Effect of fermentation time of mixture of solid and liquid wastes from tapioca industry to percentage reduction of TSS (Total Suspended Solids)

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Abstract. The waste from tapioca industry is as an organic waste that contains many important compounds such as carbohydrate, protein, and glucose. This research as aimed to know the effect of fermentation time from solid waste combined with waste-water from the tapioca industry to percentage reduction of TSS. The study was started by mixing the solid and liquid wastes from tapioca industry at a ratio of 70:30, 60:40, 50:50, 40:60, and 30:70 (w/w) with a starter from solid waste of cattle in a batch anaerobic digester. The percentage reduction of TSS was 72.2289 at a ratio by weight of the composition of solid and liquid wastes from tapioca industry was 70:30 after 30 days of fermentation time.

1. Introduction
The production of biogas from biomass is important due to the benefit from the environmental point of view and resulting renewable energy resources [1]. The raw material for biogas can derive from waste such as the wastes of tapioca industry where these wastes make environmental impacts, methane gas emissions, soil and ground water contamination and odor problem [2]. Therefore tapioca is one of the industries that generate enormous wastes of solid and liquid waste [3]. Both wastes (liquid and solid waste) from tapioca industry still contain a lot of carbohydrates, protein, and other sugar forms. Furthermore, the solid waste of tapioca industries itself still contains a lot of sugar compounds such as sucrose, glucose, fructose, dextran, galactose and nitric acid which is convertible into other products [4]. The purpose of this study was to determine the percentage reduction of TSS (Total Suspended Solids) due the time of fermentation. The raw material used was the mixture of solid waste combined with liquid waste from tapioca industry at several compositions. Then the mixture was fermented anaerobically.

2. Material and Methods

2.1 Preparation of Raw Materials
The raw materials which were solid waste and liquid waste were collect from tapioca starch factory in Sei Rampah – Sumatera Utara Province. The solid waste was mix with liquid waste before experiment at the ratio of 70:30, 60:40, 50:50, 40:60, and 30:70 by weight to create slurry. The initial pH of the slurry was 5 and then adjusted to 7 using buffer solution (Calcium Hydroxide) and initial TSS (Total Suspended Solid) was analyzed gravimetrically.
2.2 Inoculum, Batch Digester, and Operation

Fresh cattle manure was collected from a farm in Sunggal, Sumatera Utara Province. Sufficient water was added to cattle manure at a ratio of 1:1 by weight to produce the slurry which was used to inoculate test digesters with a five-days acclimation. The experiments were conducted in batch mode and an aerobic after inoculation. Schematic of anaerobic digester experimentation design layout is shown in figure 1.

![Figure 1. Schematic of anaerobic digester experimentation design layout](image)

After acclimation, the digesters were fed on a batch basis. Daily mixing was done to prevent a crust. The sampling of effluent was analyzed every 3 days until it reached the steady-state condition.

2.3 Analytical Methods

pH was measured using pH indicator, and TSS (Total Suspended Solids) were analyzed gravimetrically in the Research Laboratory of Chemical Engineering Department of USU.

3. Results and Discussion

TSS is one of the important parameters in industrial waste water treatment. On the figure below, the change of TSS value during the fermentation process in an aerobic digester.

![Figure 2. The effect of time fermentation to the reduction of TSS in several compositions](image)

Like the figure, that the longer time of fermentation resulting in the reduction of TSS because higher, although tended, fluctuated. The highest percentage of TSS reduction was achieved by the...
mixture of solid waste and liquid waste at a ratio of 70:30 at the day of 33 which was 76.2289 %. At a ratio of 60:40, the highest percentage of TSS reduction was 56.1495% at the day of 39, while it was 64.2857 % at the day of 33 at a ratio of 50:50. For the ratio of 40:60, the highest off TSS reduction was 68.6444 % at the day of 39 it was 55.4646 % for the ratio of 30:70 at the day 33. On the other hand, the volume of biogas resulted was optimum and constant at the day of 33.

The experimental result like the table below:

| Ratio of Solid Waste to Liquid Waste (w/w) | Day | TSS (mg/L) |
|------------------------------------------|-----|------------|
| 70:30                                    | 0   | 5208       |
|                                          | 33  | 1239       |
| 60:40                                    | 0   | 4976       |
|                                          | 33  | 2266       |
| 50:50                                    | 0   | 5180       |
|                                          | 33  | 1850       |
| 40:60                                    | 0   | 5326       |
|                                          | 33  | 2100       |
| 30:70                                    | 0   | 4832       |
|                                          | 33  | 3240       |

Theoretically, TSS is total solid which is resisted by a filter with a maximal particle size of 2 μm of bigger from colloidal particle size. The categories of TSS are sludge, clay, oxide metal, sulfide, algae, and bacteria. TSS is treated by flocculation and filtration in general. The negative impact of TSS due to its contribution to turbidity which can be affecting light to penetrate for photosynthesis process and visibility in the water body. Moreover, when the TSS in inlet flow is relatively high, they will need a longer time of hydraulic in a reactor for hydrolysis process by an anaerobic microorganism to become simpler compounds. Hydraulic time of 12-24 hours is not enough to hydrolysis and degradation process biologically of suspended solid in inlet flow. In this a case which was a batch process, the microorganism had enough time to degrade solids in waste. Therefore the efficiency of TSS reduction can be higher [5]. From the figure 2, it can be seen that there were fluctuate reduction.

It was because of the presence of intermediate products which could be limited the degradation process, the inhibition process in methanogens due to the higher unhydrolysed inhibitor like sulfide and inhibition due to the rise of free ammonia compounds [6]. According to the regulation by the Minister of State for Environment, the maximum of TSS for a liquid waste of tapioca industry is 50 mg/L [7]. Therefore the liquid waste of this industry cannot be thrown away to the environment. Otherwise, it should be used as liquid fertilizer or using adsorbent to diminish the TSS content.

4. Conclusion

TSS is treated by flocculation and filtration in general. The negative impact of TSS due to its contribution to turbidity which can be affecting light to penetrate for photosynthesis process and visibility in the water body. The highest percentage of TSS reduction was achieved by the mixture of solid waste and liquid waste at a ratio of 70:30 at the day of 33 which was 76.2289 %.

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