Vol. XVII & Issue No. 11 November - 2024
INDUSTRIAL ENGINEERING JOURNAL

ANALYSIS OF ORGANIC WASTES AND LIGNOCELLULOSIC BIOMASSES TO CHECK THEIR POTENTIALITY TOWARDS BIOGAS GENERATION AND WASTE MINIMISATION

Amol R. Rode
Research Scholar, Department of civil engineering, Shri Satya Sai University of Technology and Medical Sciences, Sehore, (MP) India
Email: is4562000@gmail.com

Ajay Swarup
Associate Professor, Department of civil engineering, Shri Satya Sai University of Technology and Medical Sciences, Sehore, (MP) India

Abstract

In the present study the analysis of organic waste such as Cow dung, kitchen waste and analysis of lignocellulosic biomasses (rice husk and rice straw) is done by Combustion analysis and by Chemical analysis. In combustion analysis, % moisture contents, % total solids contents, % volatile matter content, %fixed carbon content, % ash content are determined by using ASTM methods of proximate analysis [3, 4, 5 and 6]. The various elements present in organic waste (Cow dung & Kitchen waste) and in lignocellulosic biomass (Rice husk & Rice straw) such as Carbon, Nitrogen, Oxygen and Sulphur are determined by Chemical analysis. Chemical analysis is conducted by EDXA using Scanning Electron Microscope (SEM), LEO 1430VP, [Zeiss, Germany.] [7] Chemical oxygen demand of fresh slurry of feed materials is determined using standard procedure according to IS: 3025 (Part 58): 2006.[8] Similarly calorific value of organic wastes (cow dung & Kitchen waste) and lignocellulosic biomasses (Rice husk & Rice straw) is also calculated to check their potentiality towards biogas generation

1. INTRODUCTION

Reduction in the quantity of fossil fuels and day to day increment in environmental pollution has encouraged and inspired the beginners to think for economical as well as green sources of energy. Improper disposal of organic waste (livestock manure and kitchen waste) cause environmental pollution as well as health problems. Agricultural wastes after harvesting called as lignocellulosic biomasses generated from farms are again difficult to manage and hence proper utilization of these huge quantities of biomass towards energy creation is much needed and because of easy production this technology is best over other types of renewable sources. The current estimated annual quantity of biomass available in India itself is 750 million metric tons [MNRE report, 2021].[11] Similarly, the surplus biomass availability obtained from agriculture residue is at about 230 million metric tons per annum and this is equivalent to potential of about 28 GW [MNRE report, 2021].[11]

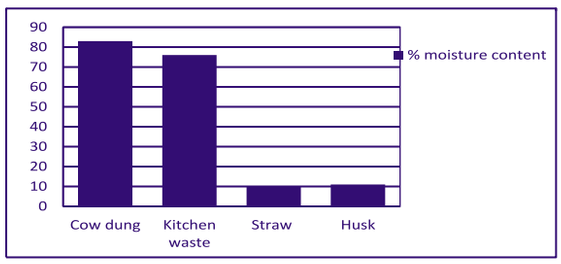
However, generation of biogas from lignocellulosic biomass is at its beginning stage requiring thorough study in the line. Digestion of lignocellulosic biomasses along with organic waste is another ecofriendly method to recreate energy and minimize the waste through anaerobic digestion so it helps to decrease emission of oxides of carbon and nitrogen. So Analysis of organic waste and lignocellulosic biomass are much important to determine and to check the potential of feed materials towards generation of biogas. In the present work organic waste as cow dung and kitchen waste collected from central part of India and characterized. Similarly, Rice husk and Rice straw collected from central part of India and characterized. Various tests under combustion analysis is done by using ASTM method of combustion analysis and chemical analysis is conducted by EDXA using Scanning Electron Microscope (SEM), LEO 1430VP, [Zeiss, Germany].[7] Similarly, Chemical Oxygen demand is determined and calorific value is also determined for organic & lignocellulosic biomasses to check their potentiality towards biogas generation & waste minimization.

2. COMBUSTION ANALYSIS

Combustion Analysis of organic wastes (Cow dung & Kitchen waste) and lignocellulosic biomasses (Rice straw & Rice husk) is done by using ASTM method of combustion analysis [3, 4, 5, and 6]. Various instruments such Hot air oven, Muffle furnace, Electronic weighing balance and porcelain dish were common instruments utilized for all ASTM methods of proximate analysis. Results of all tests conducted under combustion analysis are presented in following charts.

2.1 Result and Discussion on % Moisture Content

Chart 2.1 – Result of % Moisture content



It is observed that percentage moisture content of husk and rice straw ranged between 10 to 15% and percentage moisture content of cow dung and kitchen waste varies from 75 to 85%. More yield of biogas is possible from more percentage of moisture content [alnakeeb et al; 2017] [1]

2.2 Result and Discussion on Volatile Matter Content

Chart 2.2 Result of volatile matter content

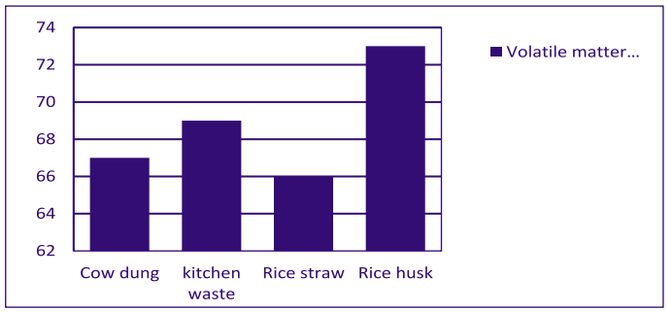
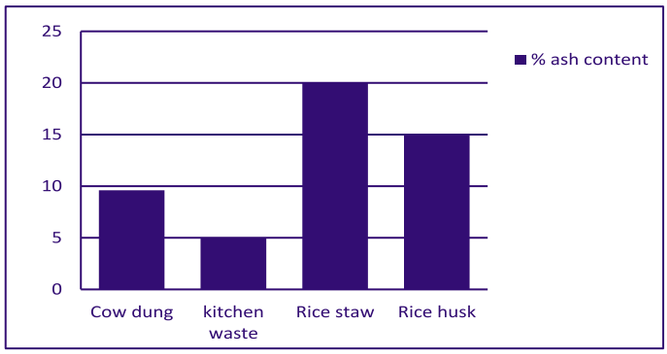


Chart 2.2 shows the result of volatile matter content and it is observed that volatile matter content of organic waste (cow dung & Kitchen waste) and lignocellulosic biomasses (rice husk & rice straw) are ranged from 60-75 %. Generation of biogas was found to be more when % volatile matter present in waste sample is above 50%.

2.3 Result and Discussion on Ash Content

Chart 2.3 Result of % ash content



From chart 2.3, it is observed that rice straw has got very high ash content (20%) followed by rice husk (15%). Similarly ash content of fresh cow dung is found to be 9.60% followed by kitchen waste (5%). Less ash content indicated that waste is better for biomass fuel.

2.4 Result and Discussion on Total Solid Content

Chart 2.4 Result of total solid content

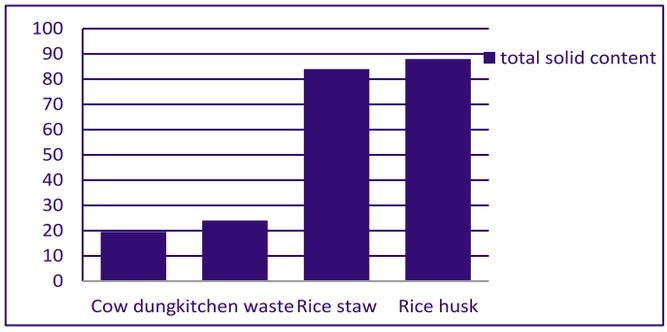


Chart 2.4 shows that result of total solid content and it is observed that total solid content in rice husk and rise straw is ranged between 80 to 90% and for kitchen waste nearly about 20% to 25% and for fresh cow dung slurry ranged in between 18 to 20%. And hence result shows that water addition is more important factor to achieve best % of total solids of feed materials discussed in literature review.

2.5 Result and Discussion on Fixed Carbon Content

Chart 2.5 Result of fixed carbon content

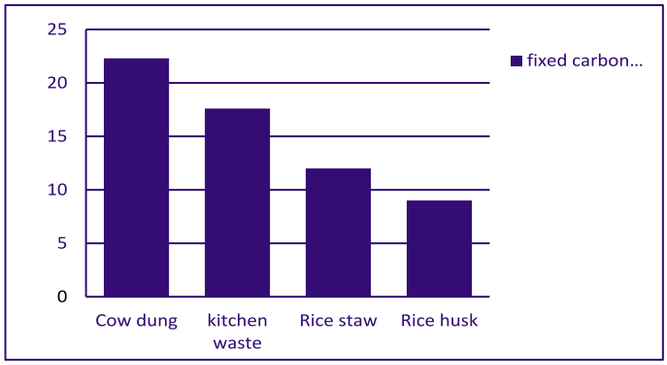


Chart 2.5 shows that result of fixed carbon content and it is observed that carbon content in rice husk is 9% than in rice straw is 15%. Hence rice straw has a great potential towards biogasgeneration than rice husk.

Table 2.1 gives the comparison of combustion analysis of feed material with the available data from other researchers. It is observed that the data based on combustion analysis obtained from the present work is comparable with literature data.

Table 2.1 Results comparison of Combustion Analysis (Present Work & Literature)

Feed Materials	Present work			Literature data			Author
	FC	ASH	VM	FC	ASH	VM	
Cattle Dung	22.3	9.6	67	19.3	19.3	46.4	Roy et al., 2010 [13]
Kitchen Waste	17.6	5	69	---	---	---	----
Rice straw	12	20	66	15.6	20.1	64.3	Miles et al;1995 [10]
				13.91	20.38	65.7	Channiwala and parikh;2002 [2]
Rice husk	09	15	69	19.2	18	62.8	Miles et al;1995 [10]
				16.95	21.24	61.81	Channiwala and parikh;2002 [2]

3.0 CHEMICAL ANALYSIS

Chemical analysis of biomass is done by EDXA using Scanning Electron Microscope (SEM), LEO 1430VP, [Zeiss, Germany.] [7] Comparison of data obtained from present work and obtained from literature data is presented in table 3.1

Table 3.1 Results comparison of Chemical Analysis (Present Work & Literature)

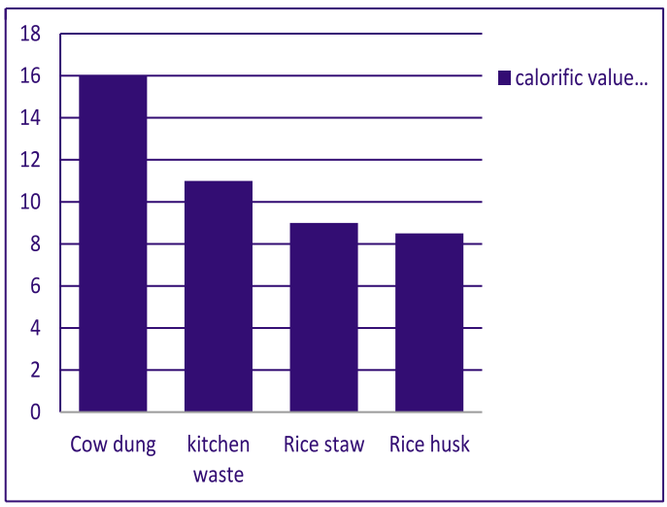
Feed materials	Present work			Literature			Author
	C (%)	N (%)	O (%)	C (%)	N (%)	O (%)	
Cow dung	35.20	1.6	55.42	33.33	--	1.68	Raheman and Mondal, 2012 [12]
				31.6	6.12	37.8	Roy et al.,2010 [13]
Kitchen waste	31.10	0.675	49.20	-----	------	-------	
Rice husk	29.30	0.355	39.75	38.9	0.6	32.0	Kirubakaran et al., 2009 [9]
				49.3	0.8	43.7	Miles etal., 1995 [10]
Rice straw	32.11	0.984	41	36.9	0.4	37.9	Kirubakaran et al., 2009 [9]
				50.1	1.0	43	Mile et al., 1995 [10]

Results of chemical analysis shows that rice straw is better option than rice husk due to better C to N ratio. The results obtained from the study are comparable with literature from other author.

4.0 RESULT AND DISCUSSION ON CALORIFIC VALUE

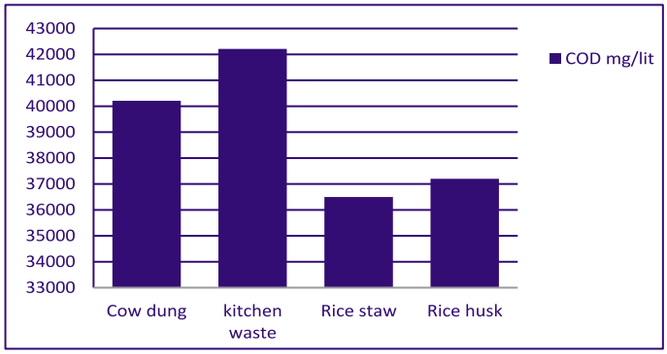
It is observed from the results that calorific power of rice straw is more than the rice husk and both the values are found in between of 8 to10 MJ/kg.

Chart 4.1 Result of calorific value



5.0 RESULT AND DISCUSSION ON CHEMICAL OXYGEN DEMAND

Chart. 5.1 Chemical oxygen demand of feed materials



Rice husk and straw got the COD values 35000-380000 mg/L COD. Cow dung has got COD of 40200.12 mg/l which is comparable with literature data [Yadvika et al., 2006] [14].

6.0 RESULT AND DISCUSSION ON FIBER ANALYSIS

Fiber analysis of feed materials is done and cellulose content %, and lignin content % shown in chart 6.1 and 6.2. Similarly lignin to cellulose ratio for all feed materials is shown in chart 6.3. Chart 6.1 indicates that all feed materials have good cellulose content and higher cellulose content indicates good potential for biogas generation.

Chart 6.1 Cellulose content (%) of feed materials

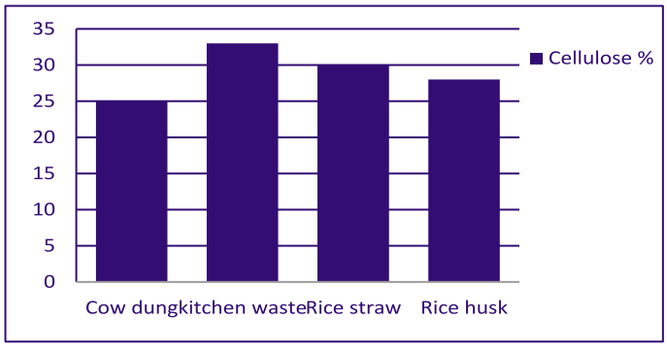
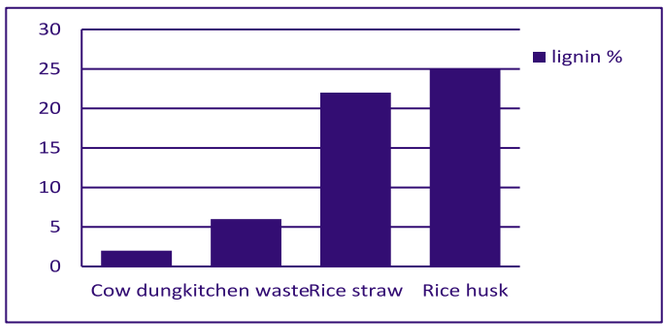


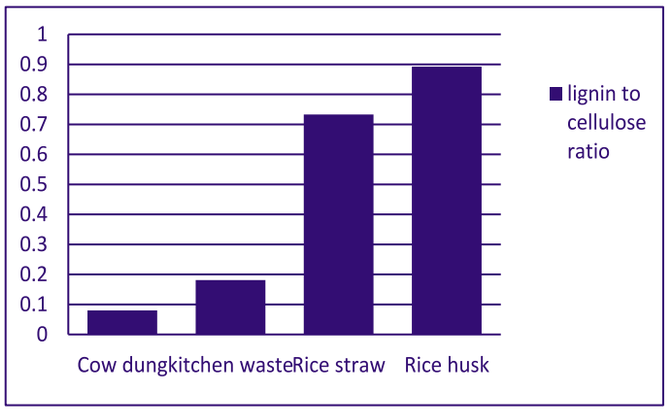
Chart 6.2 shows the lignin content (%) of the feed materials and indicates that lignin contents in organic waste is much low in the range of 2-8% and hence they are good for digestion in anaerobic process. Lignin contents in husk and straw is high (> 20%) so difficult to disintegrate in anaerobic digestion.

Chart 6.2 Lignin content (%) of feed materials



It is observed from the result that highest lignin to cellulose ratio is found for husk than that of straw.

Chart 6.3 Lignin to cellulose ratio of feed materials



CONCLUSION

From the analysis of organic waste and lignocellulosic biomasses it can be concluded that lignocellulosic biomasses after pretreatment has good potential towards biogas generation. From the results obtained, the present work suggested that rice husk and straw has a good potential towards biogas generation and also these biomasses are good source of renewable energy along with organic waste. Again as per the results of fiber analysis, both the lignocellulosic biomasses contains more and excess quantity of lignin and hence delaying the process of decomposition and directly affected the generation of biogas and minimization of waste and hence pretreatment of both the lignocellulosic biomasses is must before mixing with organic waste in anaerobic digester.

REFERENCES

[1] *A. N. Alnakeeb., Khudhayer Najim and Ausama Ahmed, (2017), Anaerobic Digestion of Tomato Wastes from Groceries Leftovers: Effect of Moisture Content, International Journal of Current Engineering and Technology, Vol 7, No 4, (2017), pp1468-1470*

[2] *Channiwala S. A. and Parikh P. P, (2002) A unified correlation for estimating HHV of solid, liquid and gaseous fuels, Vol. 81, (2002), pp1051–63.*

[3] *E 1757, Standard Practice for Preparation of Biomass for Compositional Analysis. 2001, American Society for Testing and Materials, ASTM International, West Conshohocken, PA 19428-2959, United States.*

[4] *E 1755, Standard Test Method for Ash in Biomass. 2001, American Society for Testing and Materials, ASTM International, West Conshohocken, PA 19428-2959, United States.*

[5] *E 1756, Standard Test Method for Determination of Total Solids in Biomass. 2008, American Society for Testing and Materials, ASTM International, West Conshohocken, PA 19428-2959, United States.*

[6] *E 872, Standard Test Method for Volatile Matter in the Analysis of Particulate Wood Fuels. 1998, American Society for Testing and Materials, ASTM International, West Conshohocken, PA 19428- 76 2959, United States.*

[7] *In Situ Lab for ZEISS FE-SEM, Linking Materials Performance to Microstructure, Carl Zeiss Microscopy GmbH, pp1-5*

[8] *IS 3025 (Part 58):2006, Indian Standard methods of sampling and test (physical and chemical) for water and wastewater, part 58 chemical oxygen demand (COD), copyright BIS 2006, New Delhi, India, pp1-3*

[9] *Kirubakaran V., V. sivaramakrishhnan., R.Nalini., T.Sekar., M.Premlatha, P.Subramanian, (2009), A review on gasification of biomass, Journal of Renewable & Sustainable Energy Reviews, Vol. 13, No.1, pp179-186*

[10] *Miles T. R., Miles J. T. R., Baxter L. L., Bryers R. W., Jenkins B. M. and Oden L. L, (1995), Alkali deposits found in biomass power plants, preliminary investigation of their extent and nature, Report of the National Renewable Energy Laboratory (NREL/TZ-2- 11226-1; TP-433-8142), Golden, CO, USA, 1995*

[11] *MNRE Report., 2021, Bioenergy, Ministry of new and renewable energy, Government of India, New Delhi*

[12] *Raheman H. and Mondal S, (2012), Biogas production potential of Jatropha seed cake, Biomass and Bioenergy, Vol. 37, (2012), pp25-30*

[13] *Roy P. C., Datta A. and Chakraborty N,(2010), Assessment of cow dung as a supplementary fuel in a downdraft biomass gasifier, Renewable Energy, Vol. 35, No.2, (2010) pp379-386.*

[14] *Yadvika, Yadav A. K., Sreekrishnan T. R., Satya S. and Kohli S, (2006), A modified method for estimation of chemical oxygen demand for samples having high suspended solids, Bioresource Technology, Vol. 97, (2006), pp721–726*