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# BIOSEDIMENTATION OF MINE TAILINGS BY *FUSARIUM SOLANI*

MEENAL KOWSHIK AND SARITA NAZARETH*

Dept. of Microbiology, Goa University ,
Taleigao Plateau 403 206 , Goa , India
*Communicating author. E-mail : sarita@unigoa.ernet.in

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## ABSTRACT

**Mine tailings have a high concentration of suspended material and metal complexes. It is routinely treated for sedimentation with various chemicals that in themselves are pollutants. The mycelial mass of *Fusarium solani* added to mine tailings, greatly increases the natural rate of sedimentation. Homogenisation of the biomass increases its capacity for sedimentation. Storage of the mycelium upto a week, does not affect the sedimentation rate.**

## INTRODUCTION

Mining is a major industry in the state of Goa, and accounts for nearly 10% of the total exports of iron and manganese ores of the whole country. Ten of the large mines are located in the Zuari basin while remaining 27 are in the Mandovi basin. The ore is upgraded through a benefication process wherein the ore is 'washed'. The wash waters, termed as 'mine tailings', form thick slurries of earth and metal fines. The wash waters released from the beneficiation plant carries a lot of suspended particles and fines, which require time for sedimentation and hence get released into the natural water bodies. This has led to deposition of sediment in these water bodies and an increased turbidity of the waters. The mining industries face a lot of environmental problems. The major impacts include disruption of water regime and hydrology, water quality deterioration due to mine discharges, and pollution due to wash off overburdens and discharges of tailings. (Mahajan 1994).

To bring about sedimentation, chemical flocculation processes involving lime and salt, are being used. The treated waters are then released into nearby rivers. However this results in increase in pH of these water bodies, which in turn, adversely affects aquatic life and consequently human existence. The need of biological measures to achieve a quick and effective sedimentation is gaining importance as a desirable alternative. Such work has been attempted in trial experiments by Bender (1994), Despande (1990) Kaplan (1987) and Shila M (1987).

The present work is carried out with a fungal isolate, *Fusarium solani* Which shows a great potential for a rapid and efficient sedimentation and clarification of mine tailings in laboratory experiments.

## MATERIALS AND METHODS

### Organism and culture conditions

The organism *Fusarium solani* (Mart.) Sacc. (Nazareth & Mavinkurve 1987) was maintaind on potato dextrose agar (PDA).

### Sedimentation by *Fusarium solani* mycelial mass

Mycelial biomass was obtained by growing the culture in minimal medium with glucose ( $M_G$) for two days at 150 rpm and room temperature (approx 30 degrees). 1 % pcv / v of the biomass was added to 25 ml of mine tailings taken in a measuring cylinder. Control without culture was also maintained. The contents of both the cylinders were throughly mixed for 10 seconds. The cylinders were then kept stationary and the rate of sedimentation was monitored at 5 minute intervals for 30 minutes; the absorbance of the supernatant was then measured at 415 nm.

### Effect of some parameters on sedimentation

i) Mycelial biomass requirement : The optimum ratio of mycelial biomass to mine tailings required was examined using 0-2 % pcv/v in the experiment as detailed above.

ii) Treatment of mycelia : Fungal mass was subjected to a) Homogenization by grinding with a mortar and pestle, and b) Heat drying at 60°C for 40 minutes, the dried mycelium was then powdered. Sedimentation by the treated mycelia was monitored as above, with a control using untreated mycelium.

iii) Storage age of mycelia : The culture was grown in $M_G$ medium and the mycelial biomass obtained was filtered, and stored at 4°C. On 0, 3$^{rd}$. 6$^{th}$ and 9$^{th}$ day the stored mycelial aliquote was used for sedimentation of mine tailings as above.

## RESULTS AND DISCUSSION

When *Fusarium solani* mycelial biomass was added to the mine tailings, sedimentation and clarification was achieved within 30 min, as seen in Fig. 1, the absorbance at 415 nm of the clarified water column after 30 minutes was 0.021. The control sample of the tailings in absence of mycelium took 7 days to sediment, and the absorbance of the supernatant was 0.543. This shows that the clarity of the supernatant water was much better when the mycelial mass was added as compared to the control. This is corroborated by the results of Deshpande (1990) wherein it has been shown that sedimentation of mine tailings using biomass is more efficient as

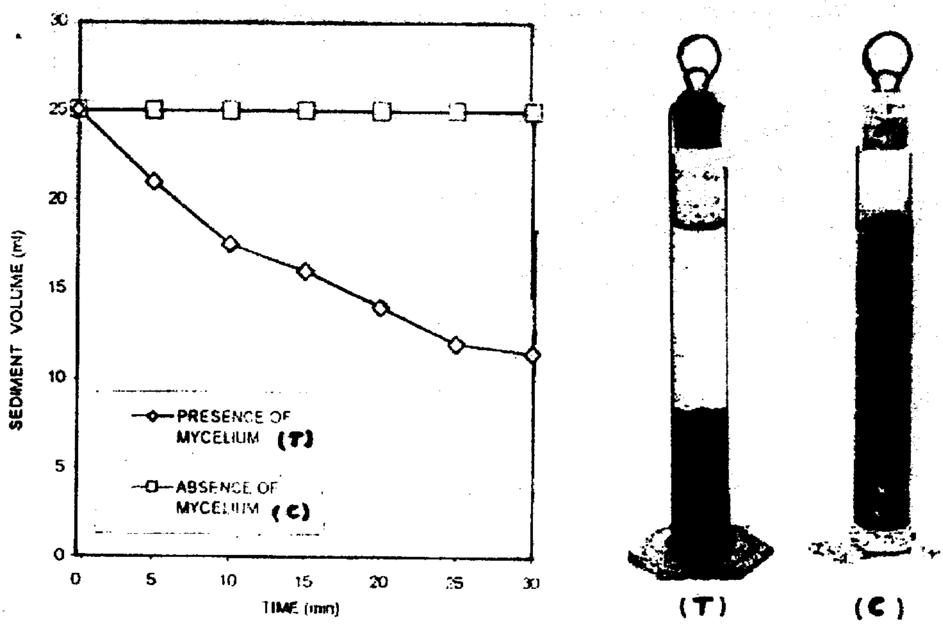
SEDIMENT VOLUME (ml)
TIME (min)
PRESENCE OF MYCELIUM (T)
ABSENCE OF MYCELIUM (C)
(T)
(C)

Fig. 1

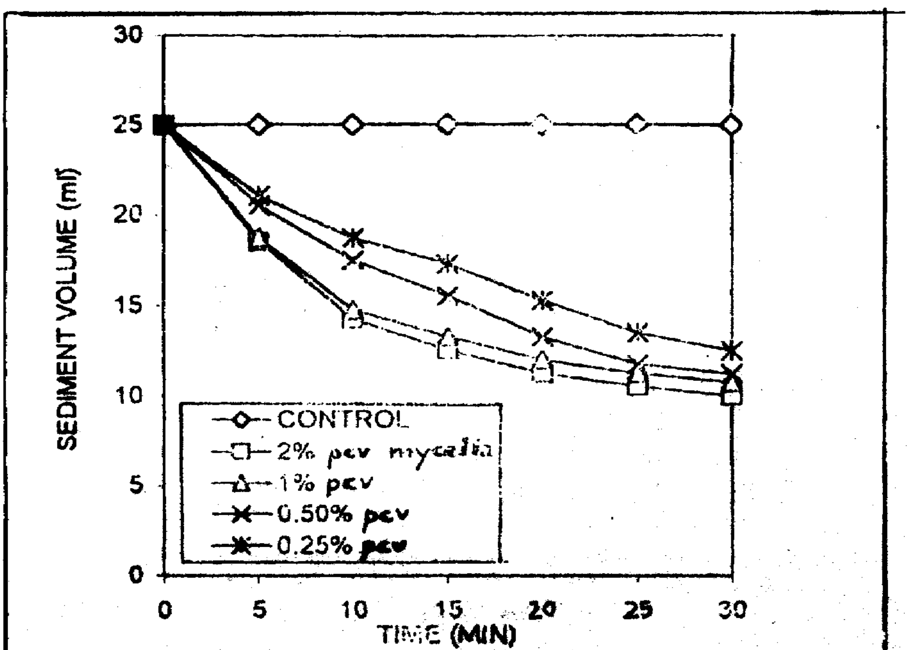
SEDIMENT VOLUME (ml)
TIME (MIN)
CONTROL
2% pcv mycelia
1% pcv
0.50% pcv
0.25% pcv

Fig. 2

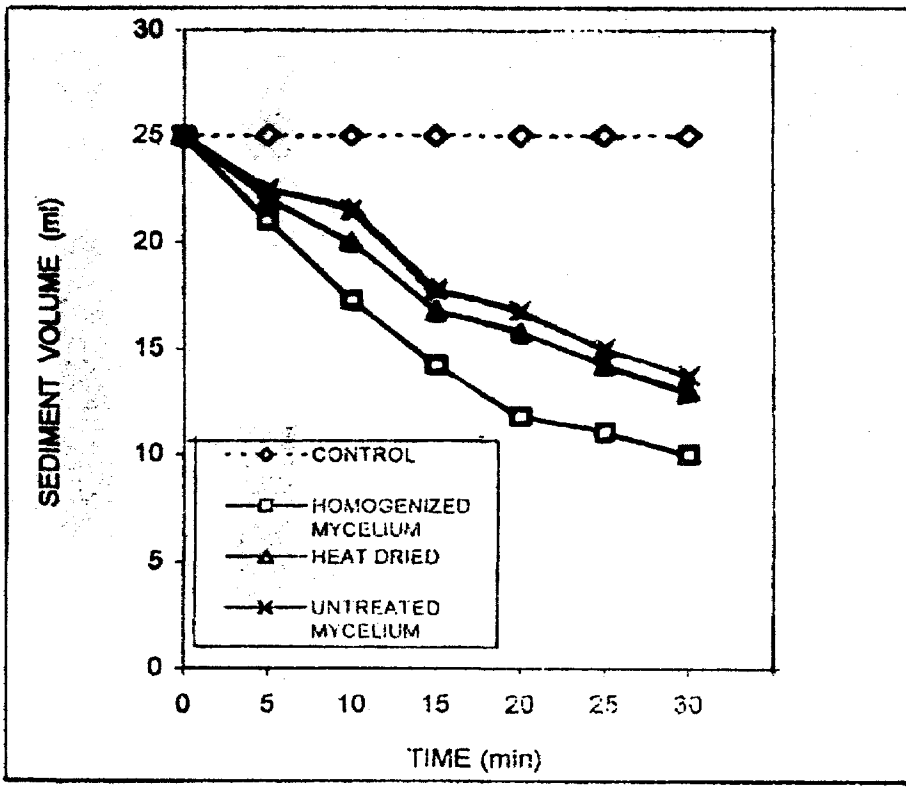
30
25
20
15
10
5
0
SEDIMENT VOLUME (ml)
0
5
10
15
20
25
30
TIME (min)
CONTROL
HOMOGENIZED MYCELIUM
HEAT DRIED
UNTREATED MYCELIUM

Fig. 3

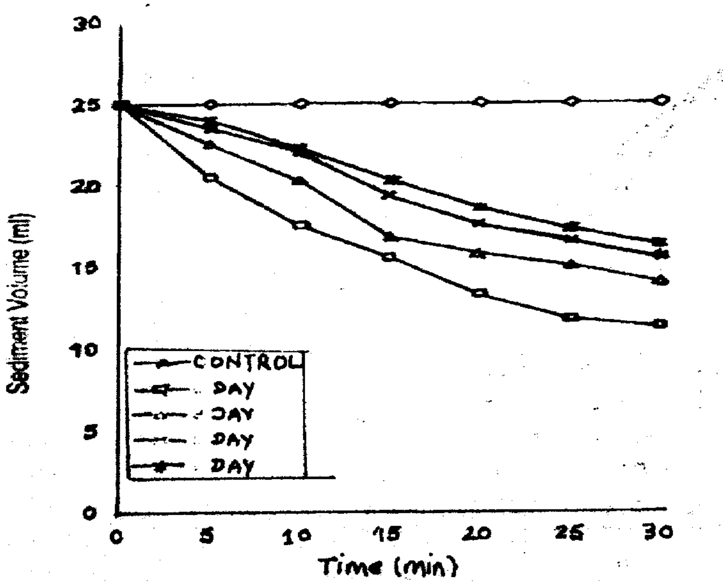
30
25
20
15
10
5
0
Sediment Volume (ml)
0
5
10
15
20
25
30
Time (min)
CONTROL
DAY
DAY
DAY
DAY

Fig. 4

compared to lime sedimentation as well as natural sedimentation. It has also been reported (Jackson, 1978) that metal concentrations in surface waters polluted by mining and smelting were lowered by microbial processes.

The sedimentation rate increases proportionately with increase in mycelial mass, upto 1 %; the use of 2 % mycelial mass yielded only a marginal incease in sedimentation rate (Fig. 2). Therefore a ratio of 1% biomass to mine-tailings ( pcv/v ) is sufficient for an efficient sedimentation and clarification of mine-tailings. It has been shown that the mycelial mass of *Fusarium solani* yielded an efficient sedimentation, when used at a lower proportion to mine tailings than was required for sedimentation with *Bacillus* and *Arthrobacter* (Deshpande, 1990). The sedimentation by *Fusarium solani* is also seen to be at a much higher rate than that achieved by bacteria, as reported by Deshpande (1990).

It was observed that the sedimentation rate increased significantly when the mycelial mass was homogenized as compared to untreated mycelia ( Fig. 3 ). Biological compounds mostly act by reducing the charge carried within the ionic atmosphere surrounding each solid particle. Due to electrostatic attraction the particles come together and sediment (Young 1982). Homogenization of the mycelia would result in increase in the surface area and hence a grater number of active sites may be exposed.

Sedimentation rate was lowered when dry heat-treated, powdered mycelium was used (Fig. 3) From this, it may be concluded that some of the components involved in sedimentation are heat labile. However the use of dried mycelium has the advantage of a longer shelf-life. In addition, toxicity of the metals in solution cannot affect the adsorptive function of the biomass. Furthermore, maintenance of the purity of the culture is not a concern (Tsezos, 1990).

Sedimentation rate by mycelia stored at 4°C was found to gradually decrease with increase in storage age as seen on the 3rd, 6th and 9th day after harvesting (Fig. 4). This indicates that as the rate of sedimentation was not greatly reduced within this period of storage, the mycelial mass could thus be stored and used over a longer period of time with reasonable effectiveness.

From the results obtained, it is seen that sedimentation of mine tailings by *Fusarium solani* is an extremely efficient system.

It is rapid even with an extremely small mycelial mass. The use of *Fusarium solani* biomass has an advantage in that it may be used as a dried powder.

Very little work has been done in this regard, and the use of such systems offers much potential for the future.

## ACKNOWLEDGEMENT

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