Energy Production From Zoo Animal Wastes

K. Thomas Klasson

Nhuan P. Nghiem

Nancy Appolon

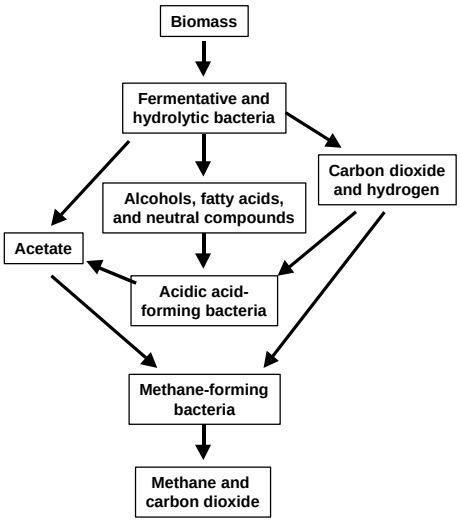
OAK RIDGE NATIONAL LABORATORY
U. S. DEPARTMENT OF ENERGY

UT-BATTELLE

Background

- The Knoxville Zoo approached us in 1999 about advise 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



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

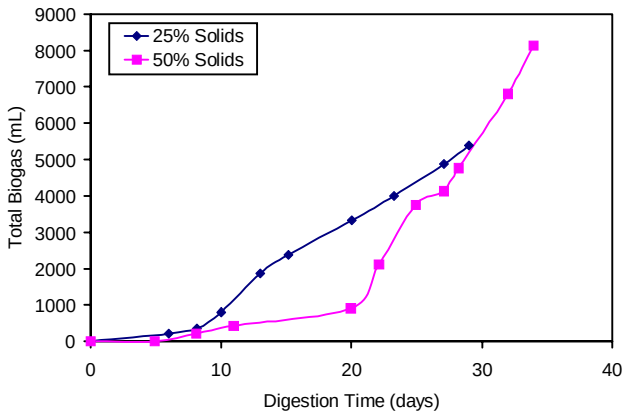
Methods

- 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

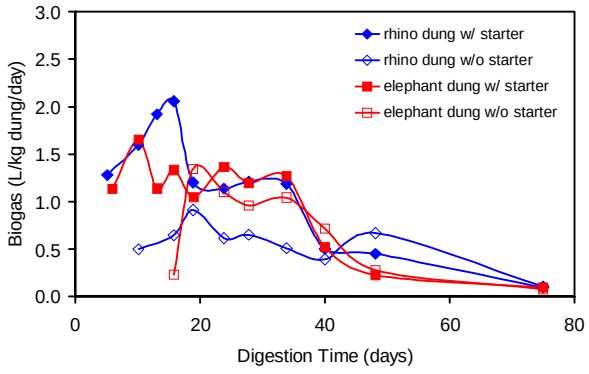
Animal Waste

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

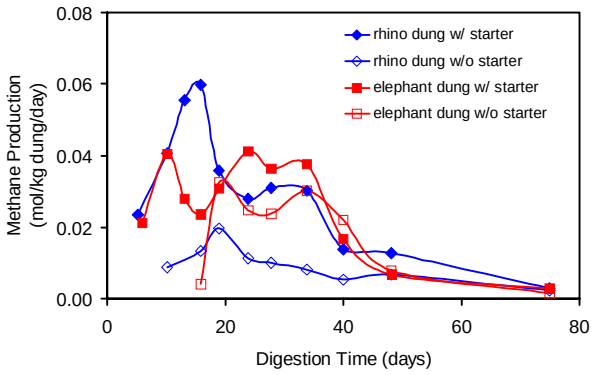
Starter (cow dung) Results



Zoo Dung Results with or without Starter



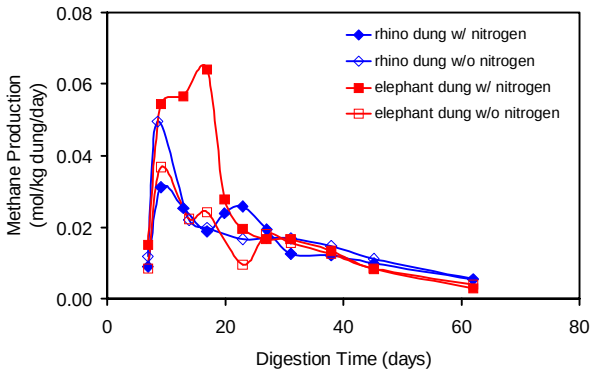
Zoo Dung Results with or without Starter



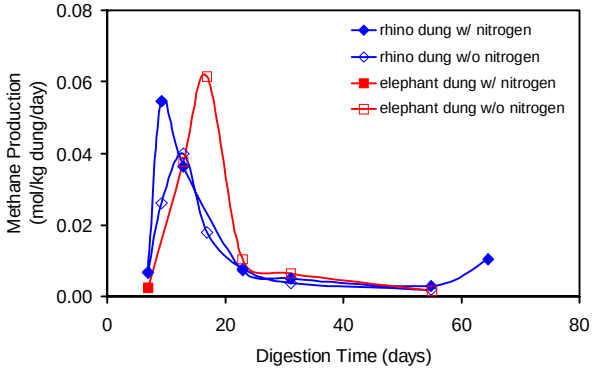
Zoo Dung Results with or without Starter

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

Zoo Dung Results at 37°



Zoo Dung Results at 50°C



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

Conclusions

- The benefit of using a starter is clearly seen in the yields.
- Both types of dung resulted in similar results 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.

Acknowledgments

- This work was sponsored by the Energy Efficiency and Renewable Energy State Partnerships Program
- Oak Ridge National Laboratory is managed by UT-Battelle, LLC, for the U.S. Department of Energy under contract DE-AC05-00OR22725