

**CULTURE AND USE OF AN EUKARYOTIC
MICROORGANISM (PARAMECIUM) FOR DEPOLLUTION
OF AN EFFLUENT**

BY

N. REVATHI
Reg. No. 93 PLS 05

A THESIS SUBMITTED TO THE AVINASHILINGAM INSTITUTE FOR HOME SCIENCE
AND HIGHER EDUCATION FOR WOMEN (DEEMED UNIVERSITY) COIMBATORE - 641 043
IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF SCIENCE IN LIFE SCIENCES

MAY 1995

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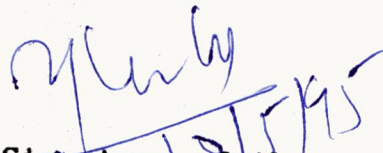
In Partial fulfilment of the requirements for the degree of
MASTER OF SCIENCE IN LIFE SCIENCES

MAY 1995


CERTIFIED AS BONA FIDE RESEARCH WORK



Signature of the
Head of the
Department



Signature of the
Dean of Faculty



Signature of the
Guide

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Introduction

INTRODUCTION

Pollution is defined as any degree of contamination of air, water or land which is likely to produce a significant adverse health effect to a significant number of persons for a forceable period of time (Barbour, 1983).

Rapid development of industries has led to the continuous inflow of ever increasing amount of various synthetic compounds which have toxic properties. Most industrial processes produce waste waters that contain varying amounts of salts and organic matter. Water pollution is more complex than air pollution and land pollution because the biological and chemical wastes that enter water is increasing due to the largest single user of water by the industry.

Effluent from industries are discharged into rivers, streams, seas or on land. They contain large amounts of toxic chemicals including phenolic compounds. Their introduction into aquatic ecosystem on a large scale can cause problems (Cook *et al.*, 1989).

Tanning industry in India is one of the oldest and stands amongst the five top export oriented industries. In tanning process vegetable and chrome tanning are the two major processes involved. The wastes contain organic matter and inorganic materials composed of flesh, hair, proteins and their degradation products, soluble sulfides, fatty matter, chrome salts and vegetable tans (Dhaneshwar, 1990).

According to Hekimoglu (1983) one of the most important inputs of the leather industry is water, which is used in all the wet processing units. By the use of classical techniques and thoughtless washing processes, large amounts of water are lost and waste water amounts are increased.

The leather tanning and finishing industry is one of the most significant polluters in terms of both conventional and toxic parameters. Tanneries annually generate over 45,000 tonnes of solid waste from chromium mediated leather tanning operations (Conrad *et al.*, 1976).

Effluent from tanning industry is one of the most complex and has a serious pollutional potential. Currently tannery wastes are disposed of in landfills, trenches which may be hazardous to plants or human health. They produce toxic effect on aquatic microorganisms, fishes and crops (Wickliff *et al.*, 1982) (Fig. 18).

The tannery effluent at Erode is discharged into a common effluent canal and mixed with the river. It contains large amounts of toxic materials which affect the water biota (Fig.13).

The uncontrolled discharge of heavily polluted tannery effluent has contaminated under ground water, caused adverse effects on the environment and could result in prepairable damage to the environment of the industrial and coastal area (Beg *et al.*, 1990) (Fig.14).

Tannery agents which gradually remove oxygen from the medium giving an unpleasant odour and practically stop the 'self purification' process of water and kill the biota. Decrease of dissolved oxygen (DO) in the medium considerably increases the toxicity (Dhanapal *et al.*, 1990).

These hazardous effluents need an efficient degradation method of treatment. The treatment of industrial waste is really a fermentation process. Biological treatment systems have been designed and operated to remove organic compounds from the aqueous waste stream.

Aeration of the waste water allows the micro-organisms to grow and degrade these hazardous substances. Biological oxygen demand (B.O.D) reduction is also increased with the aeration of the waste water.

Among the principal pollutant transformation processes, microbial degradation may be the only one force that can completely remove chemical pollutants from subsurface waters (Hwang *et al.*, 1993).

In recent years great attention has been made in this country to the development of waste free technology. The use of microorganisms for detoxication of various pollutants and working out the microbial methods of cleanup of various plants.

Micro organisms as part of the aquatic biota play an important part in the recycling of nutrients in all aquatic ecosystem. Different kinds of microorganisms play a fundamental role in the biogeochemical cycles in nature. These microorganisms remineralise organic matter to carbon-di-oxide, water and various inorganic salts.

Depending on the particular treatment techniques employed, inorganic salts present initially in the waste waters or released during waste water treatment also undergo oxidation (Blackburn,1987).

Using microbiological treatment of the effluent chemical oxygen demand (C.O.D) can be reduced to permissible limits and biological waste water treatment can effectively remove 90% or more of the organic carbon. Microbial metabolic processes may transform pollutants to non toxic forms and the total decomposition of organic compounds to inorganic compounds. Among the variety of microorganisms, paramecium is one of the most valuable depolluting organism. It reduces the hazardous organic compounds present in the waste water in an considerable manner (Fig.16).

The aim of the present investigation is

1. To evolve a method to treat tannery effluent in the laboratory conditions.

2. To find a suitable biological method, which is easy and cost less.
3. The eukaryotic micro-organisms viz. paramecium which can be easy to culture in the laboratory condition and to utilize the paramecium for waste water cleaning purpose.

Fig. 13.



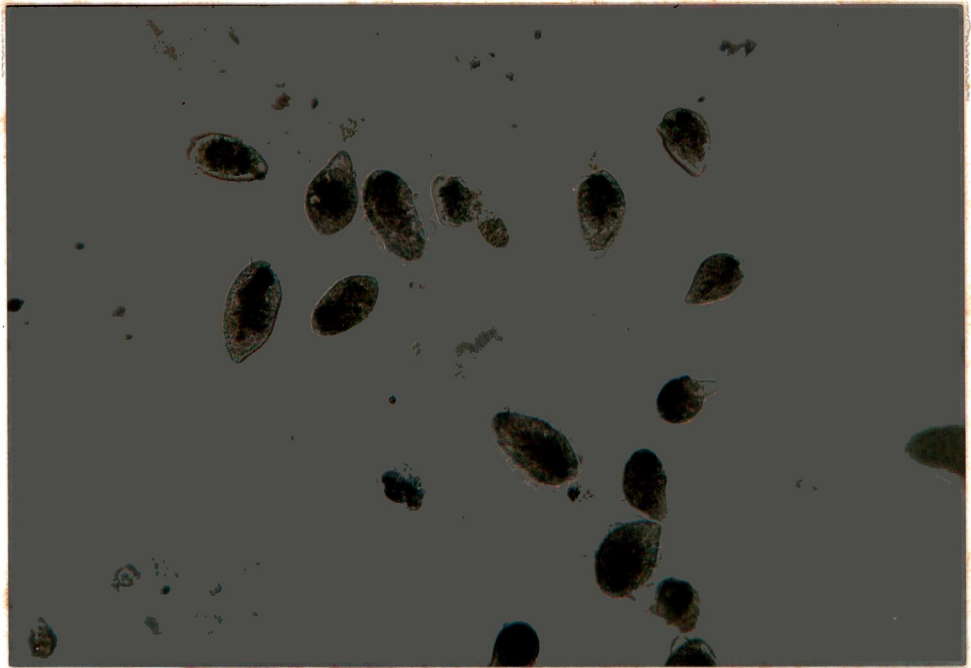
Collection spot of tannery effluent

Fig. 14.



Land fills affected by tannery effluent

Fig. 16.



Paramecia from the culture media

Fig . 18.



Disposal of Tannery Wastes in land fills .

Review of Literature

REVIEW OF LITERATURE

Moore (1953) stated in his investigation that Anthraz was transmitted to humanbeings through water course receiving tannery waste discharge.

Frequent reference has been made to the ability of microbiology to attack substrates and the end products that result. If an organism or a reaction of an organism converts a readily available and cheap raw material into a useful product it becomes feasible to translate this reaction into a large scale industrial operation (Pelizar and Reid, 1958).

In view of Eye and Lawrence (1971) the tannery effluents which contains cheifly salts of sodium, calcium, potassium and chromium when discharged into rivers greatly affect the aquatic life and thereby pose a threat to aquatic ecosystem.

Miakhan and Raman (1972) reported that discharge of tannery wastes into surface water like channels and tanks have increased their salinity to objectionable values.

The work of wang et al. (1974) on dredge disposal and treatment provides a new modified method named aerobic process. Modification can reduce nitrogen and phosphorous by the proper selection and adjusting of food sources for the microorganisms.

In Corning's (1976) view the biological treatment of effluents is feasible and can be used in any situation while secondary treatment of effluent is necessary for satisfactory disposal.

The study on the Microbiology of industrial waste was carried out by Dunican (1976). He found out that biological waste treatment can effectively remove 90% or more of the organic carbon in most wastes.

Singh (1978) reported the problem of pollution of ground water used for drinking purposes in villages situated near distilleries, tanneries and textiles.

The high mortality of fishes in higher concentrations of tannery effluents may be either due to direct effect of metal salts like Chromium, Titanium etc. or due to the blocking of gills by suspended solids which are present in the effluents leading to 'asphyxia' and death. Industrial effluents cause alteration in the composition of a natural aquatic environment and induce changes in the behavioural and pathological aspects of inhabitants (Dhanapal, 1990).

The treatment of Tannery waste water by oxygen activated sludge process was carried out by Kashiwaya and Yoshimoto (1980). The plant could treat 28,000 m³/d of the tannery waste water together with 28000 m³/d of the municipal waste water in Himeji (Japan).

The work on degradation of Industrial organic compounds by Finstein (1980) showed that aerobic treatment can readily degrade synthetic compounds than anaerobic conditions. Mahadevan and Muthukumar (1980) carried out the work of aquatic microbiology with reference to tannin degradation. Aerobic treatment unlike anaerobic treatment is found to be useful for waste waters with low concentrations of organic matter and works in the presence of oxygen drawn from air (Arora, 1981).

The entire ecosystem may be thrown out of year and may lead towards a severe biological imbalance if the water quality of the rivers and streams get degraded beyond certain limits (Jhingran, 1982).

The effluent problems has not so far been resolved due to non-availability of proper technical knowledge how for the treatment of effluents to complete satisfaction. The scheme adopted for the treatment of effluents is mostly by biological methods (Hashim, 1984).

The discharge of untreated tannery effluent into the streams may affect the physico chemical and biological characteristics of water and deplete dissolved oxygen (Sastry and Madhavakrishna, 1984). Shahul Hameed (1985) studied the impacts of tannery effluent on the water quality and on behaviour and respiration of Macrones keletius (Gunther).

The culture of Silver carp, Bighead, Grass carp and Common carp in secondary effluents of a pilot sewage treatment plant was carried out by Sin and Chiu (1987). The Silver carp and Bighead grew at a faster rate in the oxidation ponds than in a commercial pond as control. The growth of the Common carp was satisfactory but that of the Grass carp was poor. The mixture of effluents from the activated sludge and the biological filter systems enhanced fish growth as compared with the activated sludge systems alone.

A preliminary study was conducted with tannery and dairy effluents by anaerobic batch digestion to evaluate their amenability for biomethanation by Sivathanu and Kasturibai (1988). Tannery effluent is found to be rich in organic matter.

Yang and Fan (1990) carried out the treatment of leather and fur waste water. The performance of the pre-aeration tank and primary clarifier regarding BOD and COD removal approached 50%. So the organic loading was reduced. Thilagavathy and Utharah (1990) studied the effect of tannery effluent on the respiratory metabolism of Odonate nymphs.

Tannery waste water treatment and disposal of chrome tannery waste treated by activated sludge having 18 hr detention reduced 821 mg/lit of BOD to 122 mg/lit and further reduction to 30 mg/lit was feasible after 24 hr aeration sulphides were completely eliminated with 12 hr aeration and chromium removal achieved in 6 hr aeration (Dhaneshwar, 1990).

An attempt has been made to find the correlations among COD and BOD for various industrial waste waters by Krishna et al., 1991. The correlations between log (BOD) and log (COD) were found to be quite high for many industries.

The impact of tannery effluent on feeding energetics and oxygen consumption in fresh water fish Oreochromis mossambicus was studied by Subramanian and Varadaraj (1991). Rutland (1991) reported the environmental compatibility chromium containing tannery and other leather product wastes at land disposal sites. The levels of various physico chemical factors indicative of pollution were found to be exceed in the tannery waste waters in Dindigul (Aparna et al., 1990).

Guterstam (1991) carried out the work on Ecological engineering for waste water treatment, theoretical foundation and practical realities.

Kabdasli et al. (1993) revealed the treatability of chromium tannery wastes. The system provide limited nitrification and almost complete BOD removal while the COD could only be reduced to around 500 mg/lit.

Methodology

MATERIALS AND METHODS

Industries are significant points of pollution from an environmental point of view and their pollution characteristics are different from each other (Sengul and Gurel, 1993). Among the variety of industrial effluents encountered, effluent from tanning industry is one of the most complex and has a serious pollutional potential (Arora, 1981). Attention is presently being focussed on the treatment of industrial wastes.

For the present study effluent was collected from one of the tanning industry in Erode, TamilNadu. The effluent was collected in a new hard white can. Effluent was drawn in the can after carefully rinsing it 3 or 4 times with the sample to be tested. The effluent was stored in the properly closed can and the physico chemical analysis were carried out.

The parameters like DO, BOD and COD were analyzed for the raw effluent.

Colour: The colour of the sample was visually observed.

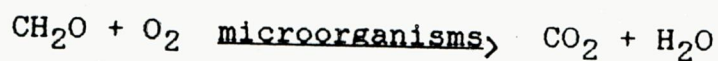
Odour : The odour of the sample was realised nassally.

Dissolved Oxygen (DO):

The DO present in the sample was estimated using winkler's method (Apha, 1980).

Biochemical Oxygen Demand (BOD) :

In spite of many limitations BOD test still remains the best available single test for assessing organic pollution. It is the only test that gives a measure of the amount of biologically oxidisable organic matter. (Manivasakam, 1987). BOD is commonly measured by the quantity of oxygen utilized by aquatic microorganisms in the biochemical degradation and transformation of organic matter under aerobic condition during 5 day period.



For the test 250 ml of the diluted sample was taken in a BOD bottle and added seeding material (seeding is the addition of small measured volume of water containing a good bacterial population to the dilution water). The bottle kept for 5 days at 20°C in a BOD incubator. After 5 days 200 ml of above diluted water was treated against sodium thio sulphate adding starch as indicator until the disappearance of blue colour. The amount of BOD was calculated as

$$\text{BOD (mg/lit)} = (E_1 - E_5) - (B_1 - B_5) \times F$$

where,

E_1 - Dissolved oxygen 1st day

E_2 - Dissolved oxygen 5th day

B_1 - Blank dissolved oxygen 1st day

B_5 - Blank dissolved oxygen 5th day

F - Dilution factor

Chemical Oxygen Demand (COD):

COD value is the amount of oxygen required for oxidation. This test is highly useful to find out the pollutional strength of industrial effluents and sewage. In COD test the sample is subjected to a chemical oxidation induced by chemical reagents and it is an artificial oxidation by which organic matters are oxidised. Hence the COD value for a sample is always higher than BOD value (Manivasakam, 1987).

50 ml of the sample was taken in a 500 ml conical flask. Added 25 ml of 0.25 N $K_2Cr_2O_7$ and 15 ml of concentrated H_2SO_4 . Heated for 1 hr on water bath with funnel. After cooling added 110 ml of water and 2 to 3 drops of Ferrous indicator. Titrated with standard ferrous ammonium sulphate. The colour sharply changed to reddish blue (wine red) colour. COD was calculated by the formula as

$$\text{COD (mg/lit)} = \frac{(\text{Blank sample}) \times \text{Normality of } Fe(NH_4)_2(SO_4)_2 \times 8000}{\text{Sample volume}}$$

Culturing of Paramecium:

Hay was cut into small pieces and boiled for 5 minutes. It was cooled for sometime. To this 50 ml of pond water, taken from the singanallur pond was added. This set up was

kept in the laboratory for 3 days without any disturbance. A large number of paramecia were noted after 3 days in the experimental set up (Fig.15).

Treatment with effluent:

Raw effluent was diluted in the ratio of 1:10 using tap water. 4.5 l of water was taken in the experimental setup. To this 500 ml of effluent was added. The bio kinetic parameters were studied for this diluted samples. The sample was taken in 3 experimental set up. The samples were treated by aeration for 8 hrs, 16 hrs and 24 hrs. Again the parameters were studied for these aerated effluents.

For the biological treatment effluent was diluted in the ratio of 1:10 using tap water. To this diluted sample 500 ml upper layer of medium containing paramecia was added. The samples were aerated for 8 hrs, 16 hrs and 24 hrs. The parameters were studied for these samples (Fig.17).

Fish survival as an indicator of Depollution:

Fish has been treated for many years as an indicator of water pollution. The fish Oreochromis mossambicus (Tilapia) of the finger ling size was selected for the experiment. Because it is easy to acclimatize and it is a good indicator of pollution.

Fish 'Tilapia' were collected from singanallur pond and acclimatized in the laboratory for 2 weeks. After acclimatization 6 fishes were simultaneously introduced into the raw effluent, diluted effluent, 8hrs, 16 hrs and 24 hrs aerated tannery effluent and also to the 8 hrs, 16 hrs and 24 hrs biologically treated effluent. The survival rate of the fishes were recorded.

The present findings are reported in different stages as follows:

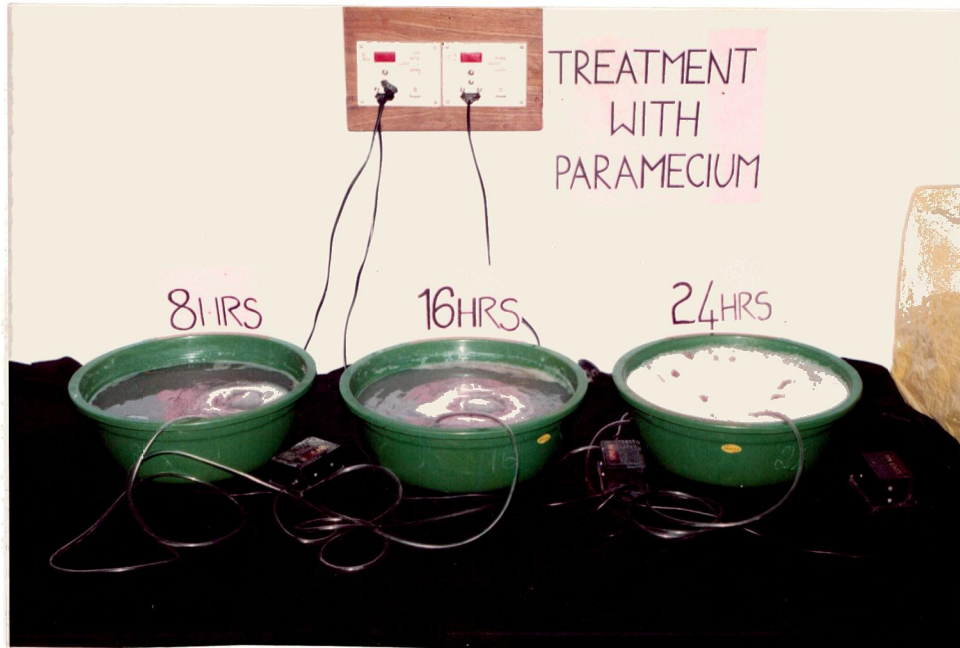
1. The first stage deals with the estimation of DO, BOD & COD for the raw effluent.
2. In the second stage the same parameters were estimated for diluted effluent and also for the tap water which is being used to dilute the effluent.
3. In the third stage the diluted effluent was treated aerobically and the same parameters were analysed.
4. In the fourth stage, treatment was given by introducing microorganism (paramecium) which was collected by using the hay culture technique. The parameters were estimated to reveal the level of depollution by paramecium.
5. Last stage includes the determination of the level of depollution by introducing the fish Oreochromis mossambicus into the treated effluent and survivability rate was recorded.

Fig. 15.



Culture of paramecia in the hay culture technique

Fig. 17.



Experimental set up with 8, 16 and 24 hours aerated and treated effluent

Results and Discussion

RESULTS

The effluent from chrome tanning industry were collected from one of the tanning industry in Erode (TamilNadu). The parameters like DO, BOD and COD were analysed for the raw effluent. DO was found to be nil whereas BOD and COD were found to be high. The BOD for the raw effluent was estimated as 887 mg/l and COD as 937.9 mg/l and is given in Table 1.

The effluent was diluted to 1:10 with tap water and the same parameters were analysed for both tap water and diluted effluent and given in Table 2. The DO, BOD and COD were calculated for the tap water as 7.5, 40 & 210 mg/l and for the diluted effluent as 8.9, 800 and 156.86 mg/l respectively.

The diluted effluent was aerated for 8 hrs, 16 hrs and 24 hrs. Again the same parameters were estimated for these 3 aerated samples. The results were given in Table 3 as DO- 25.7, BOD - 125 and COD - 280 for 8 hrs aerated sample and for 16 hrs aerated as 33.1, 89 and 290 mg/l and for 24 hrs aerated sample as 33.3, 68, and 265 mg/l respectively.

Using Hay culture technique paramecia were cultured in the laboratory and 500 ml of this culture medium containing paramecia were introduced into the diluted effluent and aerated for 8hrs, 16hrs and 24 hrs. The same parameters were

estimated. The DO, BOD and COD for the 8 hrs paramecium treated sample were estimated as 28.0, 146, 308 mg/l and for 16 hrs treated sample as 28.0, 72 and 249 mg/l and for 24 hrs treated sample as 30.0, 52 and 246 mg/l respectively.

There was no oxygen in the raw effluent but it increases during the aeration of effluent as 25.7, 33.1, 33.3 mg/l for 8hrs, 16hrs and 24 hrs aeration respectively (Fig-1). The dissolved oxygen also increases slowly for 8 hrs, 16 hrs and 24 hrs paramecium treated samples as 28.0, 28.0 & 30.0 mg/l due to the action of paramecia and given in Fig.2.

The BOD was found to be high in the raw effluent (887 mg/l) whereas it suddenly reduced to 125 mg/l in the 8 hrs aerated sample and gradually decreased to 52 mg/l in the 24 hrs paramecium treated sample (fig.3 and fig.4).

COD was found to be decreased when the duration of treatment increased. Hence in the 24 hrs aerated sample the COD was found to be 265 mg/l and in the 24 hours paramecium treated sample as 246 mg/l and the results were given in Fig.5 and Fig.6.

The amount of DO and BOD were compared and given in fig. 7 and 8. BOD decreases with the increase in DO.

The amount of DO and COD were compared for the aerated sample (8hrs, 16hrs and 24 hrs) and given in fig 9. DO and COD were also compared for 8 hrs, 16 hrs and 24 hrs paramecium treated sample and given in fig.10. COD also decreased with the increase in DO.

The fish Oreochromis mossambicus were acclimatized in the laboratory and were introduced into the raw effluent and also in the paramecium treated (8, 16 and 24 hrs) samples. The survival rate of the fish were recorded and given in Table 5. 100% mortality was observed within 15 minutes after introducing the fish into the raw effluent. % of survivability of the fishes were recorded in fig.11. 100% survivability were observed for 3 days in the 8 hours aerated sample and 6 days for 16 hrs aerated sample and 10 days in 24 hrs aerated samples.

The maximum survival days and 100% survival days of the fishes were given in fig.12. The fishes survived maximum for 6 days in the 8 hrs and 8 days in 16 hrs and 12 days in 24 hrs paramecium treated samples.

TABLE -1

BIOKINETIC PARAMETERS OF THE RAW TANNERY EFFLUENT

No.	PARAMETERS (mg/lit)	OBSERVATION
1.	Do	Nil
2.	BOD	887.0
3.	COD	937.9
4.	Chromium	12.5
5.	Total Nitrogen	546.5
6.	Carbon	49.5
7.	Colour	Dark Green
8.	Odour	Foul Smell

TABLE - 2
BIOKINETIC PARAMETERS OF THE TAP WATER
AND DILUTED TANNERY EFFLUENT

No.	PARAMETERS (mg/lit)	TAP WATER	DILUTED TANNERY EFFLUENT
1.	DO	7.5	8.9
2.	BOD	40.0	180.0
3.	COD	210.0	256.86

TABLE - 3
BIOKINETIC PARAMETERS OF THE DILUTED AND AERATED EFFLUENT

No.	PARAMETER (mg/lit)	8 HOURS AERATED EFFLUENT	16 HOURS AERATED EFFLUENT	24 HOURS AERATED EFFLUENT
1.	DO	25.7	33.1	33.3
2.	BOD	125.0	89.0	68.0
3.	COD	280.0	290.0	265.0

TABLE - 4
BIOKINETIC PARAMETERS OF THE DILUTED, AERATED AND MICROBIAL (PARAMECIUM) TREATED EFFLUENT

No.	PARAMETERS (mg/lit)	8 HOURS AERATED EFFLUENT	16 HOURS AERATED EFFLUENT	24 HOURS AERATED EFFLUENT
1.	DO	28.0	28.0	30.0
2.	BOD	146.0	72.0	52.0
3.	COD	308.0	249.0	246.0

TABLE - 5

REPORT OF SURVIVABILITY DURING THREE DIFFERENT HOURS IN
DILUTED, AERATED AND PARAMECIUM TREATED EFFLUENT

% OF SURVIVABILITY IN DAYS	HOURS OF TREATMENT		
	8 HOURS	16 HOURS	24 HOURS
1.	100	100	100
2.	100	100	100
3.	100	100	100
4.	66.6	100	100
5.	33.3	100	100
6.	0	100	100
7.		50.0	100
8.		50.0	100
9.		0	100
10.			100
11.			50.0
12.			50.0
13.			0

Fig-1

DO in 8,16 and 24 hours aerated effluent

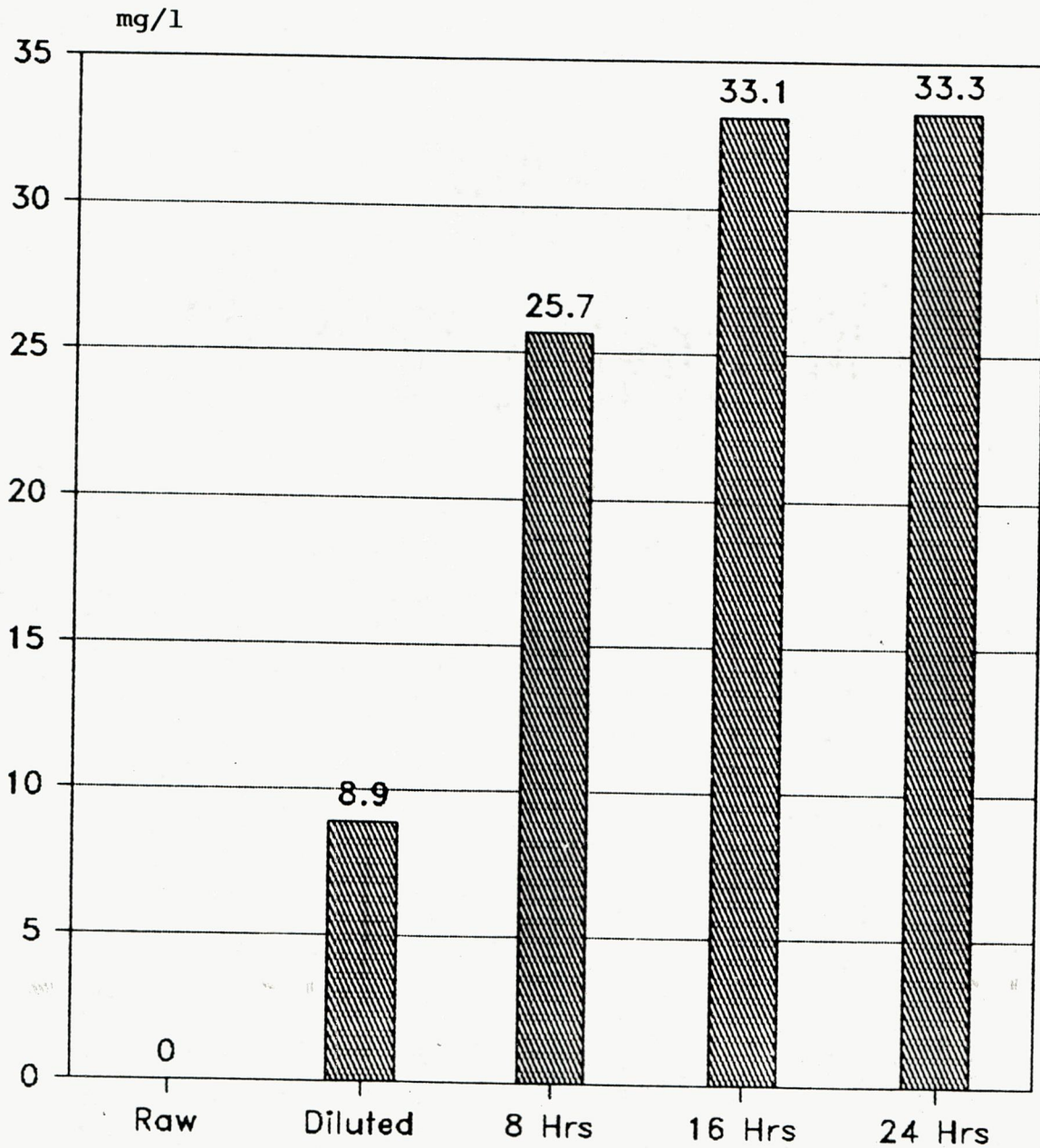


Fig-2

DO in 8,16 and 24 Hrs Paramecium treated effluent

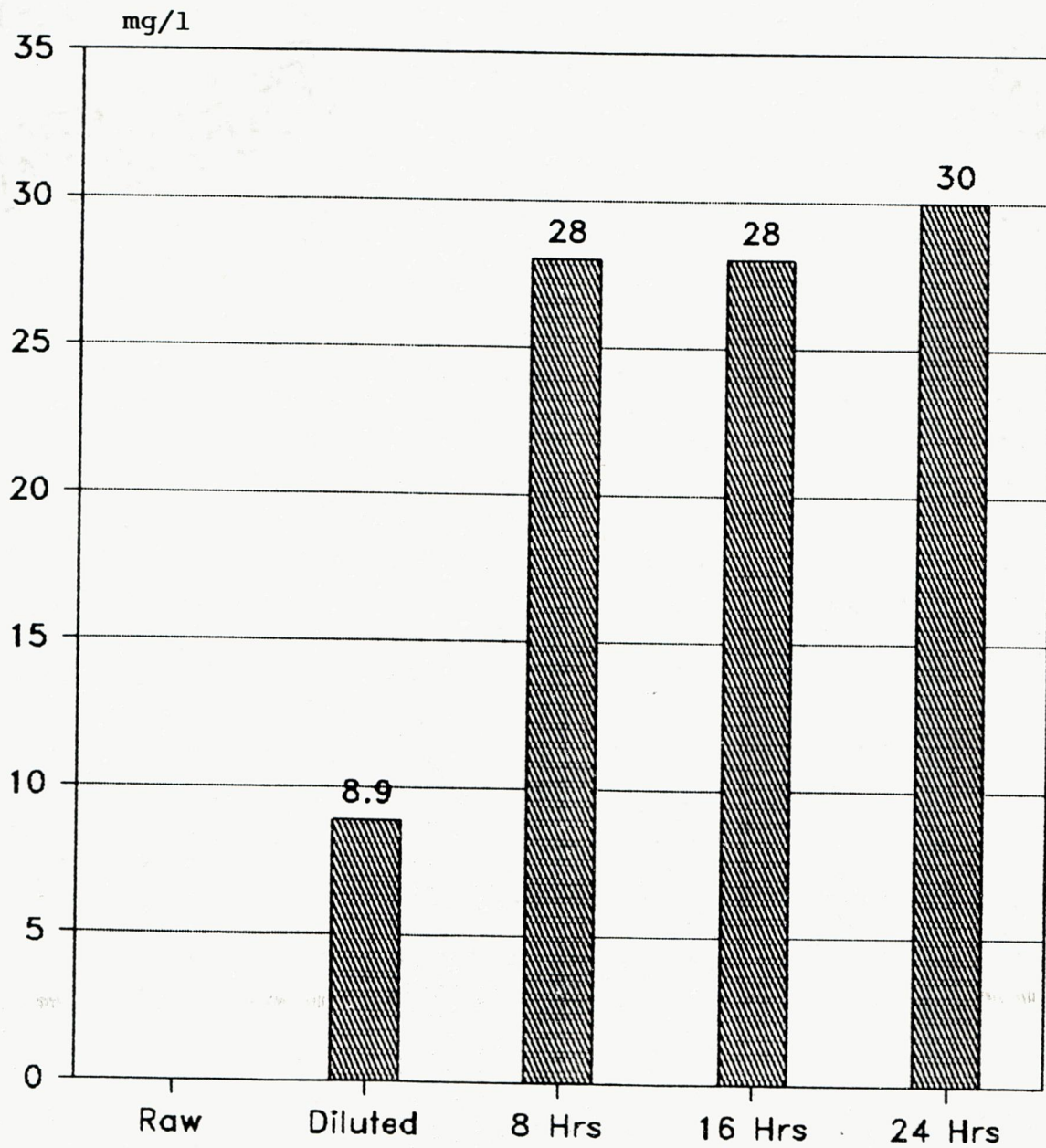


Fig - 3

BOD in 8, 16 and 24 Hrs aerated effluent

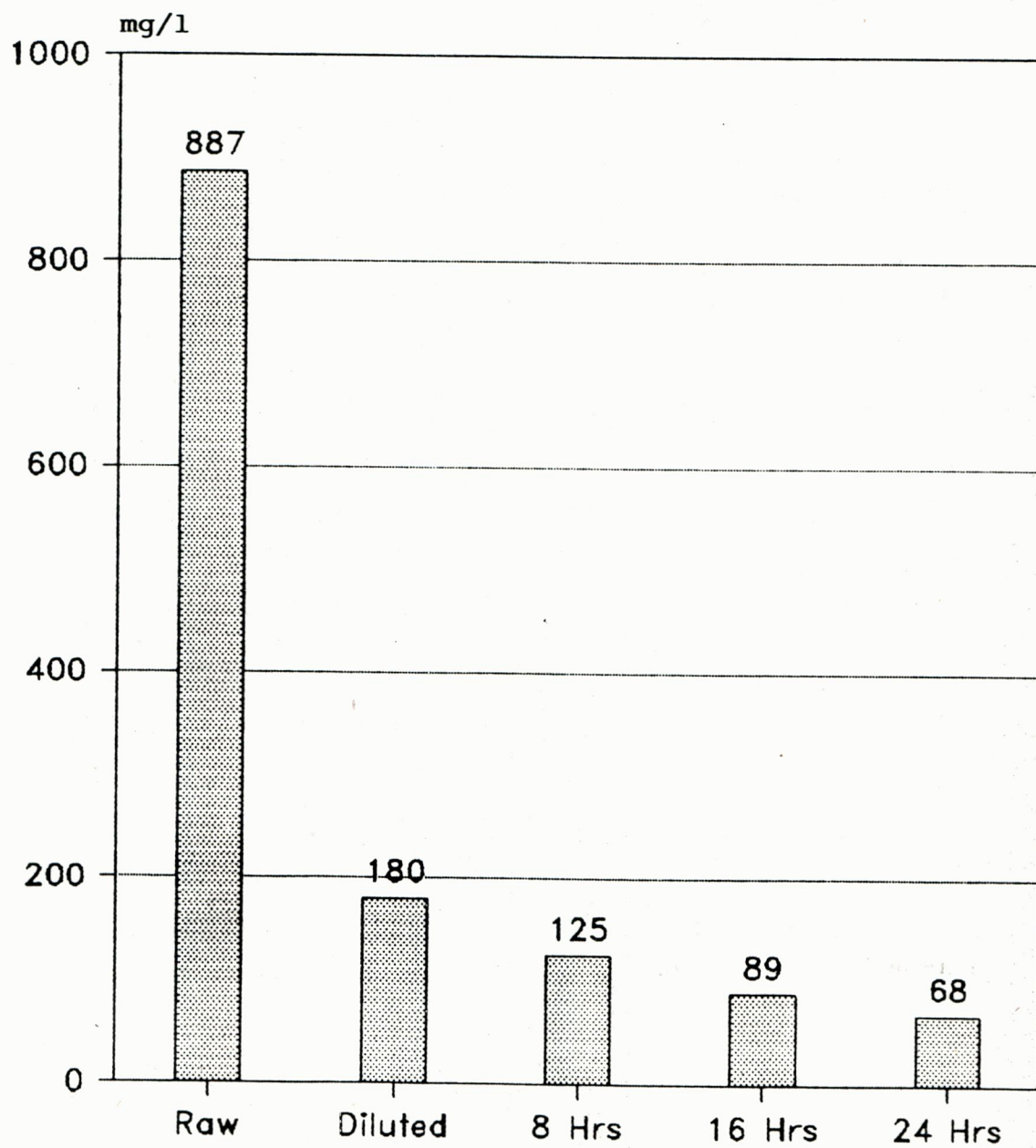


Fig-4

BOD in 8,16& 24Hrs Paramecium treated effluent

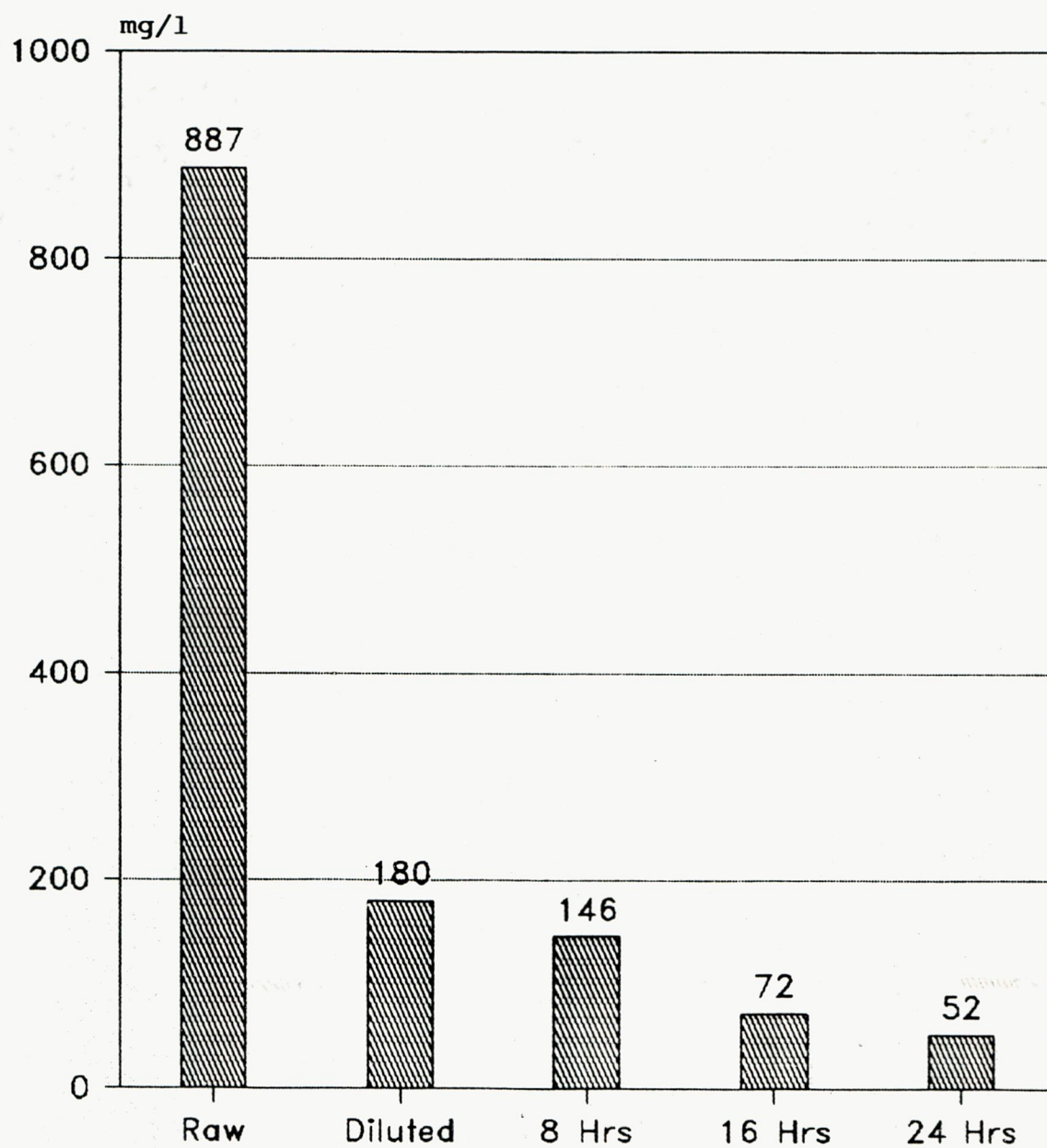


Fig - 5

COD in 8,16 and 24 Hrs aerated effluent

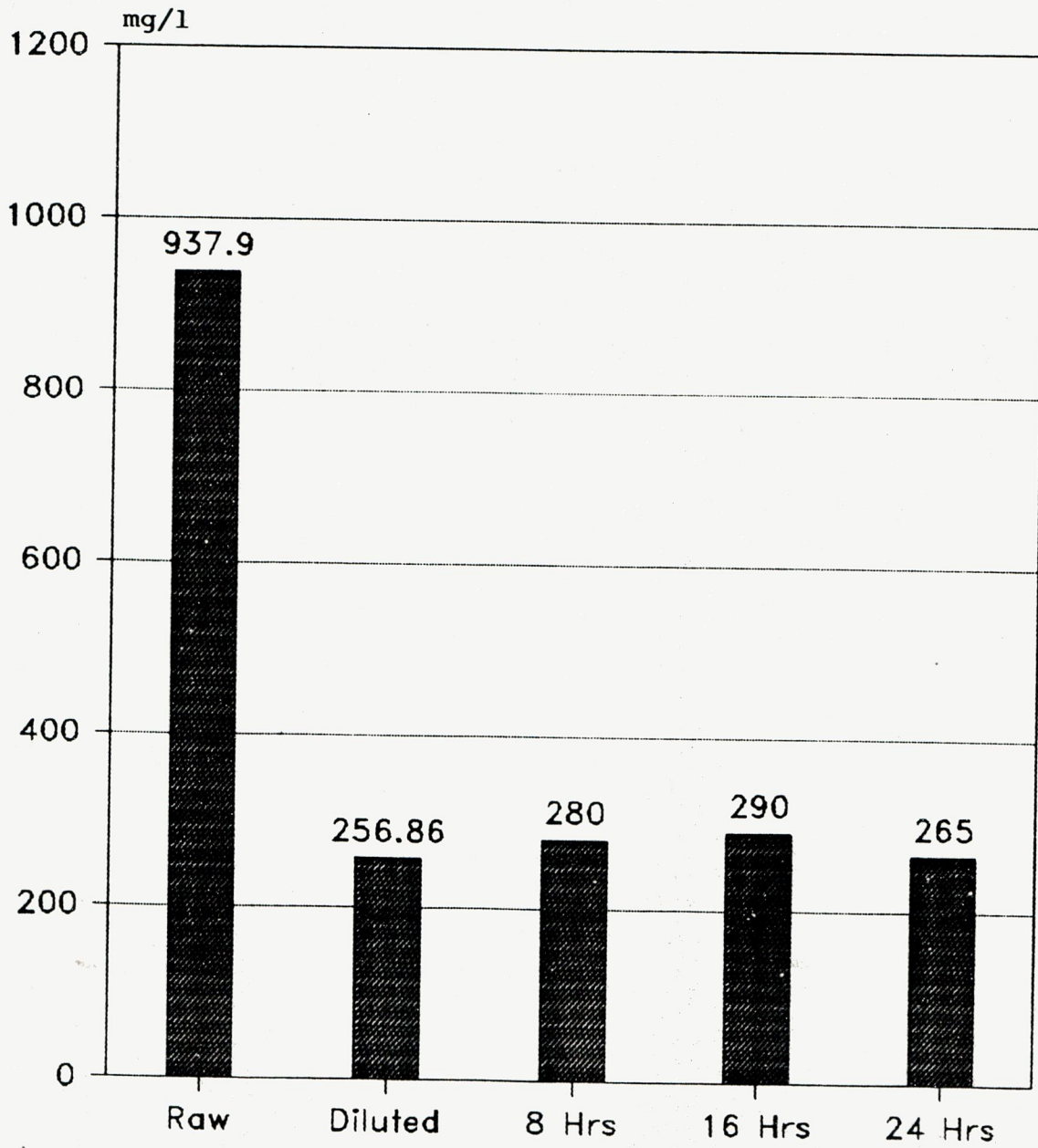


Fig - 6.

COD in 8,16 & 24Hrs Paramecium treated effluent

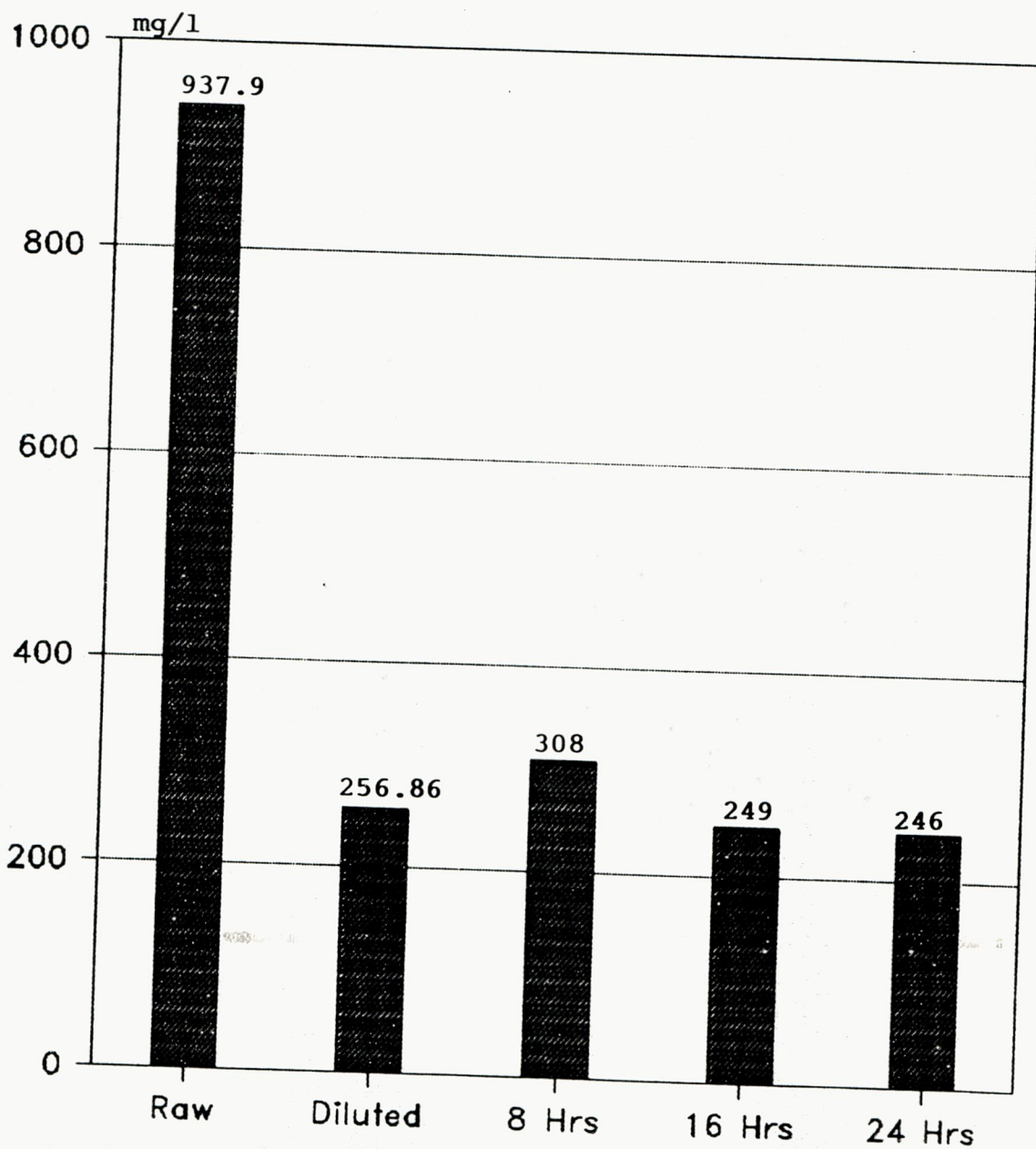
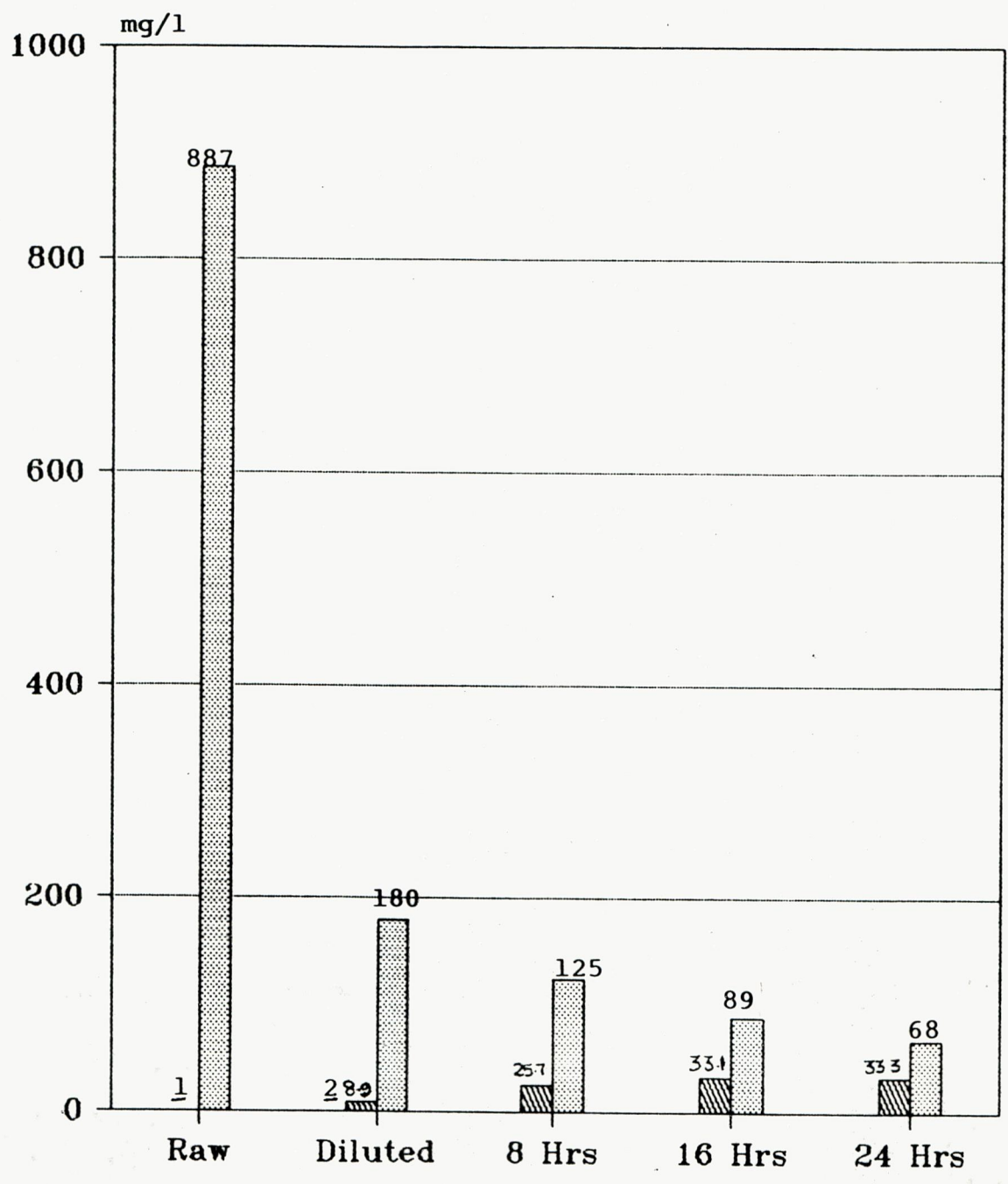


Fig - 7

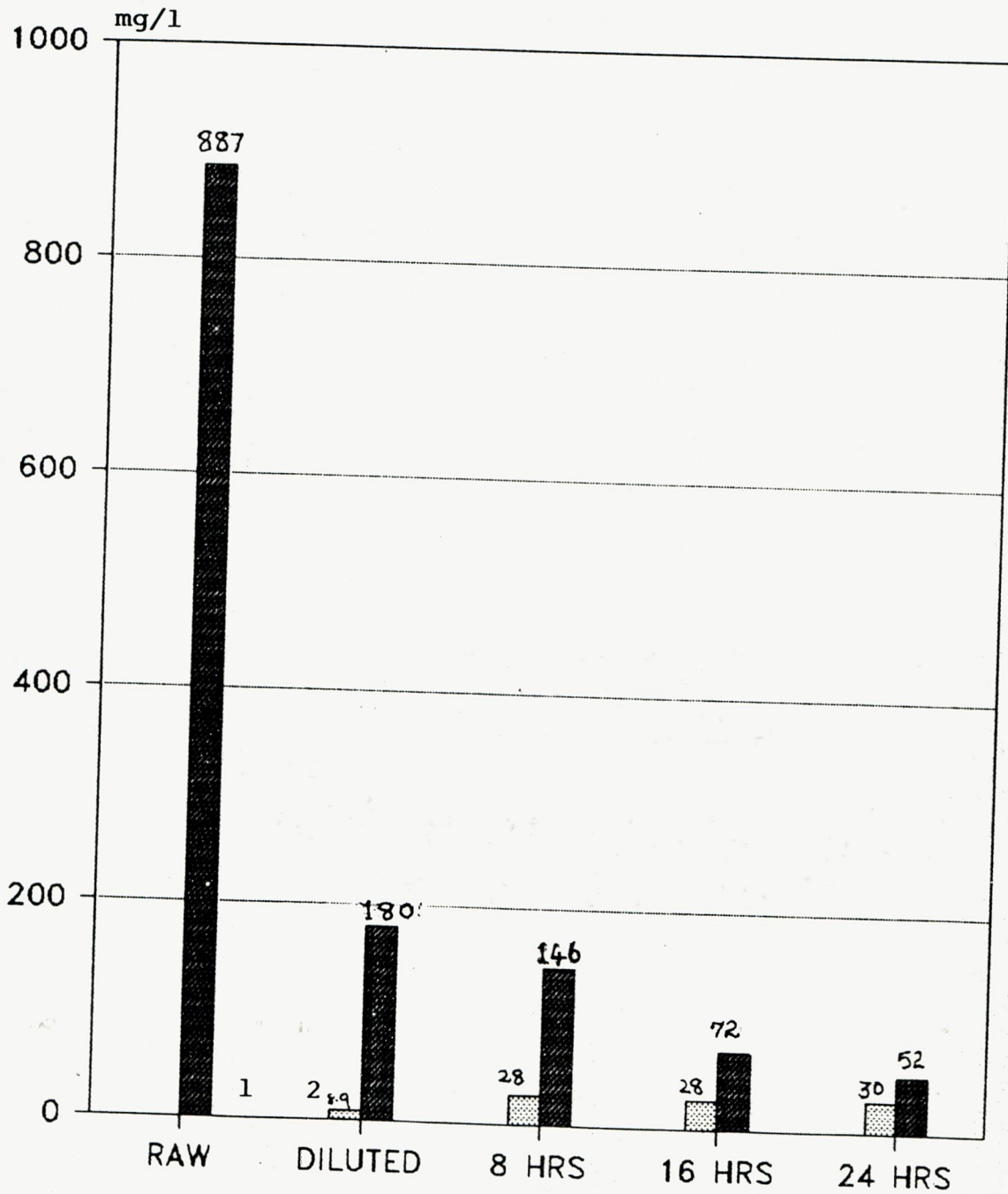
Comparison between DO and BOD in
8, 16 and 24 Hours aerated effluent.



- 1. BOD
- 2. DO

Fig - 8

Comparison between DO and BOD in
8, 16 and 24 Hours Paramecium
treated effluent.



- 1. BOD
- 2. DO

Fig. 9

Comparison between DO and COD in
8, 16 and 24 hours aerated effluent.

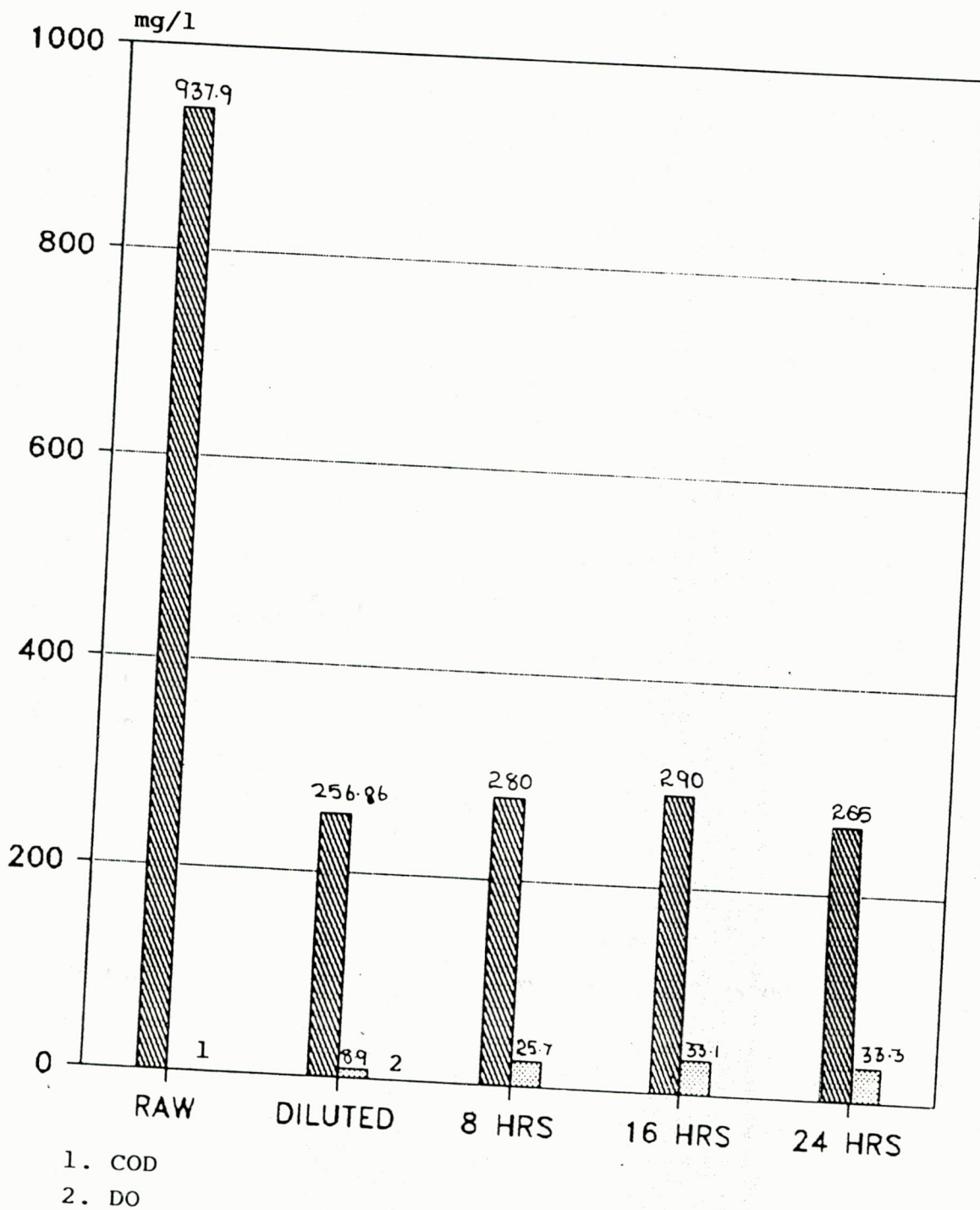
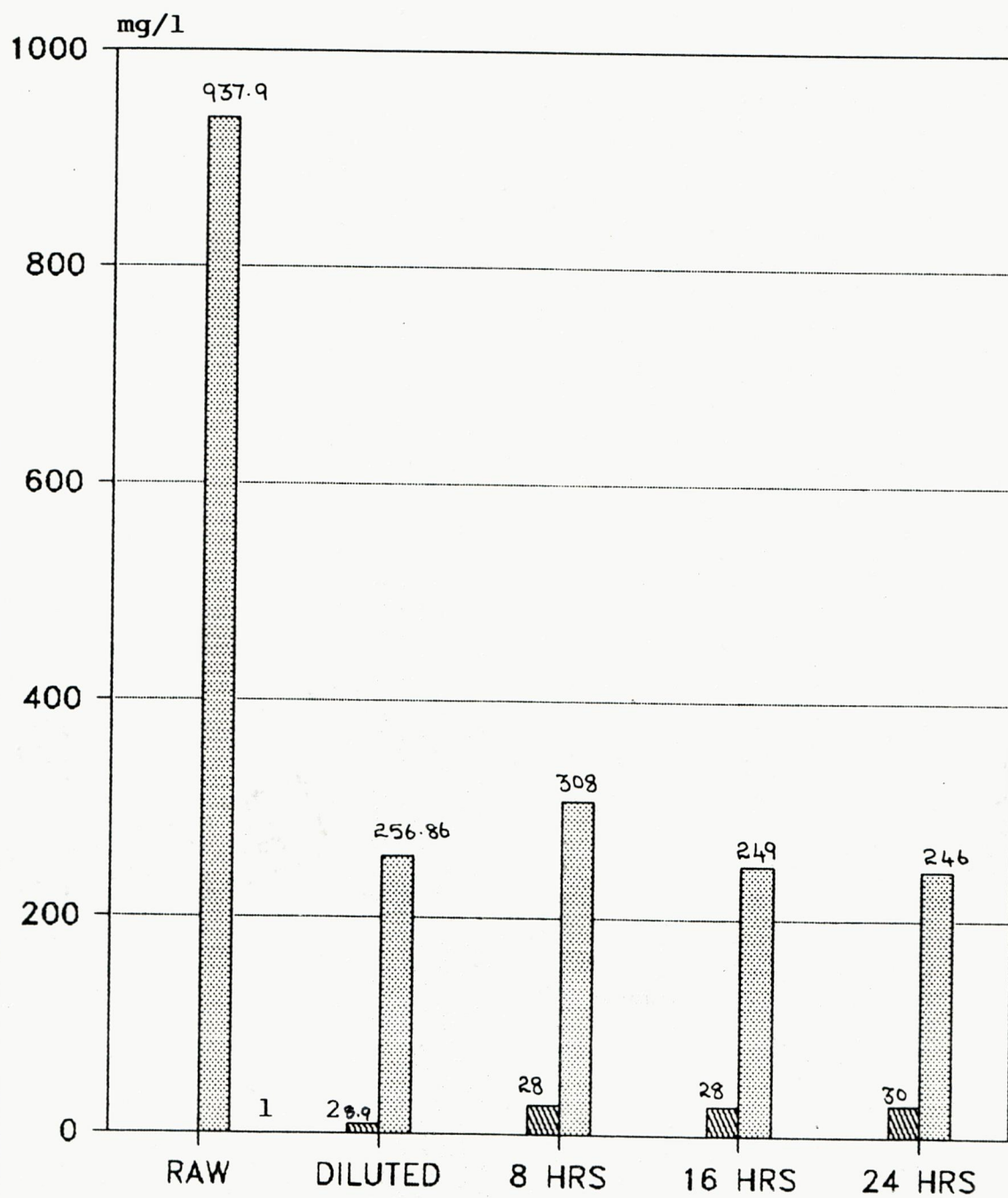


Fig. 10

Comparison between DO and COD in
8, 16 and 24 hours Paramecium
treated effluent.



1. COD

2. DO

Fig - 11

% of survivability of fish Oreochromis mossambicus in 8, 16 and 24 hours
Paramecium treated effluent.

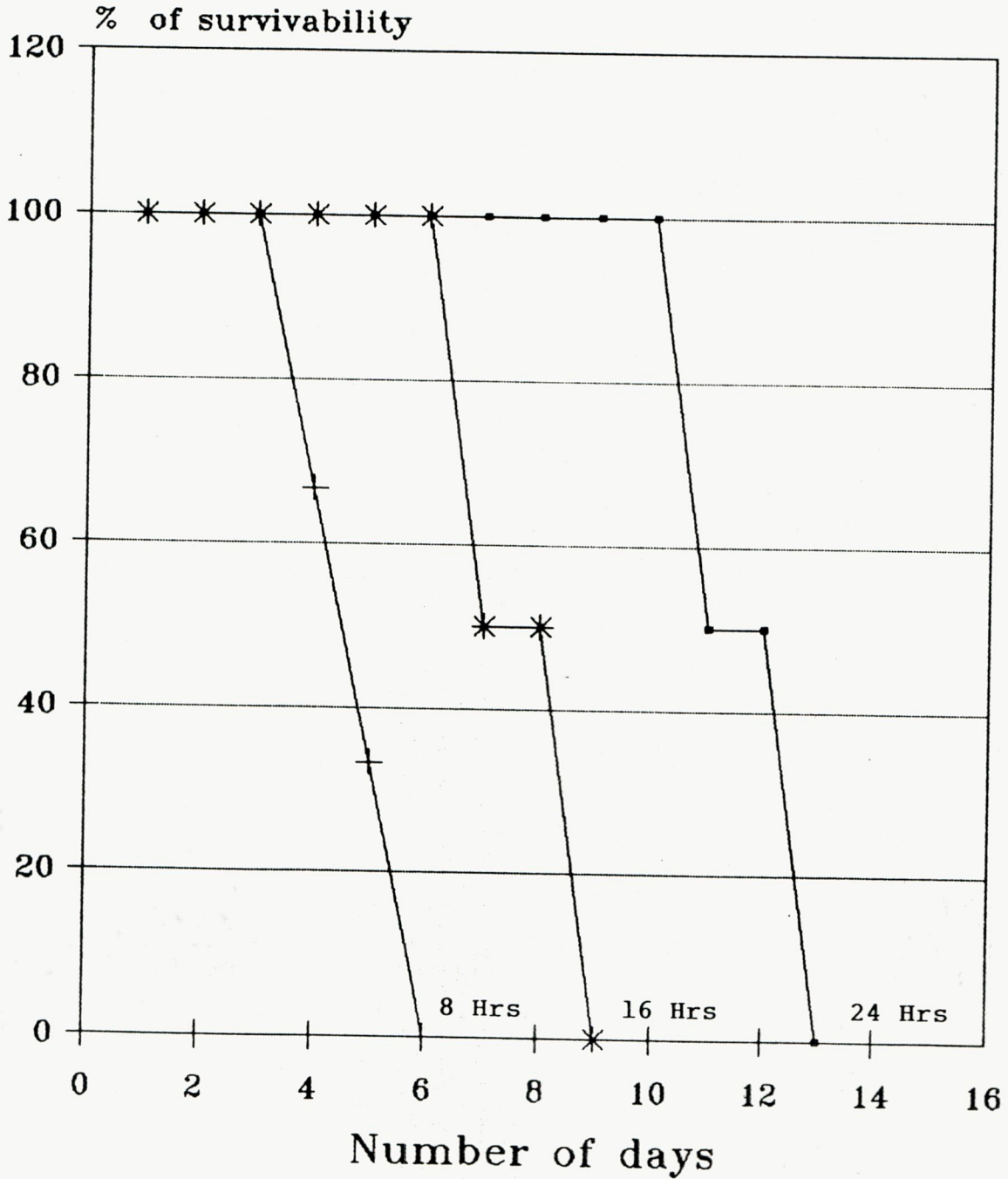
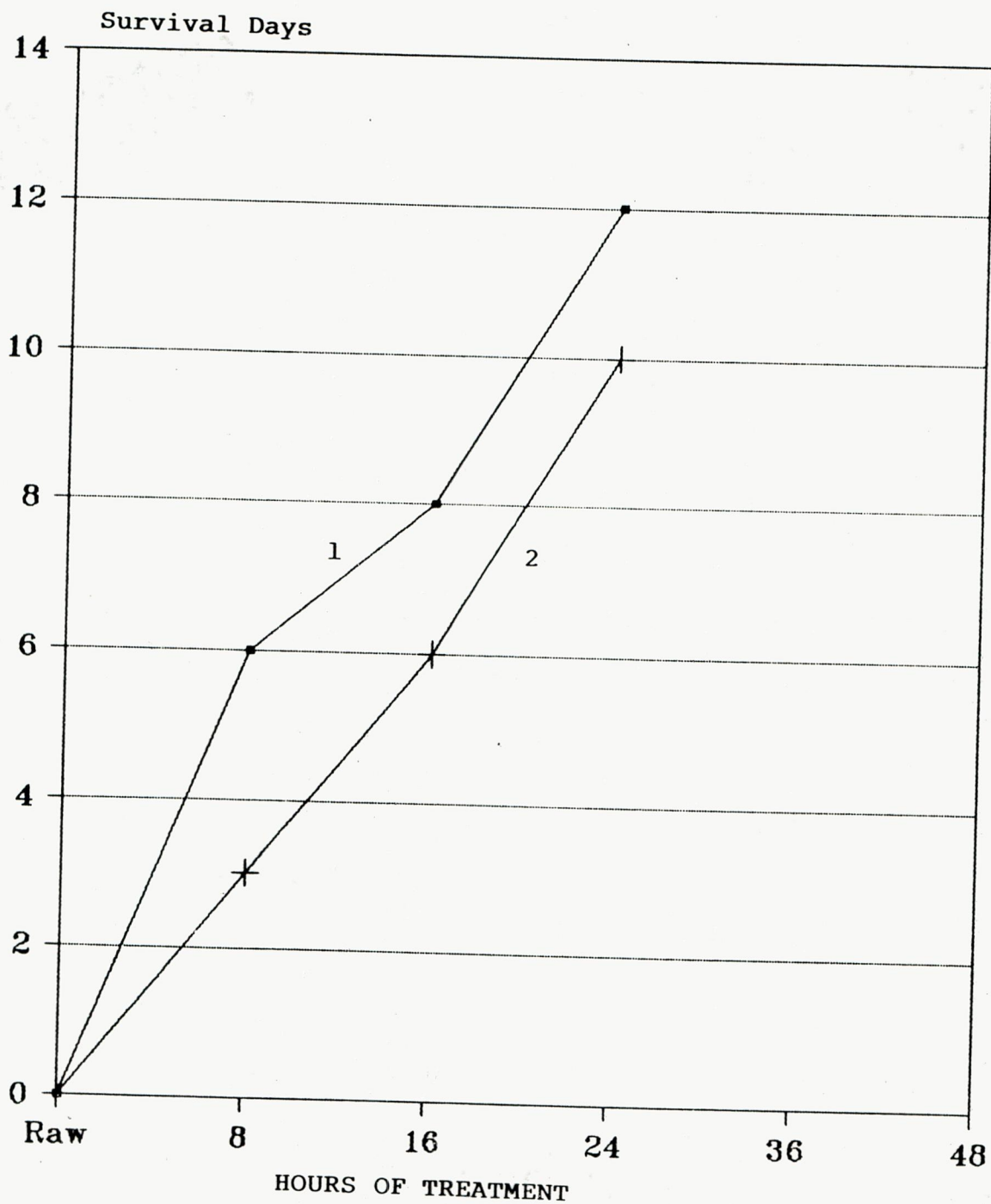


Fig - 12

Maximum and 100% survival days of fish
Oreochromis mossambicus in 8, 16 and 24 hours
Paramecium treated effluent.



1. Maximum Survival Days

2. 100% Survival Days

DISCUSSION

In the present investigation bio kinetic parameters of the tannery effluent (Erode) like BOD and COD were found to be high (887 and 937.9 mg/l) whereas DO was completely absent. These higher value of the raw effluent was due to the presence of organic matter and inorganic material both in solution and suspension, composed of high pH value, high chloride, and sulphide, concentrations, high sodium with chlorides and sulphides, chromium and tannin, high concentrations of BOD and COD (Arora, 1981).

The present investigation was supported by Chauhan *et al.* (1993) that the effluents from Agra and Mahajan tanneries contains higher quantity of total dissolved solids, BOD, COD, Chlorides, Sulphates, Carbonates, bicarbonates, Calcium, magnesium, potassium and lower quantity of DO. Level of various physico chemical factors indicative of pollution in the tannery effluent were found to be exceed the quality standards (Aparna *et al.*, 1990).

The DO was totally absent in the raw effluent. It affects the growth of aquatic organisms. Lloyd (1961) found out that low DO content in the medium considerably increases the toxicity of fishes. Tannery effluents contain sodium sulphide, chromium, and other tannery agents that remove oxygen from the receiving water and give it an unpleasant odour (Barnhart, 1978).

The foul smell of the effluent was due to the removal of oxygen by receiving sodium sulphides, chromium and other tannery agents. The effluent when diluted with tap water (1:10) showed decreased level of BOD and COD whereas DO was increased from nil to 8.9 mg/l. Alam *et al.* (1991) in his study reported that fishes were suffered 30 - 60% mortality when exposed to undiluted industrial effluents and less mortality were reported when industrial effluents were diluted. During dilution the DO was increased and supported the survival of fish for a certain period.

The raw effluent contains BOD and COD as 887 and 937.9 mg/l. Sudden fall was noticed during the aeration of the effluent to 8,16 and 24 hrs to 125,89 and 68 mg/l of BOD and COD as 280,290 and 265 mg/lit. By giving oxygen to the microorganisms in the effluent through aeration it could be possible to decrease the level of BOD and COD. Similar observation was made by Judkins and Michael (1986) in the textile waste. Aeration of the waste allowed the indigenous micro organisms to grow and degrade the malodorous substances. Even in the presence of other carbon sources the malodorous substances could be degraded by the selected strains. The aerobic micro organisms could metabolise the

aromatic compounds such as phenol and P-cresol and it has been extensively studied by Bourque (1986). The pattern and magnitude of changes in water and sediment quality were examined due to aeration by Jana and Sengupta (1994).

DO in the diluted effluent was increased from 0 to 25.7, 33.1 and 33.3 mg/l during the aeration of the effluent to 8, 16 and 24 hrs. Increased DO has brought down the BOD and COD values in the effluent. Arora (1981) stated that aerobic treatment unlike anaerobic is found to be useful for wastewaters with low concentration of organic matter and works in the oxygen drawn from air. Under aerobic conditions carbohydrates were converted into carbon dioxide and water. Deamination, decarboxylation and transamination of amino acids also occurred. The substances present in the effluent are broken by microbes utilising the DO which result in the depletion of oxygen of the medium, which is lethal to fish life when discharged into water bodies.

An attempt had been carried out to treat tannery effluent by using a eukaryotic microorganism (paramecium) to decrease or to remove the hazardous wastes such as BOD and COD from the effluent.

Attention is presently being focussed on the fates of organic chemicals in biological treatment systems. Most

systems have designed and operated to remove organic compounds from the aqueous waste stream and performance has been designed in terms of removal of a non-specific parameter from the waste water parameters like total organic carbon, BOD and COD have historically been used in treatability studies (Blackburn, 1987). Effluent biosolids were ingested and incorporated into the cellular material of aquatic food chain organisms. The major sink for total suspended solids from biological treatment systems is postulated to be biological oxidation.

The BOD of the raw effluent was found to be high as 887 mg/l and no DO was noted. According to NEERI Report (1979) and Sladech *et al.* (1982) the BOD can be used as an important parameter to know the level of pollution. It gives an approximate measure of the amount of biologically, degradable organic matter in the effluent. BOD was decreased from 887 to 146 mg/l. (8 hrs treated samples) after the treatment of effluent by paramecium, when the treatment time increased, the BOD was decreased to 52 mg/lit in the 24 hrs treated sample. This was due to the more consumption of oxygen by paramecia from the effluent.

Thabraaj *et al.* (1962) found out that by treating in activated sludge unit BOD of the diluted vegetable tannery waste was reduced. Chrome tannery waste treated by activated sludge having 18 hrs detention reduced to 30 mg/l was feasible after 24 hrs aeration.

A combined treatment technology consists of wet air oxidation followed by aerobic biological oxidation was carried out for the treatment of paper and pulpmill effluent. The initial substrates COD was varied in the range of 1000 - 4000 mg/l. Using aerobic biological oxidation the effluent COD could be brought down to permissible limits (less than 100mg/l) (Veenila et al., 1988) when the COD is less than 20,000 mg/lit biological oxidation becomes more advantageous (Joshi et al., 1985).

COD was found to be 937.9 mg/l in the raw effluent. But due to 24 hrs aeration of the diluted effluent the COD was brought down to 265 mg/l and it was further decreased to 246 mg/l when the treatment was given for 24 hrs. This sudden fall was due to the aeration and by the action of paramecia. Sihorwala et al. (1991) found out that anaerobic packed bed reactors give higher COD removal than anaerobic digestors.

Mortality of fishes is a regular feature through out the year in the affected zone of the reservoir, but when stored, wastes are frequently emptied, fishes are killed outright by the combined action of deoxygenation and toxicity (Singh et al.; 1989).

The fish Oreochromis mossambicus were survived well in the 24 hrs treated samples. They survived for the maximum days of 12 in the 24 hrs treated sample and 100%

survivability was recorded for 10 days whereas in the 8 hrs treated sample they survived for the maximum days of 5 and 100% survivability was recorded for 3 days. The more survival days in the 24 hrs treated sample indicated that the effluent which was treated for a long time could brought down the levels of toxic materials and increased the DO which could support the survivability of fishes for a considerable time.

Further investigation may be taken up to remove BOD and COD fully by the microorganism to make the tannery effluent more suitable for culturing of fish.

Summary and Conclusion

SUMMARY AND CONCLUSION

The present investigation was carried out to depollute the chrome tannery effluent by using an eukaryotic microorganism (Paramecium).

The salient findings of the present study are as follows:

1. The DO, BOD and COD were found to be very high in the raw chrome tannery effluent. But the levels of BOD and COD were come down after aeration and treatment with paramecia.
2. The effluent was diluted using tap water and was aerated for 8hrs, 16hrs and 24 hrs. This treatment brought down the BOD from 887 to 68 mg/l. COD was also decreased from 937.9 to 265 mg/l. whereas DO was increased from 0 to 33.3 mg/l.
4. Paramecia were cultured by using hay culture technique.
5. The paramecia were treated aerobically in to the diluted tannery effluent by giving different hours of aeration like 8,16 and 24.
6. The DO which was nil in the raw effluent was increased slowly during the aeration of paramecia treated sample in 8,16 and 24 hrs (28,28 and 30 mg/l).
7. As the aeration time of the treated effluent increased (8,16 and 24) the BOD decreased from 887 to 146, 72 and 52 mg/l due to the action of paramecia.

8. Dilution of the effluent in the presence of paramecia when aerated for 8,16 and 24 hrs, COD has also decreased from 937.9 to 308, 249, 246 mg/l respectively.
9. 100% survival rate in the 8,16 and 24 hrs treated effluent was 3,6 and 10 days. 24 hrs aerated sample was more suitable for fish survival than the other two treated samples.
10. Maximum survival days of the fish in 8,16 and 24 hrs treated effluent was 5,8 and 12 days. Fishes survived well in 24 hrs treated sample.
11. The present study proves that the hazardous pollution level in the effluent declined by the action of paramecia and aeration and the treated samples were found to be suitable for the survivability of Oreochromis mossambicus for a specified period.

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