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ISOLATION OF FUNGI FROM FOUNDRY SOIL FOR BIOMINERALIZATION

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Abstract: Solid waste management has become one of the global environmental issues, as there is continuous increase in industrial by-products and waste materials. Due to lack of land filling space and its ever increasing cost, utilization of waste material and by-products has become an attractive alternative to disposal. The beneficial use of such by-products in construction materials results in reducing the cost of construction materials' ingredients and also helps in reducing disposal problem. Waste foundry sand (WFS) is one of such industrial by-product which could be used in construction materials. The leachate obtained from such materials may contain hazardous compounds, which may possibly effect the environment. Leaching characteristics are essential in understanding the environmental impact or toxicity, disposal and potential development of beneficial applications of WFS. This paper reports on isolation of fungi that produces organic acid for the demineralization on WFS and the development of fungal treated sand for concrete properties.
Keywords: Solid waste management, waste foundry soil, fungi.

INTRODUCTION

Foundries use high-quality size specific silica sands for use in their molding and casting operations. The raw sand is normally of a higher quality than the typical bank run or natural sands used in fill construction sites. In the casting process, molding sands are recycled and reused multiple times. Eventually, however, the recycled sand degrades to the point that it can no longer be reused in the casting process. When it is not possible to further reuse in the foundry it is removed from the foundry and termed as waste foundry sand (WFS). Some foundry dusts have been found to have higher concentrations of metals relative to sand (Winkler and Bolshakov, 2000). Heavy metals are common environmental pollutants that are released in WFS as a result of casting in metal foundries. These include chromium, cadmium, mercury, lead, nickel, arsenic and silver (Ji *et al.,* 2000). These heavy metals as well as their compounds are toxic to living organisms.

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Waste foundry sands represent the highest amount of solid wastes generated by foundries. The high cost of land-filling and the potential uses of waste foundry sand in construction purposes have prompted research into their beneficial reuse. With increased restrictions, industries are constrained to find alternative ways to reuse waste. Now days, the use of microorganisms for recycling of foundry sand is increasing. Three principles are mainly observed on mineralytic effects of bacteria and fungi, namely acidolysis, complexolysis and redolysis. A series of organic acids are formed by fungal (as well as bacterial) metabolism resulting in organic acidolysis, complex and chelate formation. A combination of all three mechanisms might be responsible for metal solubilization, often termed "bioleaching" (Ledin M., Pedersen, 1996; Brandl, 2001). The use of recycled product has been increased worldwide due to conserving resources as well as reduction in fund available for the concrete of construction. The upcoming days make challenges for civil engineers for the utilization of the recycled solid waste and by-products for the basic properties of concrete and its materials.

Fungi are ubiquitous in natural environment and more than 70,000 species of fungi have been described. Some estimates suggest that 1.5 million species may exist (Hawksworth and Mueller, 2005). The filamentous fungi isolated from heavy metal contaminated soil such *Aspergillus* and *Pencillium* has high level of resistance to a number of metals which makes them attractive potential candidates for further investigations regarding their ability to remove metals from contaminated waste water (Ezzouhri *et al.,* 2009).

Bioleaching may be defined as an interaction between microbes and metals that causes the solubilization of metal, and is based on the ability of microorganisms to transform solid compounds, thus resulting in soluble and extractable elements (Brandl et al., 1997). The bioleaching is based on three principles, namely (i) the transformation of organic or inorganic acids (protons); (ii) oxidation and reduction reactions; and (iii) the excretion of complexing agents. Metals can be leached either directly (i.e., physical contact between microorganisms and solid material) or indirectly. The present study described the isolation of fungi from WFS based on their ability to produce organic acid and cacite formation; to mineralize WFS and to analyse its ability for the production of bioconcrete.

MATERIALS METHODS

SAMPLE COLLECTION

Foundry Soil sample was collected foundries in and around the Coimbatore for isolation of fungi.

ISOLATION OF FUNGAL CULTURE

Potato dextrose agar (PDA) was used for the isolation of fungi. The soil sample was processed with isolation procedure using the soil dilution plate method. Petri plates were incubated at 28^{0}C for 4 days. After incubation distinct colonies were counted and re-cultured for purification. The cultures were maintained on PDA slants at 4 ^{0}C.

QUALITATIVE ESTIMATION OF ORGANIC ACID

Isolated cultures were subjected for screening of organic acid production following the of (Abin *et al.,* 2002) modifications procedure

FUNGAL TREATMENT OF WASTE FOUNDRY SANDS

For Fungal treatment, WFS was spread in plastic tray in specific manner (layers) for proper spread of fungal mycelium. For this, 1 cm thick layer of WFS was made as bottom layer and it was drenched with water.

Five days grown fungal culture was used inoculate WFS and spore count was performed using Haemocytometer (1.9 x 10^7 spores/ml).

STUDY OF CONCRETE PROPERTIES

Concrete cubes having size 150 mm x150 mm x 150 mm using concrete mixture without WFS (Control), concrete mixture containing WFS (1%) and 10, 20 and 30 days fungal treated WFS of as partial replacement of fine aggregate.

RESULTS AND DISCUSSION

Four fungal cultures were isolated from foundry soil (Fig. 1). Fungal cultured were observed for structure of hyphae, shape and structure of conidiophores, color, and pattern of conidia under compound microscope.

Microscopic studies of showed that fungal hyphae were septate, hyaline and slightly brown in color. Conidiophores were found to be long with smooth walled biseriate large size globose vesicle. Metulae and phialides were found to cover the entire surface of vesicle and conidia were brown to black in color (Fig. 2).

Screening of fungal cultures was done by acid producing capacity of fungal isolates. In this, fungal cultures were inoculated on broth containing Bromocresol purple 28 °C for 2-3 days for the appearance of blue color in the broth. This medium is basically used as pH indicator in which reduction in pH is indicated by change of deep blue color to yellow color.

S1 were able to acidic metabolite production as it produced yellow color and S2, S3 and S4 showed bluish yellow color on medium containing Bromo - cresol blue (Fig. 3). The formation yellow color around the fungal colonies on broth containing bromocresol blue indicates the production of organic acid by fungal culture when sucrose was provided as carbon source. The presence of organic acid produced by fungal cultures changed from blue to yellow due to pH reduction. Similar results were observed by (Gutarowska and Czyrowska, 2009). This finding is in line with previously reported studies (Kaur *et al.,* 2012) that *Aspergillus niger and Eupenicillium crustaceum* were the dominant fungi in Foundry located soil.

WFS were treated with fungal culture of S1 (1.9 x 10^7 spores/ml) and it was incubated at room temperature for 30 days. The treated WFS ((Fig. 4) were collected at the interval of 10 days and it was used to cast the cubes with concrete for further studies.

Cubes (Fig. 5) were made using concrete mixture without WFS (Control), concrete mixture containing WFS (1%) and 10, 20 and 30 days fungal treated WFS of as partial replacement of fine aggregate (1%).

CONCLUSION

Four fungal cultures were isolated from foundry soil were screened out as high acid producers as compared to other isolates. Morphological and microscopic characteristics of fungal isolates were found by Lacto phenol cotton blue staining. It was studied on the effects of incorporating fungal treated waste foundry sand (WFS) on concrete. Future study focuses on analysis of casted bricks.

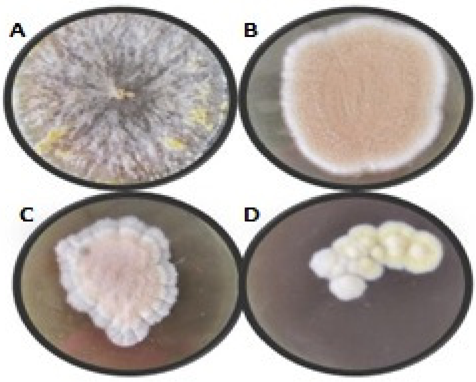

Fig. 1. Isolated cultures from soil sample

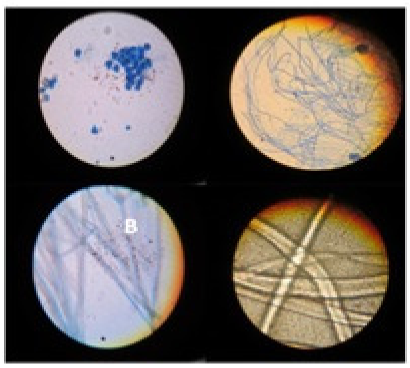

Fig. 2. Lacto phenol cotton blue staining

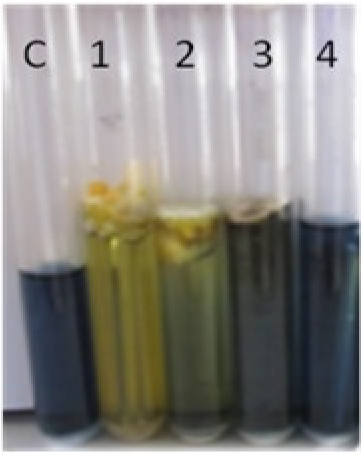

Fig.3. Organic production by selected fungal cultures (C- Control; 1-4 isolated culture)

Fig.4. Different days of fungal treated WFS

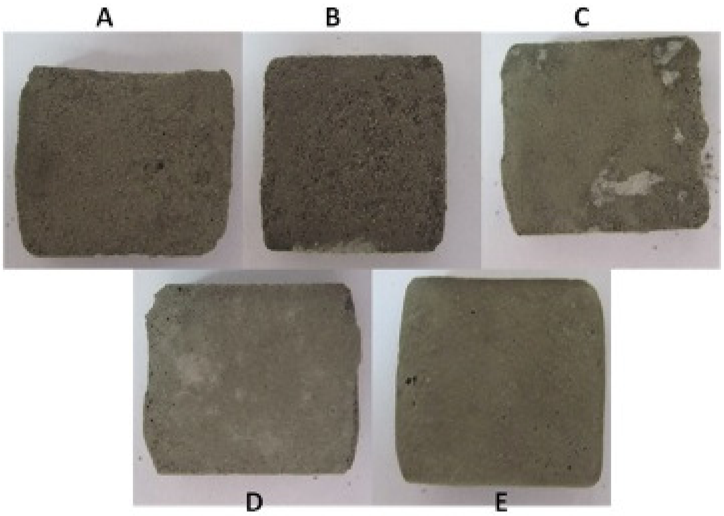

Fig.5. Casting of Concrete Cubes
(A-10 days, B- 20 days and C- 30 days of fungal treated WFS;
D-untreated WFS 1%: E- Control)

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