A Biological Treatment for Color Removal in Distillery Effluents

L.M.L. Dilini, M.M.S.N. Prematihilake *and* D.T. Udagedara
Uva Wellassa University, Badulla, Sri Lanka

Introduction

Distilleries are one of the industries generating enormous amount of wastewater which is about 10–15 L of effluent for the production of 1 L of alcohol. The fermentation of carbohydrates present in molasses is carried out by yeasts, which yields ethyl alcohol. The pH of the raw molasses is adjusted to 4 - 4.5 to prevent bacterial growth and then fermented liquor containing alcohol is degasified and alcohol is separated, leaving behind the waste called "spent wash". The spent wash is the major polluting waste of the distillery, which has very high Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) values. The COD often crosses a value of 1×10^{5} mgL^{-1} and BOD reaches 7×10^{4} mgL^{-1} (Goel, 2006).The waste is dark brown in color due to caremalization of some sugar. It also contains nearly 2% of the dark brown recalcitrant pigment called melanoidin, which does not get degraded easily by microorganisms, posing a great difficulty in its removal. Molasses has very high quantity of fermentable sugars. These sugars react with amino acids and undergo Maillard reaction and then polymerize to form melanoidin, which is a major color containing compound in the distillery effluent. Putrescible organics like skatole, indole and other sulfur compounds produces obnoxious smell in the effluent and when it comes in contact with high temperature, becomes more toxic to aquatic biota. The waste has substantial quantities of dissolved solids and suspended solids with high quantity of nitrogen, which can reach up to 2000mgL^{-1}. The pH of spent wash remains in the acidic range varying from 3 to 5.4 (Goel, 2006). The distillery waste also has high quantities of potassium along with sulphates.

Melanoidin containing distillery effluents require pretreatment before safe disposal into the environment, because the direct disposal causes serious soil and water pollution by inducing coloration and eutrophication problems in aquatic environments- which leads to reduction of sunlight penetration in water bodies. Additionally, it in turn decreases both photosynthetic activity and DO concentration affecting the normal life cycle of aquatic fauna and flora (Goel, 2006). Further, it causes reduction in soil alkalinity, inhibition of seed germination and damage to vegetation upon land disposal. Treatment of distillery wastewaters by physical or chemical methods was found not feasible due to the high cost and generation of secondary pollutants. But compared to them biological treatments are more economical and environmental friendly. Many fungi species have the ability of removing color from wastewaters. Especially white rot fungi exhibit extensive bioremediation activities that are mainly based upon their capabilities to produce extracellular lignin modifying enzymes (Pant and Adholeya, 2007). In this research we studied several white rot fungi activity towards decolorization of distillery effluents.

Methodology

Ten *polyporusbasidiomycetes* white rot fungi species were collected for distillery waste water treatment from Matara area.Effluent was collected from Pelwatte distillery inButtala. Effluent was dark brown in color, semi liquid and a dense material. About 5mm squares were cut from collected basidiocarps and placed on PDA plates and were incubated for 7 days. Among them, five fungal species were selected for the experiment due to their rapid growth.

Above efficiently growing five fungal specieswere isolated using streak plate method. Streaked cultures were incubated again for 7 days.Then, using these cultures new plates were prepared by spread plate method incubatingagain for seven days.

Liquid broths were prepared for five fungi species using Potato Dextrose. 5mm x 5mm mycelium plugs of isolated cultures were added to them. 23µL (concentration 1000 ppm) of distillery effluent were added to each liquid broth. Three replicates of each sample were prepared. The absorbance was measured using UV spectrophotometer after 5 days of incubation within the 7-dayincubating period. General Linear Model and Completely Randomized Design were applied for statistical analysis.

Results and Discussion

Data were statistically analyzed with General Linear Model in order to understand effect of fungal species and time on color reduction of the effluent. Both fungal species and time were variables for color reduction. According to the above general linear model data, both P values of time and fungus were 0. Having a P value less than 0.5 indicates that there is aneffecton both time and fungal species type for color reduction.

All five fungal species had reduced the color after five days of their growth probably due to their enzymatic reactions. Among them fungal species 'C', tentatively identified as *Lenzites botulin* is the most efficient color reducing species.

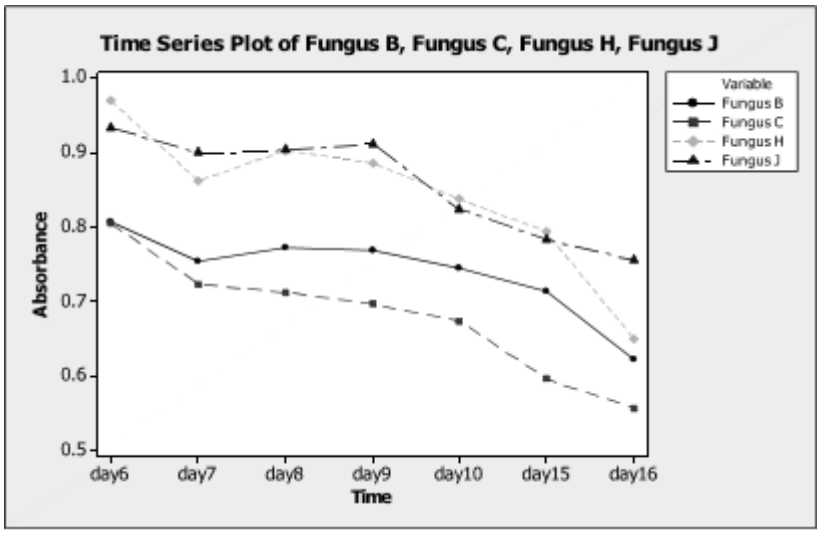

Figure 1. Absorbance reducing of different fungal species with time.

According to the Beer- Lambert law,
A= abc (Absorbance proportional to concentration)

This equation shows the linear relationship between absorbance and concentration of an absorbing species.
Color reducing percentage of fungal sp. C is,
(1.543-0.556) = 0.987
(0.987/1.543*100) = 64%

Conclusions

The color of distillery effluent wastewater was reduced by *PolyporusBasidiomycetes* white rot fungi which are commonly grown in decaying woods. The most efficient color reducing fungal species was fungal "C" (*Lenzites botulin*). It reduces the color gradually by fungal enzymatic

activities due to fungal growth with the time. Efficiency of color reducing rate changes with different fungal species according to the time.

References

Goel, P. K., 2006. Water pollution causes, effects and control. Maharashtra, Karad-415124.

Pant, D., Adholeya, A., 2007. Enhanced production of ligninolytic enzymes and decolorization of molasses distillery wastewater by fungi under solid state fermentation. Biodegradation, 18(12), 647-659.