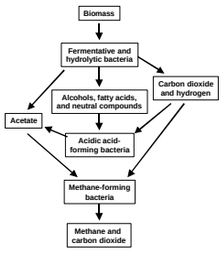
Energy Production from Zoo Animal Wastes

K. Thomas Klasson, Nhuan P. Nghiem, and Nancy Appolon
Oak Ridge National Laboratory

Background

- The Knoxville Zoo approached us in 1999 about advice on improved options for disposal of elephant and rhinoceros dung.
- Production rate is 40 tons/week (100 lb/elephant/day)
- The current method separates herbivore and carnivore dung. The majority of herbivore dung comes from the elephants and rhinoceros.
- The herbivore dung is delivered to local composting company, but delivery and tipping fee applies.
- As an alternative, methane generation in anaerobic digesters may be possible.

Anaerobic Digestion



Methods

- Digesters
  - glass bottles 250 mL- 2 L with gas collection bags
- Incubation
  - not agitated at 37° or 50°C
- Gas production measurements
  - water displacement
- Gas composition
  - GC for air, CH_4, and CO_2 separation

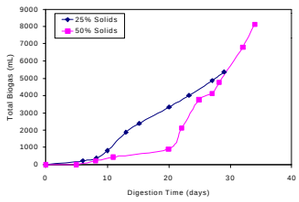
ORNL's Experimental Approach

- Collect zoo and cow dung
- Prepare starter digester with cow dung
- Start zoo dung digesters with or without cow starter
- Study temperature (37° - 50°)
- Study potential amendments

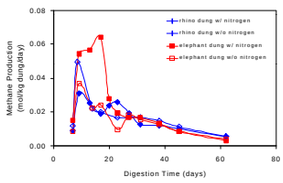
Animal Waste

Dung Type	Moisture Content (%)	TVS (g/g dry)	TVS (g/g wet)
Elephant	83	0.91	0.15
Rhinoceros	81	0.83	0.16

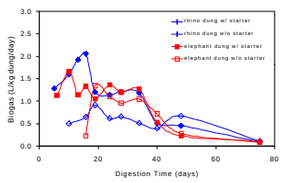
Starter (cow dung) Results



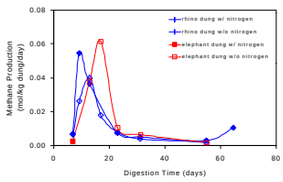
Zoo Dung Results at 37°



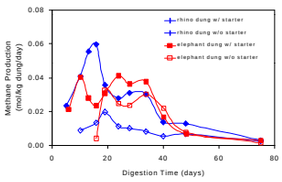
Zoo Dung Results with or without Starter



Zoo Dung Results at 50°C



Zoo Dung Results with or without Starter



Conclusions

- The benefit of using a starter is clearly seen in the yields.
- Both types of dung resulted in similar results with a biogas yield on dung of 0.051-0.057 L/g. This compares favorable with the results obtained by Mandal and Mandal *(Energy Convers. Mgmt.*, 38, 679-683 (1997)), who obtained 2.4-3.3 L gas from 150 g of "dense" animal dung, such as camel and horse dung.
- The final pH of the digesters at the end of the incubation period was 6.95-7.39.

Zoo Dung Results at 37° and 50°C

Digester	Dung (g)	TVS (g)	Biogas (L STP)	CH_4 (L STP)	Yields (L biogas/g dung)	Yields (L CH_4/g dung)	Yields (L CH_4/g TVS)
Rhinoceros dung w/ nitrogen at 37°C	37.5	6.1	1.17	0.69	0.031	0.019	0.11
Rhinoceros dung at 37°C	37.5	6.1	1.23	0.72	0.033	0.019	0.12
Elephant dung w/ nitrogen at 37°C	37.5	5.7	1.59	0.99	0.042	0.026	0.17
Elephant dung at 37°C	37.5	5.7	0.98	0.61	0.026	0.016	0.11
Rhinoceros dung w/ nitrogen at 50°C	37.5	6.1	0.89	0.50	0.024	0.013	0.082
Rhinoceros dung at 50°C	37.5	6.1	0.67	0.38	0.018	0.010	0.062
Elephant dung w/ nitrogen at 50°C	37.5	5.7	0.10	0.01	0.003	0.000	0.00
Elephant dung at 50°C	37.5	5.7	0.89	0.54	0.024	0.014	0.094

Zoo Dung Results with or without Starter

Digester	Dung (g)	TVS (g)	Biogas (L STP)	CH_4 (L STP)	Yields (L biogas/g dung)	Yields (L CH_4/g dung)	Yields (L CH_4/g TVS)
Rhinoceros dung w/ starter	37.5	6.1	2.12	1.24	0.057	0.033	0.20
Rhinoceros dung w/o starter	37.5	6.1	1.16	0.44	0.031	0.012	0.072
Elephant dung w/ starter	37.5	5.7	1.90	1.13	0.051	0.030	0.20
Elephant dung w/o starter	37.5	5.7	1.21	0.68	0.032	0.018	0.12

Acknowledgments

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