1988) were used for the above study.

Standard Parameters like pH, free ammonia, urea, total Kjeldahl nitrogen, BOD, Oil and grease, SO_2, NOx chromium were selected for the study. Methods as described by APHA (1985) & Trivedy & Goel (1986) were used.

Result and Discussion

Flow sheet showing interconnection among plants and treatment facilities is shown in Fig.3

The values of various important parameters which were studied are shown in Table 1 & 2. The graph shows the amount of pollution decrease during the year 1995-96 to 1998-99.

The strategies of the Present study have already been described above. The value of free

ammonia in treated effluent was found to be 0.99 mg/1. The value of pH was recorded as 7.6.

The quantity of raw water demand and effluent discharged was found to be 4056400m^3 and 393085.8m^3. While according to Gupta (1997) the quantity of raw water discharged was 437111m^3 and 393085.8m3 for quantity of discharged effluent. Here the loss in the quantity of discharged effluent shows the better utilization of effluent from plant (Figure 4&5).

The value of B.O.D. was found to be 12.6 ppm while the MINAS (1985) was given as 30.0 ppm. Saxena and Mehra (1989) found Kjeldahl Nitrogen in fertilizer plant effluent as 150mg/1 while comparing to IFFCO value it is only 23.69 mg/1 which is within the prescribed limit.

Due to effective environmental managment system, the treated effluent and ambient water quality is maintained.

From the above data, we can conclude that with the effective pollution and environmental management system at IFFCO Aonla unit, the quality of final effluent after treatment and ambient air quality is well with in the limits.

Conclusion

After evaluating and analyzing the various pollutants and pollution control measures at IFFCO Aonla, the following conclusions can be drawn-

(1) The utilization of treated waste water in irrigation practices is unique of its kind. The philosophy of utilization can be extended throughout the conutry, therof utilizing the precious natural water resources.

2) A study is needed for gainful utilization of solid waste (i.e. chromium hydroxide, $CaCO_3$, NaOH) as raw material for dye and pigment industries.

3) Acid and alkali, utilized for pH balancing can be replaced with CO_2 gas.

4) Development of green belt around the factory to reduce the percentage of carbon dioxide in the ambient air.

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Table No. 1

Average value of treated effluent analysis (in μgm/Nm³)	
Parameter	**Result of analysis**
pH	7.6
T.K.N.	23.69
Free ammonia	0.99
B.O.D.	12.6
Hexavalent chromium	NT
Oil and grease	NT
Nitrate	1.67

Table No. 2

Average value of ambient air quality (in gm/Nm³)	
Parameter	**Result of analysis**
Sulphur dioxide	NT
Nitrogen oxides	17.10
Ammonia	50.50
Carbon monoxide	NT
Suspended Particulate	135.05
Urea dust	180.0

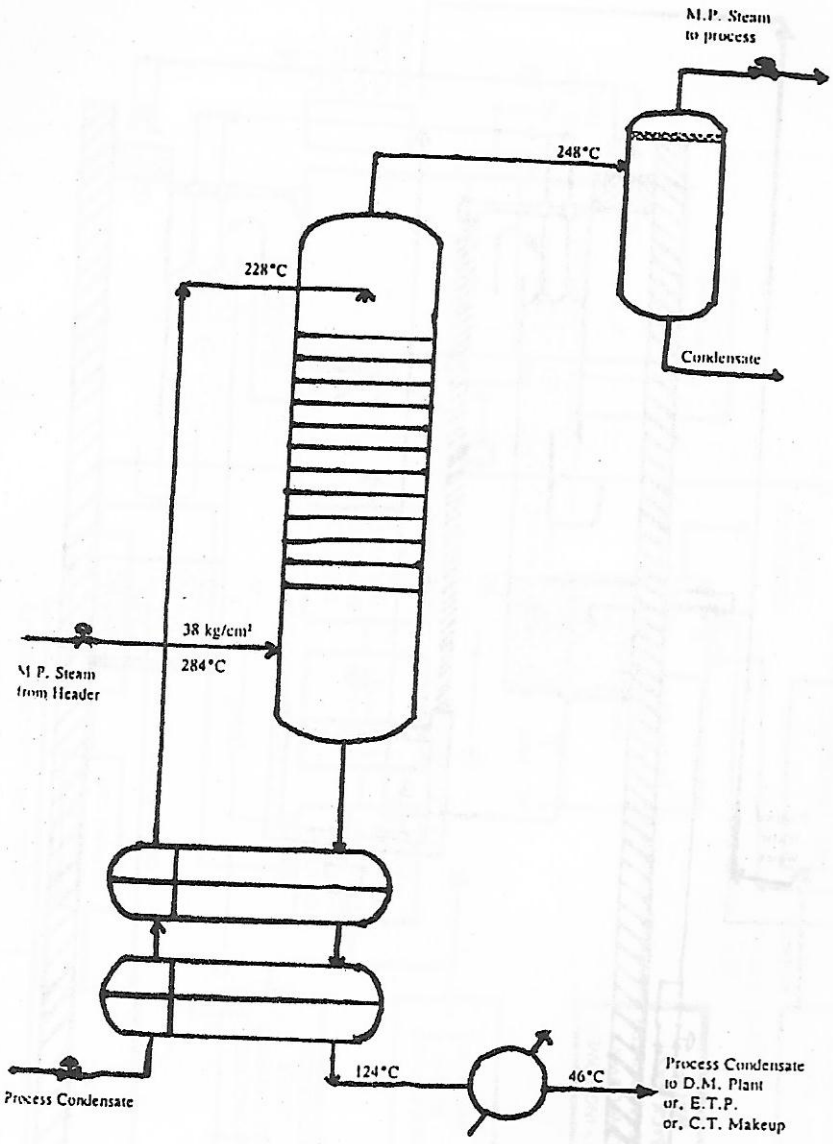


Fig. 1 : Flow diagram of process condensate stripping section

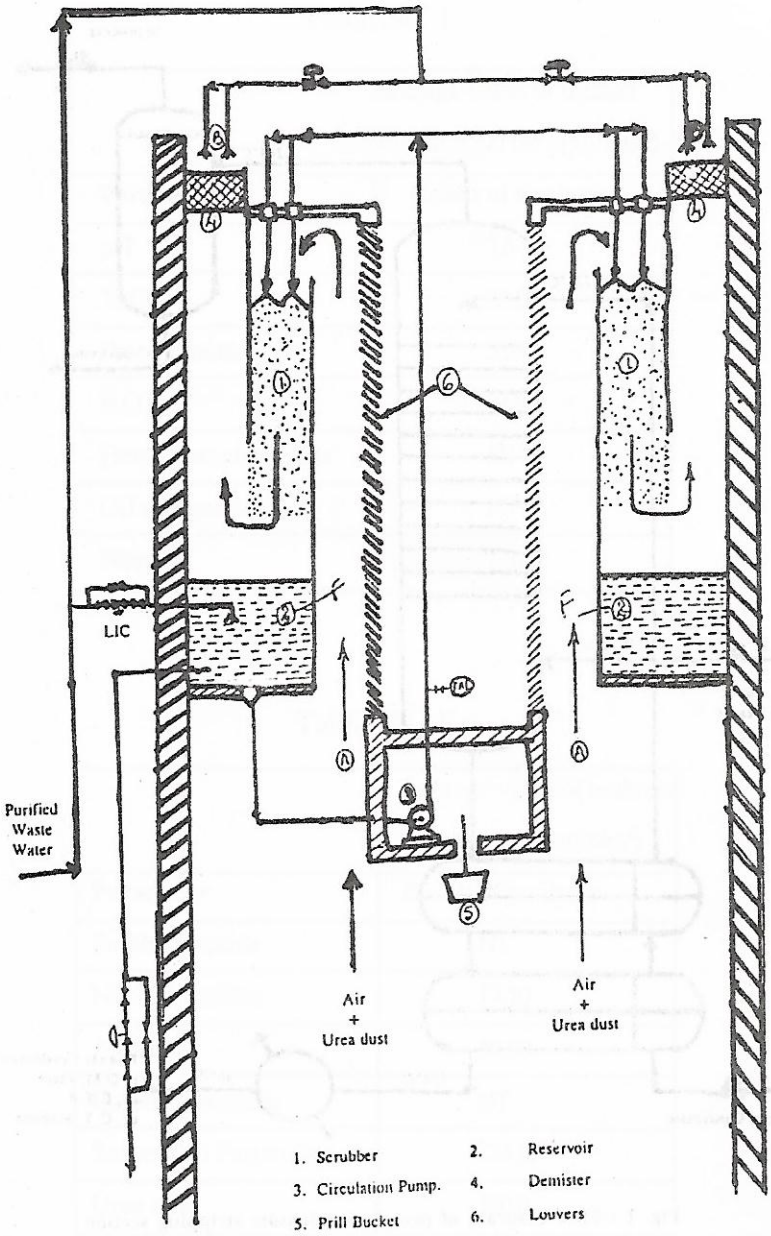


Fig. 2 : Flow diagram of dedusting system of urea prilling tower

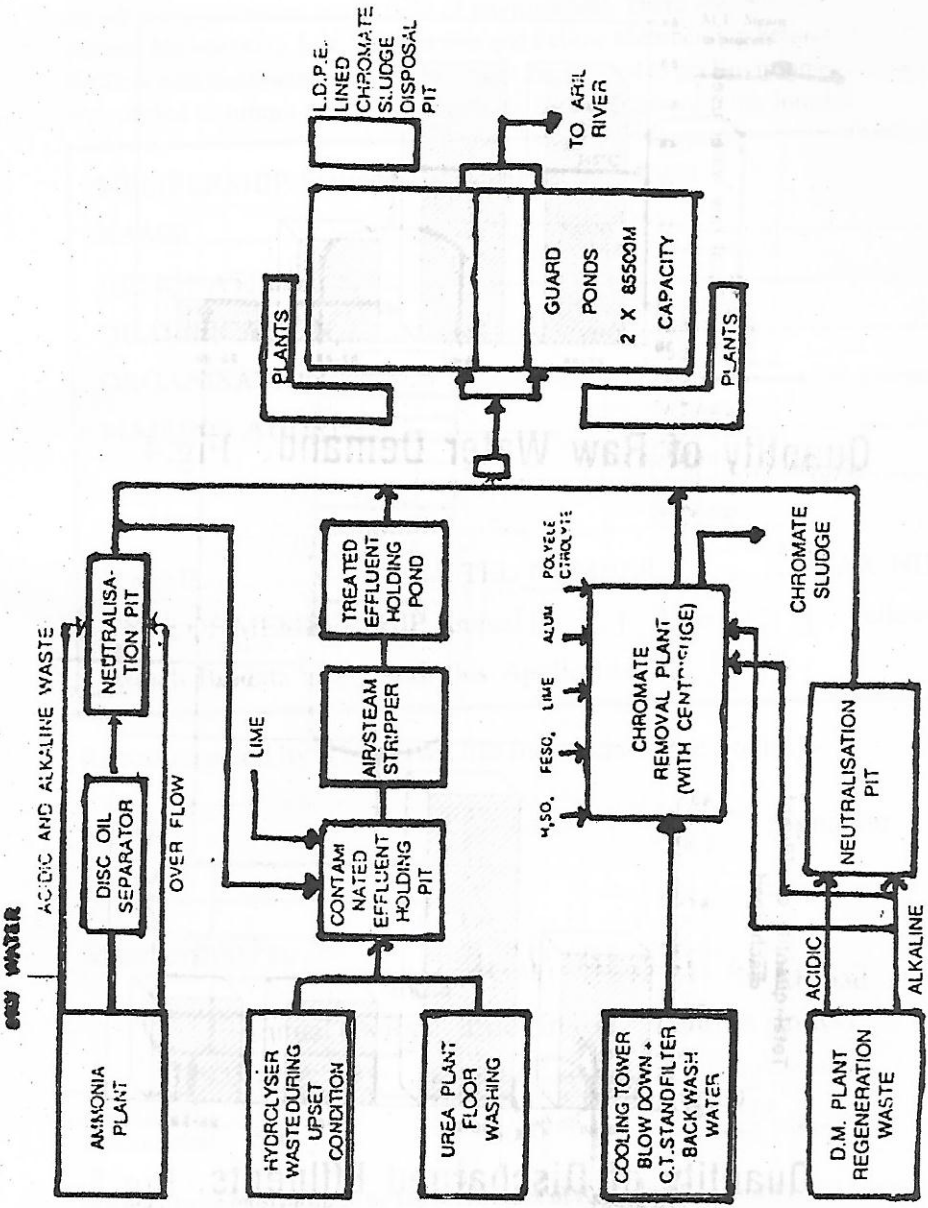
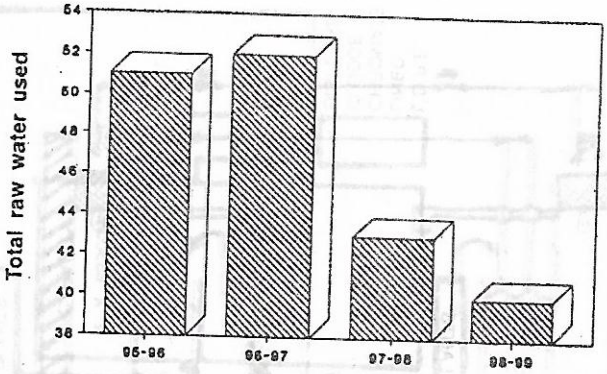
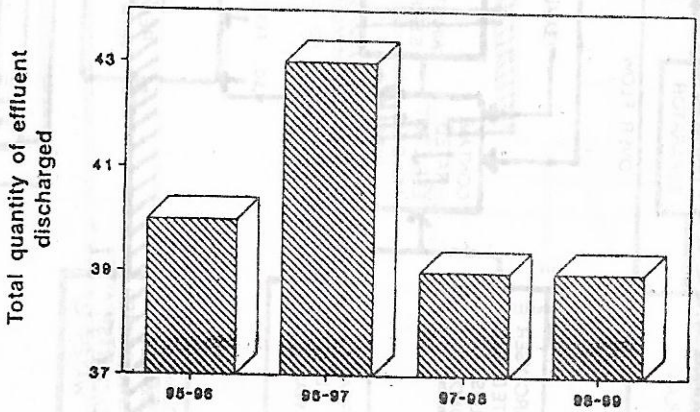


Fig. 2 : Flow diagram of pollution control measure at IFFCO Aonla



Quantity of Raw Water Demand. Fig.4



Quantity of Discharged Effluents. Fig.5

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