

# High Biogas production from Slaughterhouse Wastewater Treatment System of Mwanza in Tanzania by using rice straw under moderate operating conditions



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## Abstract

The study aims to improve the Biogas production from the slaughterhouse wastewater treatment plant of Mwanza by anaerobic co-digestion using rice straw as co-substrate. The experiment was carried out in batch mode with different carbon / nitrogen ratios (C / N ratio = 20: 1, 25:1, 30:1) at room temperature (20°C - 26. 4°C ). The Biogas analyzer, 5000 Geoth was used to analyze the composition of Biogas. The highest yield of methane-rich Biogas was obtained with a carbon/nitrogen ratio of 20:1. The Biogas yield has reached six times the amount released from the digestion of slaughterhouse wastewater without rice straw. Moreover, the addition of rice straw has shown great potential for the good treatment of slaughterhouse wastewater. Chemical Oxygen demand ( COD) was removed up to 75% at C/N ratio 20:1 while it was removed up 25% just for the digestion of slaughterhouse wastewater without rice straw addition. The results indicate that rice straw is a good co-substrate to get the appropriate carbon/nitrogen ratio (C/N ratio 20:1) for the performance optimization of the slaughterhouse wastewater treatment system of Mwanza in biogas production. Practically, it is recommended to use 51.2 kg of rice straw for 1m<sup>3</sup> of slaughterhouse wastewater for stable digestion to proceed and improve the biogas yield six times more under moderates operating conditions.

## Introduction

- ❖ Energy is the base of the economy for human development
- ❖ renewable energy resources including biogas are potential replenishing indefinitely and preserve the environment for future generation
- ❖ Biogas results from the anaerobic digestion of organic matter in the environment free of oxygen
- ❖ Anaerobic digestion proceeds in four phases such as hydrolysis, acidogenesis, acetogenesis, and methanogenesis and each step needs an appropriate typical group of microorganisms
- ❖ The lack of balance between nutrients, carbon, and nitrogen can interrupt the reactions that occur during the biogas production process.
- ❖ To assure the anaerobic digestion process stability, the values of all factors including the carbon/nitrogen ratio must be optimized.
- ❖ The composition of slaughterhouse wastewater resulting from its first pretreatment step is diluted blood, fat, suspended solids, and possibly some manure.
- ❖ The slaughterhouse wastewater composition leads to a high quantity of nitrogen and consequently to an imbalance of nutrients (carbon, nitrogen) into feedstocks.
- ❖ Rice straw is poor in nitrogen content which indicates the high value of carbon to nitrogen ratio

## Goal, Objectives & Aims

### Goal

- ❖ The Performance optimization of the slaughterhouse wastewater treatment system of Mwanza

### Aim

- ❖ Improvement of Biogas generation

### Objectives

- ❖ Anaerobic co-digestion of the slaughterhouse wastewater sampled from Mwanza plant
- ❖ The use of rice straw as co substrate with different mixing ratios to know the optimum value
- ❖ analysis of carbon and nitrogen content in slaughterhouse wastewater and rice straw
- ❖ Analysis of major constituents of slaughterhouse wastewater to know its characteristics
- ❖ Analysis of a gas generated to know the methane content in Biogas.
- ❖ Analysis of the impact of rice addition on COD removal at the end of experiment

## Materials & Methods

### Materials

- ❖ The Slaughterhouse wastewater has been sampled from the slaughterhouse wastewater treatment plant of Mwanza, Tanzania
- ❖ Rice straw samples were collected from the field in Kiyungi, Moshi, Tanzania

### Methods

- ❖ the use of batch digesters and the Water Displacement Method to measure a generated amount of biogas
- ❖ the Biogas composition analysis by BIOGAS 5000 Geotech analyzer
- ❖ C/N ratio analysis by using the Cornell composting Equation and CHNS-O Analyzer
- ❖ the main parameters in the Slaughterhouse wastewater and rice straw and the mixture analysis by using Digester DBR 200 HACH and Spectrophotometer DR 2800HACH, BOD oxitop Box, Digital pH- meter and a digital thermometer

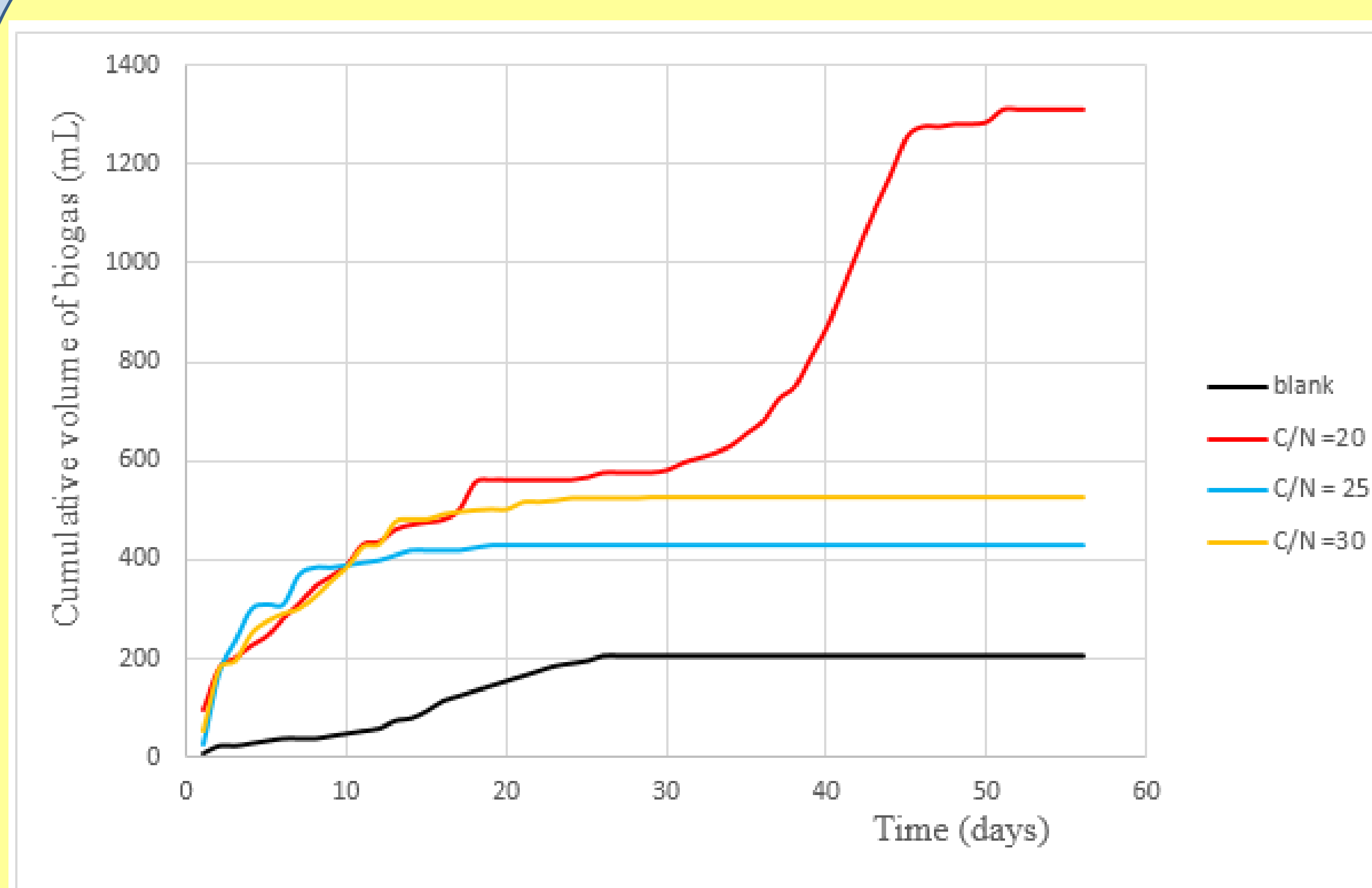
## Results & Discussion

### Characterization of raw materials

Parameter	Slaughterhouse wastewater	Rice straw
pH	6.93	n.d
BOD <sub>5</sub> (mg/L)	1800	n.d
COD (mg/L)	11750	n.d
BOD / COD	0.15	n.d
TS (mg/L)	31820	81.65
TVS (mg / L)	31796	96.26
C/N	15.79:1	58.3:1
T P(mg / L)	90	n.d
TN(mg / L)	709.5	n.d

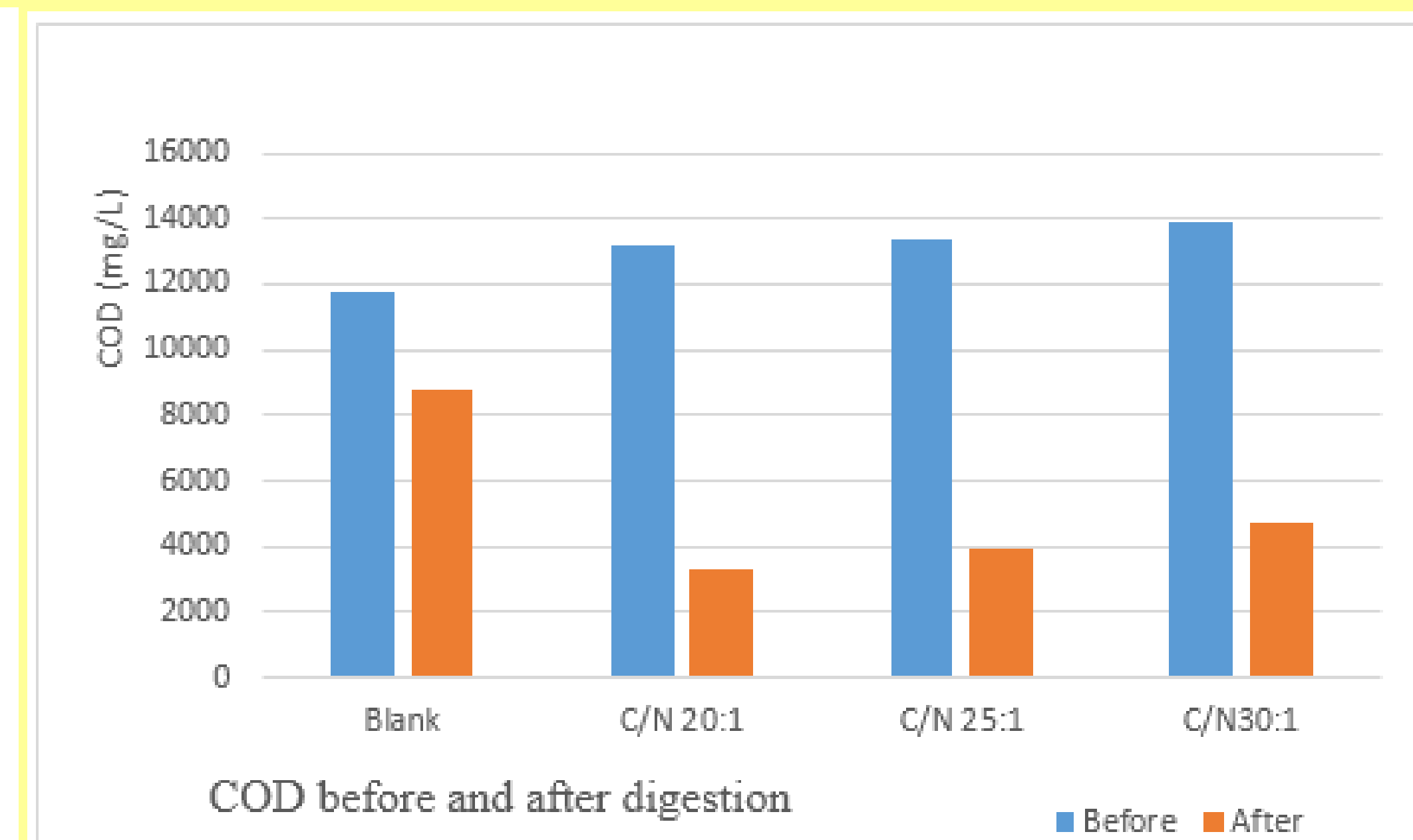
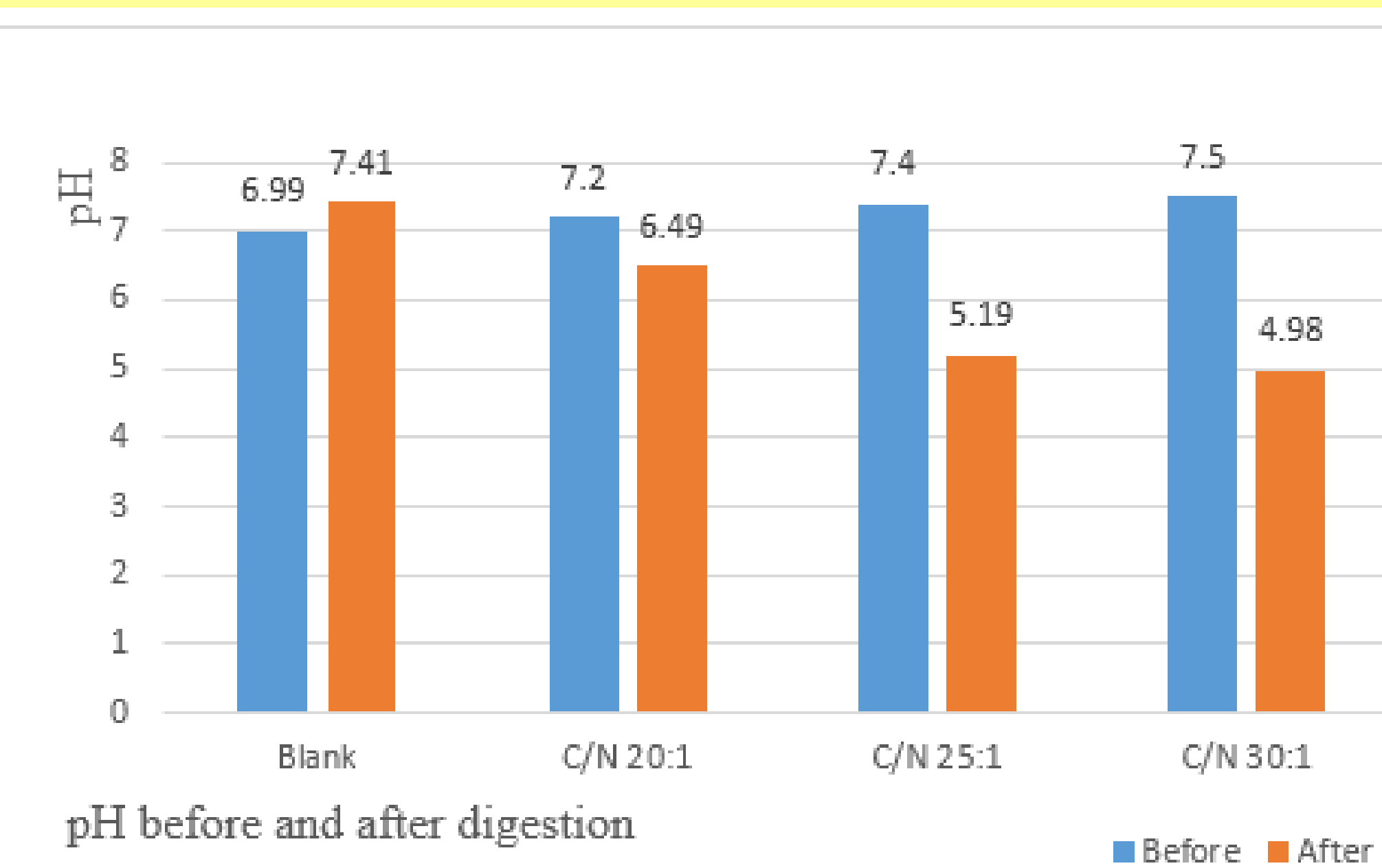
- ❖ A high potential for slaughterhouse wastewater from Mwanza plant to be a feedstock to perform an anaerobic digestion.
- ❖ The ratio BOD<sub>5</sub>/COD < 0.3 indicates the presence of toxic in slaughterhouse wastewater or microorganism requires its stabilization for stable anaerobic digestion
- ❖ A carbon to nitrogen ratio for slaughterhouse wastewater from Mwanza system should be adjusted to the optimum value
- ❖ rice straw can be a co-substrate to optimize the carbon to nitrogen ratio of Mwanza plant slaughterhouse wastewater.
- ❖ The raw materials have a high potential for biodegradability
- ❖ The pH can not affect the microorganism activity because it is neutral

### Biogas Production and its composition



- ❖ The rate of biogas production was most elevated for digesters in the presence of rice straw.
- ❖ A released volume of biogas rich in methane content is higher for co-digestion using rice straw with a C/N ratio 20:1 whereas it is low for digestion using slaughterhouse wastewater only.
- ❖ The higher methane content was obtained for the digester with a carbon to nitrogen ratio 20:1 (58.7%) and an experiment control digester (56.4%) while it was low for digester with C/N ratio 25:1 (39.2%), and too low for that of C/N ratio 30:1 (22.8%).
- ❖ the methanogens growth conditions are better for a carbon to nitrogen ratio 20:1 than for a Blank.
- ❖ there is no lack of balance between nutrients ( carbon, nitrogen) into biogas during the anaerobic digestion with carbon to nitrogen ratio 20:1
- ❖ There are inhibitors for C/N ratio 25:1 and C/N ratio 30:1

## Digested samples analysis



- ❖ The pH values 7.41 and 6.49 are inside of a required range of pH (6.5 -7.5) to justify the biogas rich in methane content obtained for blank and co digester with C/N ratio 20:1.
- ❖ a slaughterhouse wastewater co-digestion can be the efficacy option for wastewater treatment besides improving the biogas production

## Conclusion

- ❖ rice straw is a good co-substrate to optimize the performance of the slaughterhouse wastewater treatment system of Mwanza.
- ❖ the biogas yield for carbon to nitrogen ratio 20:1 reached six times the amount released from the digestion of slaughterhouse wastewater only.
- ❖ It is recommended to use 51.2 kg of rice straw for 1 m<sup>3</sup> of slaughterhouse wastewater for stable digestion to proceed.

## References

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