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Full Length Research Paper

Efficiency of A*spergillus niger* in Reducing Certain Physicochemical Parameters of Coffee Effluent

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Abstract
This research is an attempt to characterize fungal strain isolated from coffee processing waste water and to study its effect on coffee processing waste water treatment. The physico-chemical properties of the raw coffee processing wastewater were found to be very high. The present study aimed to determine the efficiency of Aspergillus niger in the degradation of certain parameters of coffee processing effluent. The results proved that Aspergillus niger shows significant reduction in all the parameters.

***Key words**: Biodegradation, Coffee effluent, Physicochemical parameters.*

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Introduction

Coffee is one of the most popular beverages consumed throughout the world. It belongs to the family Rubiaceae. *Coffea arabica* and *Coffea robusta* are the two principal varieties of the genus cultivated all over the world for commercial purpose (Padmapria *et al*., 2015). Chikmagalur district of Karnataka state is one of the major coffee producing regions in India, having a number of small-scale coffee pulping plants. Coffee processing plants produce very highly polluted wastewater, because coffee processing plants consume significant quantity of water and produces large amount of wastewater that contains high concentration of organic matter, nutrients, suspended matter and highly acidic wastewater (Tekle *et al*., 2015 and Samanvitha *et al.,* 2013). This effluent if discharged into natural water bodies without treatment pollutes by depleting dissolved oxygen present in it (Daivasikamani *et al.,* 2014). Pollution of natural water bodies will have an adverse effect on domestic users, aquatic life, livestock and coffee processing units in the downstream (Dejen *et al*., 2015). The problem of water pollution will be aggravated in coffee tracts because the processing period coincides with dry season when the flow in natural water bodies will be at minimum level. The studies conducted from time to time on quantum of effluent generated and pollution load in it have revealed that around 12,000 to 60,000 liters and 18,000 to 70,000 liters of effluent was produced for every tone of Arabica and Robusta coffee processed respectively (Daivasikamani *et al.*, 2014). In coffee producing regions of Western Ghats (e.g. Chickamagalur district, Karnataka state) these effluents have resulted in large environmental problems, creating the need for low cost technologies for the treatment. The most effective means of controlling water pollution results from bioremediation. In the present study, potential application of *Aspergillus niger* for the coffee effluent treatment has been investigated. *Aspergillus niger* is one of the most common species of the genus *Aspergillus* which is easily identifiable with its white to yellow mycelial culture surface later bearing black conidia. This species is very commonly found in coffee effluent and it shows excellent pollutant removal capabilities.

Materials and Methods

Study area

The effluent for the study was collected from Central Coffee Research Institute Balehonnur, Chikmagalur District of Karnataka state, India.

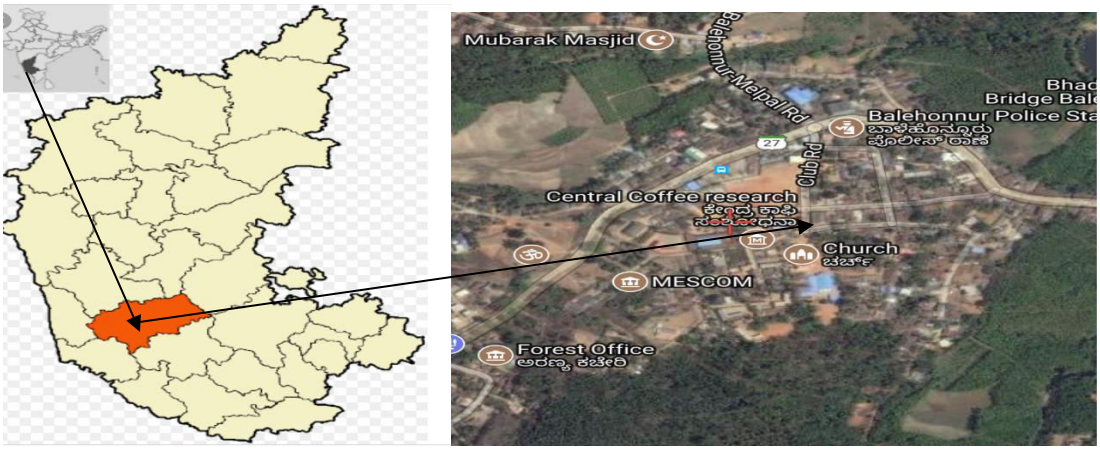

Fig 1: Location map showing the collection point of the coffee effluent.

Collection of samples and Analyses

The samples for the analyses were collected from the coffee processing unit and stored at 4°C in the laboratory. Standard methods (APHA, 2009) were used for analyses of physico-chemical parameters of the coffee processing effluent. The physico-chemical parameters analysed were total dissolved solids, BOD and COD.

Isolation and Characterization of Fungi

Aspergillus niger was isolated from the effluent sample by serial dilution method on Potato Dextrose Agar (PDA) medium. The colonies on PDA plates were identified based on their morphology and reproductive structural characteristics (Nagamani *et al*., 2006). Isolated pure cultures were maintained on PDA media and stored at 4^0C.

Experimental design for Treatment

The effluent was diluted to different concentration in order determine potential degradation efficiency of the organism. Raw effluent is designated as 100% concentration and it is diluted to three different concentrations viz. 25%, 50%, 75%. The effluent was filtered using Whatman No 1 filter paper and nine days old isolated *Aspergillus niger* was inoculated into the conical flask containing 250ml of respective concentrations of coffee waste water. The effluent treated without introducing *Aspergillus niger* is kept as control. The anaerobic treatment under aseptic condition was maintained in laboratory scale and treatment was conducted for a period of seven days in triplicates.

Results and Discussion.

Results are expressed as mean±SE. The statistical analysis was carried out using one-way ANOVA followed by Tukey's t-test. The difference in mean values at $p<0.05$ were considered as statistically significant. Statistical analysis was performed using ez ANOVA 0.98 version. The color of the raw coffee effluent was dark brown before treatment, with very high TDS, BOD and COD values. After treatment with *A.niger* the color became pale yellow. Effluent having objectionable odor was almost reduced after treatment. The temperature coffee effluent remained same before and after treatment. Initial acidic pH was reduced to near neutral after treatment. Treatment of coffee waste water using *Aspergillus niger* has shown remarkable degradation of listed parameters which is statistically significant and results are tabulated in Table 1.

Total dissolved solids (mg/L) after treatment was reduced gradually by 82.10% in raw effluent, 83.13% in 75% concentration, 85.22% in 50% concentration and 89.29% in 25% concentration where as in control 16.13% reduction of total dissolved solids was observed (Figure.1). BOD was reduced to 86.08% in raw effluent, 87.79% in 75% concentration 89.62% in 50% concentration and 91.58% in 25% concentration where as in control 18.68% reduction was observed (Figure.1). Reduction of COD (mg/L) in the effluent was 77.82% in raw effluent, 80.75% in 75% concentration, 83.75% in 50% concentration, 84.76% in 25% concentration and in control COD was reduced to 11.4 % (Figure.1). The reduction of all the listed parameter showed by 25% concentration>50%concentration>75%concentration>raw waste water>control (Figure 1). It is clearly evident that *A.niger* has shown appreciable degradation efficiency and performed well in 25% concentration of the effluent. This indicates dilution enhances the potential degradation of coffee waste water. In raw effluent, the high concentration of organic loads may have reduced the efficiency of organism in the treatment.

Conclusion

It is concluded from the present study that the coffee effluent generated from coffee processing unit presents a serious threat to the natural water bodies. The parameters studied i.e. total dissolved solids, BOD and COD were much higher than the prescribed limits.

The results revealed that the fungus *Aspergillus niger* is efficient in reducing the concentration of certain parameters. The study establishes the potential use of *A. niger* in making the effluent cleaner after treatment and hence *Aspergillus niger* is recommended for the treatment of coffee wastewater.

Table 1: Concentration of the effluent parameters after treatment with *Aspergillus niger.*

Parameters	Raw	75% concentration	50% concentration	25% concentration
TDS(mg/L)	1002.5±0.26**	895.3±0.17**	691.43±0.29**	302.3±0.29**
BOD(mg/L)	200.3±0.17**	150.46±0.14**	120.7±0.25**	60.46±0.29**
COD(mg/L)	632.73±0.43**	433.83±0.26**	289.26±0.17**	203.06±0.56**

*Key: (mg/L) = milligram per liter. Values are expressed as mean ± SE (n=3), *p<0.05; **p<0.01, denotes significance with respect to initial values using one-way ANOVA followed by Tukey's test.*

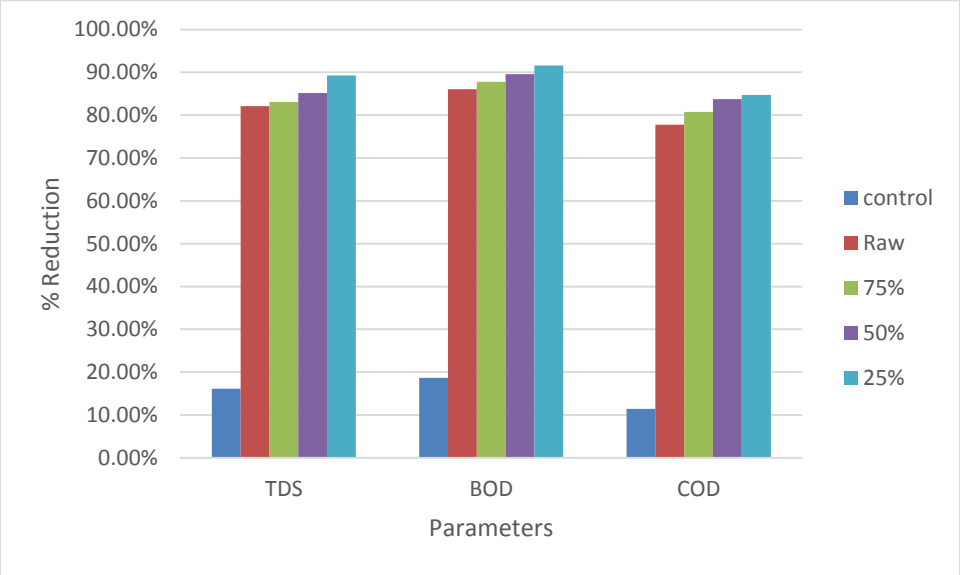

Fig 2: Reduction percentage of TDS, BOD and COD in 25% concentration, 50% concentration, 75% concentration, raw and control of the effluent.

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