Bio treatment of Brewery Wastewater Treatment using Hycura

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Abstract

This study focused on the investigation of bio treatment of brewery wastewater using engineered micro organisms like Hycura. Brewery wastewater was treated in a 10L tank over a 5 day period with Hycura loadings of 0.05 g/L. The wastewater chemical oxygen demand (COD), biological oxygen demand (BOD), pH, total suspended solids (TSS), total Kjeldahl nitrogen (TKN) and total phosphates (TP) were measured using standard methods on a daily basis. The ph of the brewery waste changed from alkaline to neutral during the treatment process whilst the COD reduced by 87%, BOD by 88%, TSS by 94%, TKN by 68% and TP by 81%. The effective bio treatment of the brewery wastewater is attributed to the metabolism of Hycura.

Keywords: BOD, brewery wastewater, COD, Hycura, TKN, TP, TSS

1. Introduction

Biological treatment of wastewater is becoming increasingly popular as a wastewater treatment option due to its simplicity and low cost especially in the beer production industry (Muilligan and Gibbs, 2003; Fillaudean et al., 2006). The beer production industry is one of the booming industries in Southern Africa. The beer production process which is shown in Figure 1 has several key stages such as malting, milling, mashing, wort preparation and fermentation. These stages utilise water such that at the end of the process a lot of wastewater is generated and it is reported that for every litre of beer produced an additional 10L of wastewater are produced (Bodike and Thatikonda, 2014). There is need for economically treating this wastewater for either possible reuse into the plant or end use in other industries such as the agricultural industry.

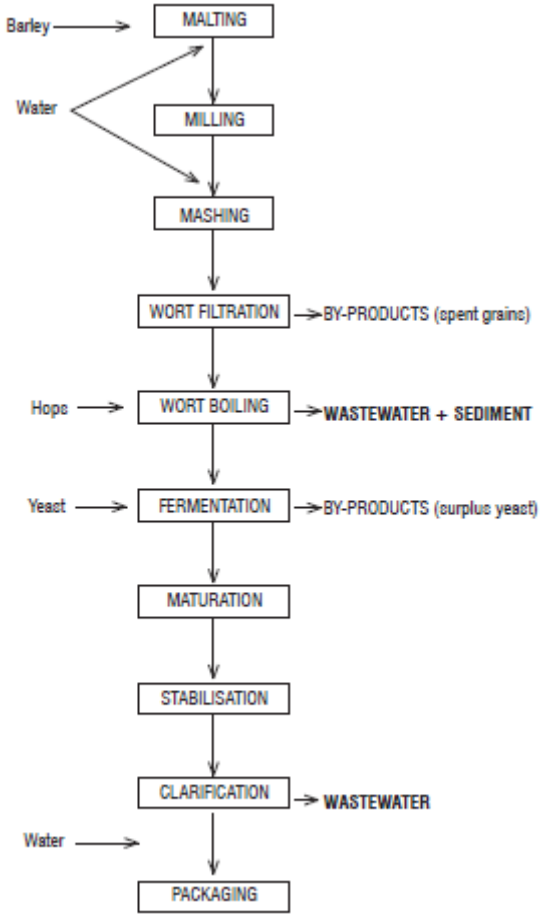

Figure 1. Beer production process (Varnam and Sutherland, 1994)

The quality of wastewater is mainly measured by its physicochemical parameters which include the chemical oxygen demand, the biological oxygen demand, the total suspended solids, pH, total Kjeldahl nitrogen and total phosphates. The chemical oxygen demand (COD) refers to the amount of oxygen that is used to oxidise both organic and inorganic pollutants found in wastewater. Biological oxygen demand (BOD) refers to the amount of oxygen required by micro organisms to oxidise soluble organic matter available in wastewater. High BOD values are an indication that less oxygen is available to plants and animals in the wastewater. Total suspended solids (TSS) refers to the amount of solids in suspension in wastewater and these can easily be consumed by bacteria. Total Kjeldahl nitrogen refers to the amount of organic nitrogen that is available in wastewater. Total phosphates (TP) refer to inorganic phosphate that is available in wastewater and normally exists as orthophosphate.

Recent studies have reported that application of micro organisms as bio inoculants enhance the wastewater treatment efficiency during process wastewater treatment (Nzila et al., 2016; Shah, 2017). Engineered catalysts like Hycura are becoming important as anaerobic biological wastewater treatment bio augmentation micro organisms due to their ability to enhance the removal of contaminants in wastewater. This study focused on investigating the potential of utilizing Hycura in the treatment of brewery wastewater water.

2. Materials and Methods

Brewery wastewater was obtained from a local brewery plant and afterwards anaerobic treatment of the wastewater was conducted in a 10 L vessel inoculated with 0.050 g/L of Hycura. Treatment was allowed to take place over a period of 5 days under anaerobic conditions and the resultant effluent was filtered. The raw brewery wastewater and the treated effluent were tested for total suspended solids (TSS), biological oxygen demand (BOD), total Kjeldahl nitrogen (TKN), pH and total phosphates (TP). The physicochemical parameters were measured in accordance to APHA (2005) wastewater parameters measurement methodologies. The COD, BOD, TSS, TP and TKN were measured in milligrams per litre (mg/L).

3. Results and Discussion

3.1 Brewery wastewater characteristics

The brewery wastewater was characterized by high COD, BOD and TSS concentrations of 1400 mg/L, 640 mg/L and 320 mg/L respectively. The characteristics indicated that biological treatment of the wastewater was possible. A summary of the brewery wastewater characteristics in comparison to the World Health Organization (WHO) guidelines for effluent disposal are shown in Table 1.

Table 1. Raw brewery wastewater properties

Parameter	Brewery wastewater	WHO Guidelines for disposal
COD	1400±100	125
BOD	640±31	30
TSS	320±10	50
TKN	40±3	10
TP	31±2	2
pH	10.4±0.1	6.0-9.0

*All values are in mg/L except for pH

3.2 Effect of bio treatment on brewery wastewater

3.2.1 Effect on COD

The brewery wastewater COD concentration decreased with increase in the retention time with an 87% decrease in COD being observed at 5 days (Figure 2). When Hycura was inoculated in the wastewater it allowed for the removal of bio contaminants has it fed on these pollutants resulting in a decreased COD. Jaiyeola and Bwapwa (2015) reported that the use of bio treatment in brewery wastewater treatment resulted in COD reduction ranging between 74-100%.

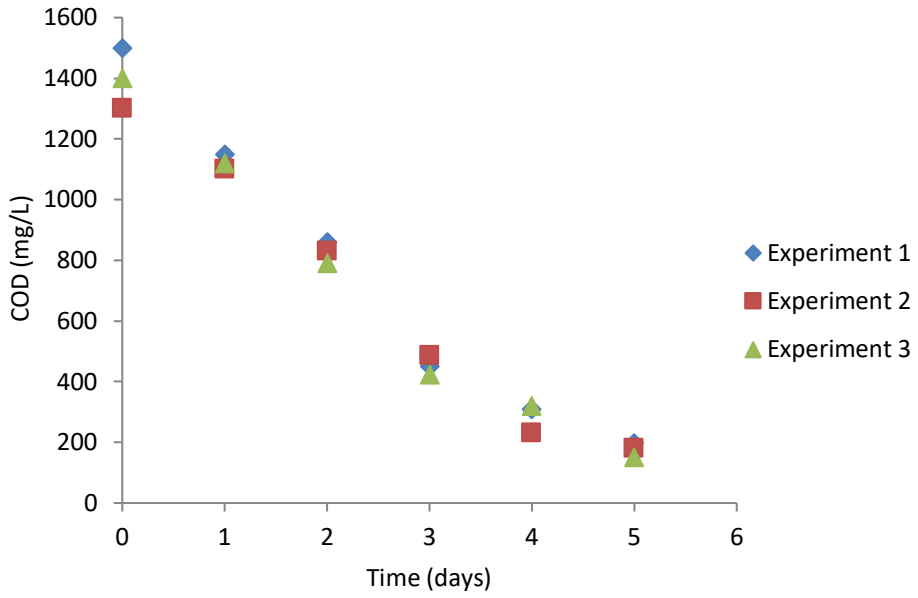

Figure 2. COD changes during brewery wastewater bio treatment

3.2.2 Effect on BOD

The BOD concentration in the brewery wastewater decreased with increase in the retention time with a reduction of 88% being observed (Figure 3). As Hycura was inoculated into the brewery wastewater, it stated to feed on the organic pollutants for its metabolic processes effectively reducing the BOD concentration in the brewery wastewater. BOD removal efficiencies ranging between 90-94% have been reported in other systems whereby bio treatment of brewery wastewater was employed (Sharda et al., 2013).

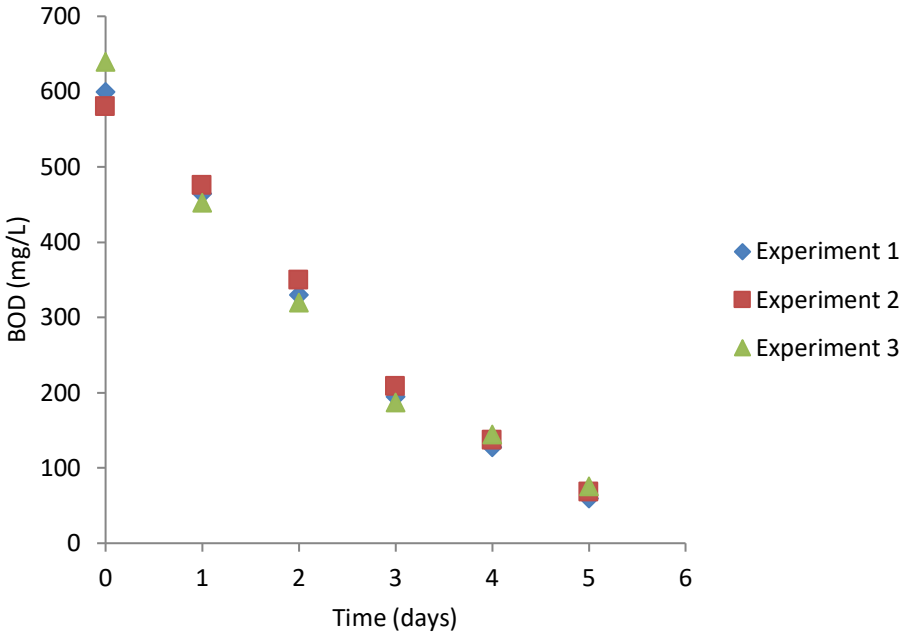

Figure 3. BOD changes during brewery wastewater bio treatment

3.2.3 Effect on TSS

The TSS concentration decreased as the retention time increases with a final increase of 94% being observed at day 5 (Figure 4). The TSS reduction can be attributed to the reduction in both the COD and BOD when the brewery wastewater was treated with Hycura as the inoculants micro organism.

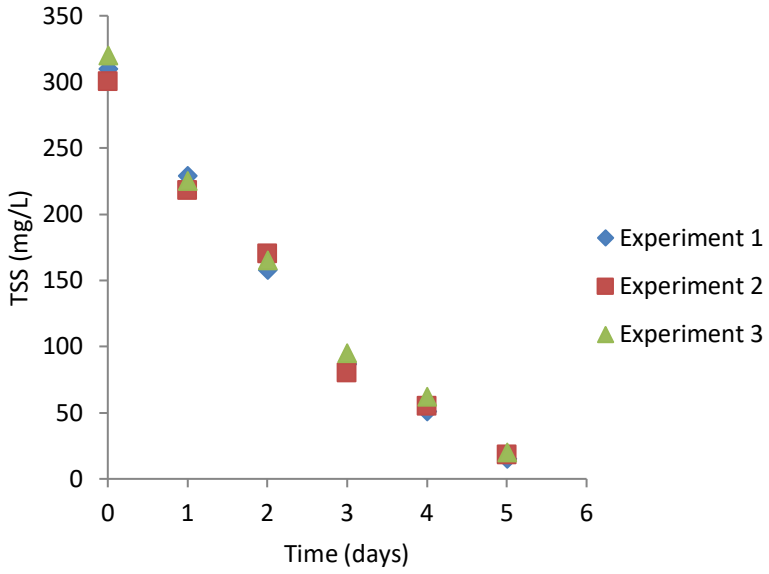

Figure 4. TSS changes during brewery wastewater bio treatment

3.2.4 Effect on TKN

The TKN concentration decreased significantly with increase in retention time of up to 5 days upon inoculation with Hycura as the bio treatment media (Figure 5). The TKN concentration reduced by 68% during the 5 day period. The reduction was attributed to the usage of nitrogen by Hycura during its metabolism during the wastewater treatment phase.

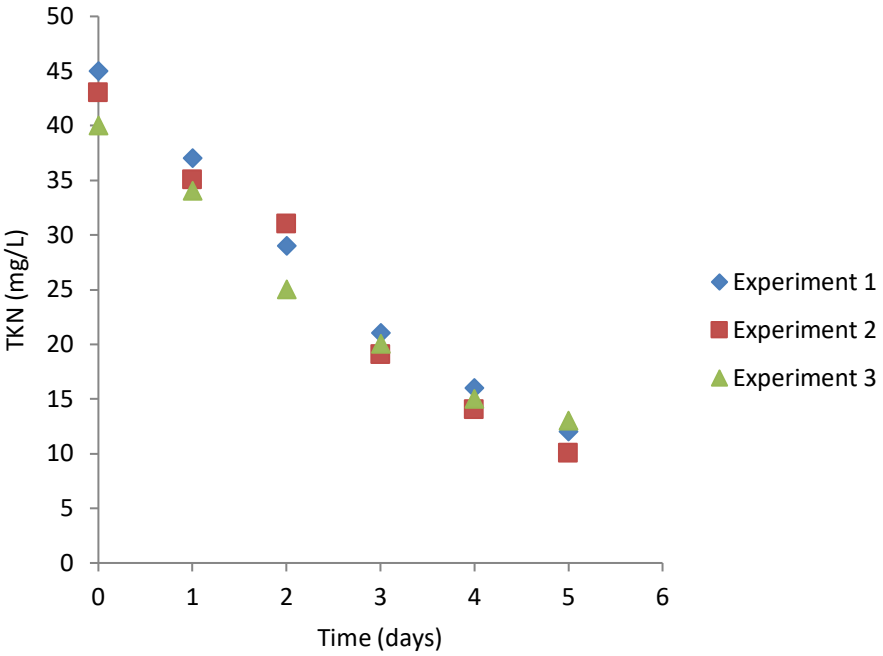

Figure 5. TSS changes during brewery wastewater bio treatment

3.2.5 Effect on TP

The TP concentration significantly reduced by 81% as brewery wastewater was treated using Hycura over a period of 5 days (Figure 6). Phosphate is one of the major nutrients that are required by micro organisms for growth and reproduction and this was the probable reason why phosphate concentration reduced when brewery wastewater was bio treated with Hycura.

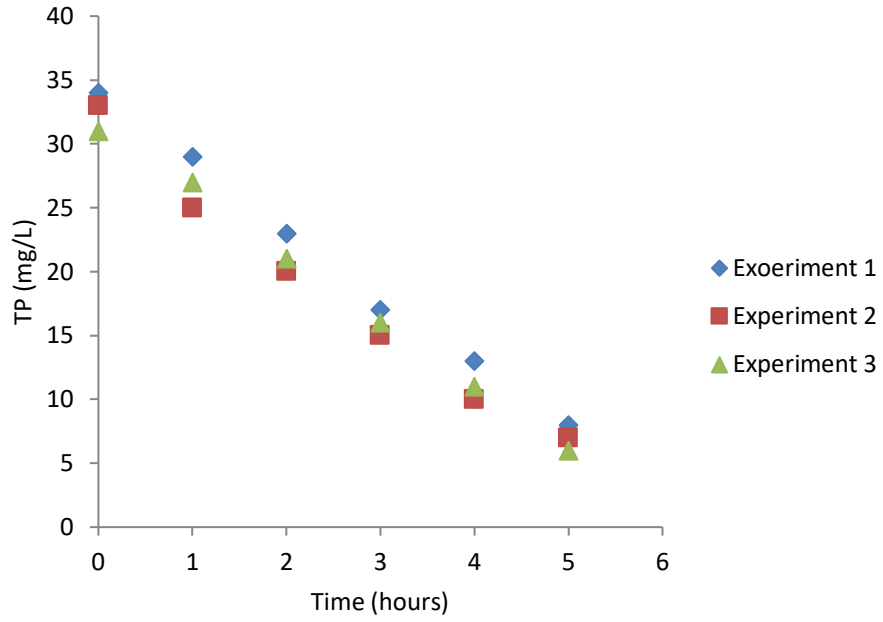

Figure 6. TP changes during brewery wastewater bio treatment

3.2.6 Effect on pH

The brewery wastewater ph changed from being alkaline to neutral upon bio treatment with Hycura over a retention period of 5 days (Figure 6). This behaviour can be attributed to the effect of bio contaminants removal in the brewery wastewater. Bodike and Thatikonda reported an almost similar trend in pH change when they used Pseudomonas Species as a bio treatment micro organism for brewery wastewater.

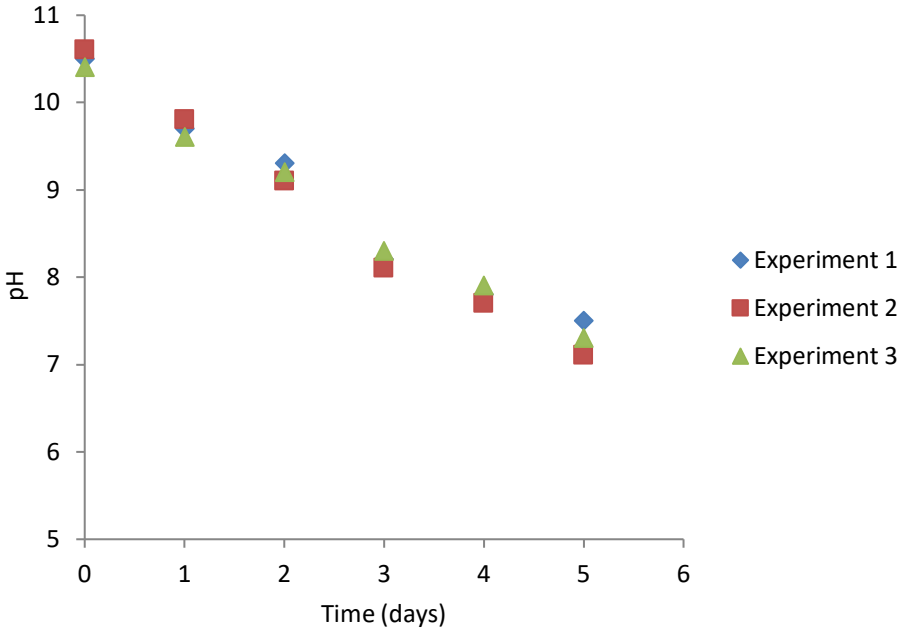

Figure 7. pH changes during brewery wastewater bio treatment

From the observation, it is noted that Hycura effectively treats brewery wastewater through the removal of bio contaminants. The TSS and pH were treated to the range of acceptable values by WHO, whilst the other parameters were slightly off. A summary of the characteristics of the bio treated brewery wastewater is shown in Table 2.

Table 2. Treated brewery wastewater properties in comparison to WHO guidelines for disposal

Parameter	Treated brewery wastewater	WHO Guidelines for disposal
COD	176±24	125
BOD	76±8	30
TSS	20±3	50
TKN	13±3	10
TP	6±1	2
pH	7.3±0.1	6.0-9.0

*All values are in mg/L except for pH

4. Conclusion

Bio treatment of brewery wastewater treatment using Hycura is an attractive option as a biological wastewater treatment option. The physiochemical properties of the brewery wastewater showed a significant decrease upon treatment with Hycura over a 5 day period. Reductions of more than 70% were reported for COD, BOD, TSS,

TKN and TP and they observed values were almost within the set guidelines for WHO effluent disposal guidelines.

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