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Biodegradation of rice straw under anaerobic digestion

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Abstract

To mitigate environmental impacts caused by illegal burning of rice straw in rural fields, anaerobic digestion of rice straw could be an excellent alternative for the treatment of this sub-product of paddy rice harvest. The effect of inoculum/substrate ratio (I/S) on biogas yield and biodegradation of rice straw was carried out in batch reactor under room temperature (25° to 27°C) and for 60 days of digestion. Results demonstrate a high biogas production (410 L/kgVS) at 0.8 of I/S ratio, with methane content over 70%. The modified Gompertz model was utilized to simulate the cumulative biogas yield from different I/S ratios. Degradation of volatile solids (VS), cellulose, hemicellulose, lignin, silica and cellular content indicated that rumen content is an efficient degrader for lignocellulosic material. This study provides useful parameters to evaluate the biogas production via anaerobic digestion of rice straw, as a promising alternative energy in rural areas.

Keywords

Lignocellulosic material; rumen content; degradation efficiency; inoculum to substrate ratio; biogas yield; co-digestion.

Nomenclature

Cellular C.$_{de}$	Degradation efficiency of Cellular content (%)	**SER**	Second experimental run
Cellular C.$_{re}$	Cellular content of digested residues of experimental group (%)	**SLR**	Solid loading rate, kg/m^3
Cellular C.$_{rs}$	Initial Cellular Content of rice straw (%)	**Silica$_{de}$**	Degradation efficiency of Silica (%)
Cellulose$_{de}$	Degradation efficiency of Cellulose (%)	**T**	Anaerobic digestion time (d)
Cellulose$_{re}$	Cellulose content of digested residues of experimental group (%)	**TS$_b$**	TS of blank reactors (%)
Cellulose$_{rs}$	Initial Cellulose content of rice straw (%)	**TS$_{de}$**	Degradation efficiency of TS (%)
F733	Rice straw variety Fedearroz 768 from Colombia	**TS$_{re}$**	TS of digested residues of experimental group (%)
F767	Rice straw variety Fedearroz 767 from Colombia	**TS$_{rs}$**	Initial TS content of rice straw (%)
F768	Rice straw variety Fedearroz 768 from Colombia	**V$_w$**	Working volume, mL
F2000	Rice straw variety Fedearroz 2000 from Colombia	**VS$_b$**	VS of blank reactors (%)
FER	First experimental run	**VS$_{de}$**	Degradation efficiency of VS (%)
Hcellulose$_{de,}$	Degradation efficiency of Hemicellulose (%)	**VS$_{re}$**	VS of digested residues of experimental group (%)
Hcellulose$_{re}$	Hemicellulose content of digested residues of experimental group (%)	**VS$_{rs}$**	Initial VS content of rice straw (%)
Hcellulose$_{rs}$	Initial Hemicellulose content of rice straw (%)	**W$_b$**	Weight of digested residues of the blank group(g)
I/S	Inoculum to substrate ratio (VS/VS)	**W$_{re}$**	Weight of digested residues of the experimental group (g)
Lignin$_{de}$	Degradation efficiency of Lignin (%)	**λ**	Lag phase time (d)
Lignin$_{re}$	Lignin content of digested residues of experimental group (%)	**β$_0$**	Final biogas production (mL/gSV)
Lignin$_{rs}$	Initial Lignin content of rice straw (%)	**β(t)**	Cumulative biogas yield (mL/gSV)
		μ$_m$	Maximum biogas production rate (mL/gSV.d)