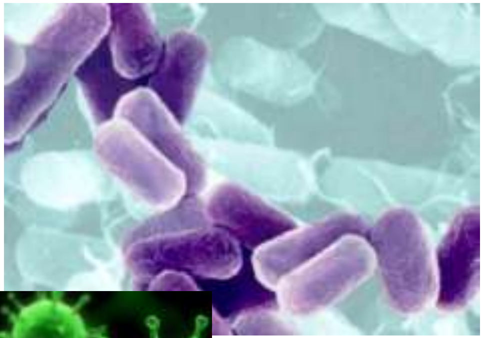
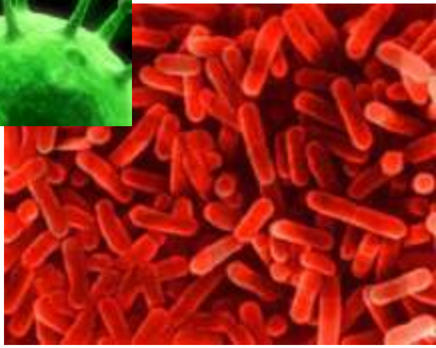
# Microbial Tools for Manure Management

Luis C. Solórzano, Ph. D., Dipl. ACAS
Sr. Technical Service Manager-America's
Silage Inoculants and Ruminant DFM's
Fitchburg, WI

# Topics

- Bacteria in manure management
  - Purpose
  - Types of bacteria
- Use of bacteria for:
  - Compost
  - Biogas
  - Lagoons
- Take home messages





# Bacteria

- Microorganisms:
  - Often unicellular
  - Omnipresent
  - Posses biochemical properties
    - beneficial
    - pathogenic

# Purpose of Using Bacteria in Manure Management

- Decompose organic matter anaerobically into useful compounds:
  - Amendment of soils
  - Energy
  - Reduce amount of solids
- Environmental benefits
  - Reduce offensive odors/improve air quality
  - Reduce potential for contamination
  - Reduce pathogens
  - Reduce insects
  - Nutrient management
  - Reduce gasses  and their toxicity

# Types of Bacteria

- Bacteria types based on Operational Temperature:
  - Psychrophiles: prefer cold
  - Mesophiles: mid-temperature
  - Thermophiles: prefer warmth

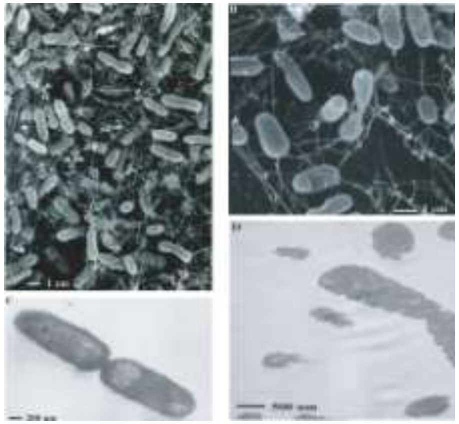
# Psychrophiles

- -10 to 20 $^{o}$C
- Found in Artic and Antartic
- Greatest attention on milk contamination (crystallization)
- Contain lipid cell membranes and use proteins as “antifreeze” to survive below freezing
- Limited commercial applications
- Examples: Arthrobacter, Psychobacter, Pseudomonas, Sphingomonas

# Mesophiles

- 10 to 50 $^{o}$C
- Found in soil and water
- Most pathogens found in this group
- Great for composting
- Increase temperature
- Examples: Staph. Aureus, Salmonella, Proteus vulgaris

# Thermophiles



- 50 - 70 $^{o}C$
- Will not grow at 20 $^{o}C$
- Very difficult to study
- Great in compost/landfills
- May live in acidic conditions: Thermoacidophile
- Examples: Humicola isolens, Thermomyces lanuginosus, fungi: A. fumigatus

# Composting

# Composting

- Purposeful biodegradation of organic matter performed by microorganisms
- Results in an organic mixture used to amend soil structures, water retention properties and to provide nutrients

# Compost

- The bacteria typically used include mixtures of mesophiles and thermophiles (eg. B. megaterium, B. licheniformis, B. subtilis)

- These bacterial mixtures will produce enzymes to help in the decomposing process (cellulases, proteases, amylases, xylanases and pectinases)

- Typical dosification rates ~7 x $10^9$ CFU/$ft^3$of compost material

# Biogas Trial

**Leibniz-Institut für Agrartechnik**

**Potsdam-Bornim e.V. 2008**

# Trial outline

- Maize 37.7% DM was ensiled following DLG guidelines for 49 days @ 25C
- ***Lactobacillus plantarum*** **CH6072 was compared to an untreated control**
- **4 replicates / treatment**
- **Measured fermentation parameters & losses**
- **After opening, silages were placed in anaerobic digesters following** VDI 4630 (2004) guidelines to measure methane production

# Silage Analysis

| Parameter | Untreated | CH6072 |
|---|---|---|
| DM (%) | 37,0 | 37,6 |
| pH | 3,82 | 3,85 |
| Lactic acid (% DM) | 4,0 | 3,6 |
| Acetic acid (% DM) | 0,8 | 1,1 |
| Ethanol (% DM) | 1,4 | 1,5 |
| Sugar (% DM) | 2,9 | 2,5 |
| Crude protein (% DM) | 8,4 | 8,4 |
| DM losses (%) | 2,4 | 2,4 |

# Biogas Analysis Method

Batch experiments were carried in four replicates with lab-scale vessels with a working volume of 2,0 litres according to the guideline VDI 4630 (2004). A constant temperature of 35° C was maintained through a water bath:

# Biogas Analysis Method

**Sludge after anaerobic digestion of maize and animal slurry was used as inoculum. The reactor vessels were connected with calibrated wet gas meters for measuring the biogas production up to 28 days, related to corrected organic dry matter $ODM_C$. The content of methane in the biogas was analysed by means of a gas analyser (ANSYCO GA94) and results to cumulative methane yield. The volume of biogas was calculated to normalised litres (Nl); (dry gas, $t_0$=273K, $p_0$= 1013hPa) and the methane and carbon dioxide content was corrected to 100% (headspace correction according VDI 4630). The volume of biogas produced from the inoculum was substracted from the batch tests with substrate.**

# Methane Production

| | Methane yield @ end of test (g/l) | % increase | Maximum methane yield (g/l) | % increase |
|---|---|---|---|---|
| Untreated | 279 | | 314 | |
| CH6072 | 315 | +12,9% | 356 | +13,4% |

# Assumptions

- Typical methane yield is 100 $m^3$ / t fresh matter (FM)
- 1$m^3$ methane produces 3,8 kwh electricity
- Typical medium sized biogas plant requires about 10.000 tonnes maize / year
- A typical German house uses 3.600kwh/year.
- Based on this trial, using CH6072 on 10.000t maize would generate electricity for an extra **150** houses!

# Conclusions

- Addition of CH6072 increased methane production by 12.9%
- Maximum methane was increased by 13.4% (extrapolated from day 0-28 methane production)
- Treatment with CH6072 in this trial would have resulted in an increase in electricity of +3.010 Kwh / ha of corn silage.
- There was little difference in fermentation of or losses in the corn silage between treatments in this trial.

# Manure Lagoons

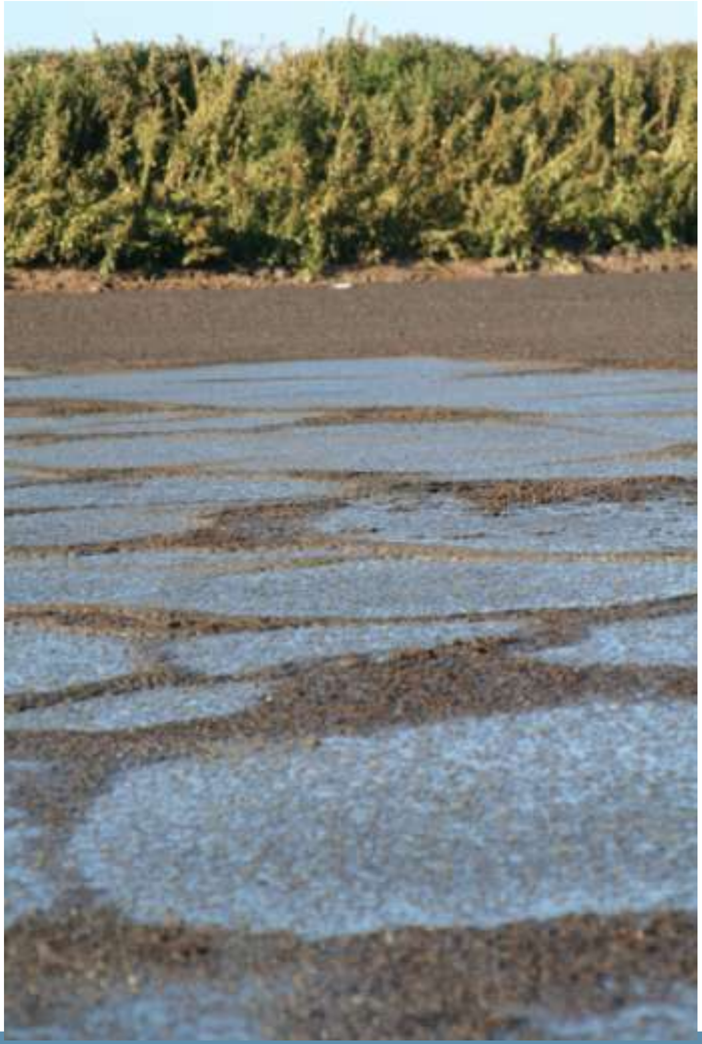
# Manure Lagoon Research

- Direct inoculation of dairy lagoons
- DFM (swine):
  - Lab bench work
  - Bacteria used as a DFM and then effect of manure lagoon measured

# Equipment used for injecting Maneuver

# Injection of Maneuver

**Maneuver at work. We were not told that the newspaper bedding for the cows also went into the lagoon. We had to increase the dosage. Immediately the decrease of flies was noticeable.**

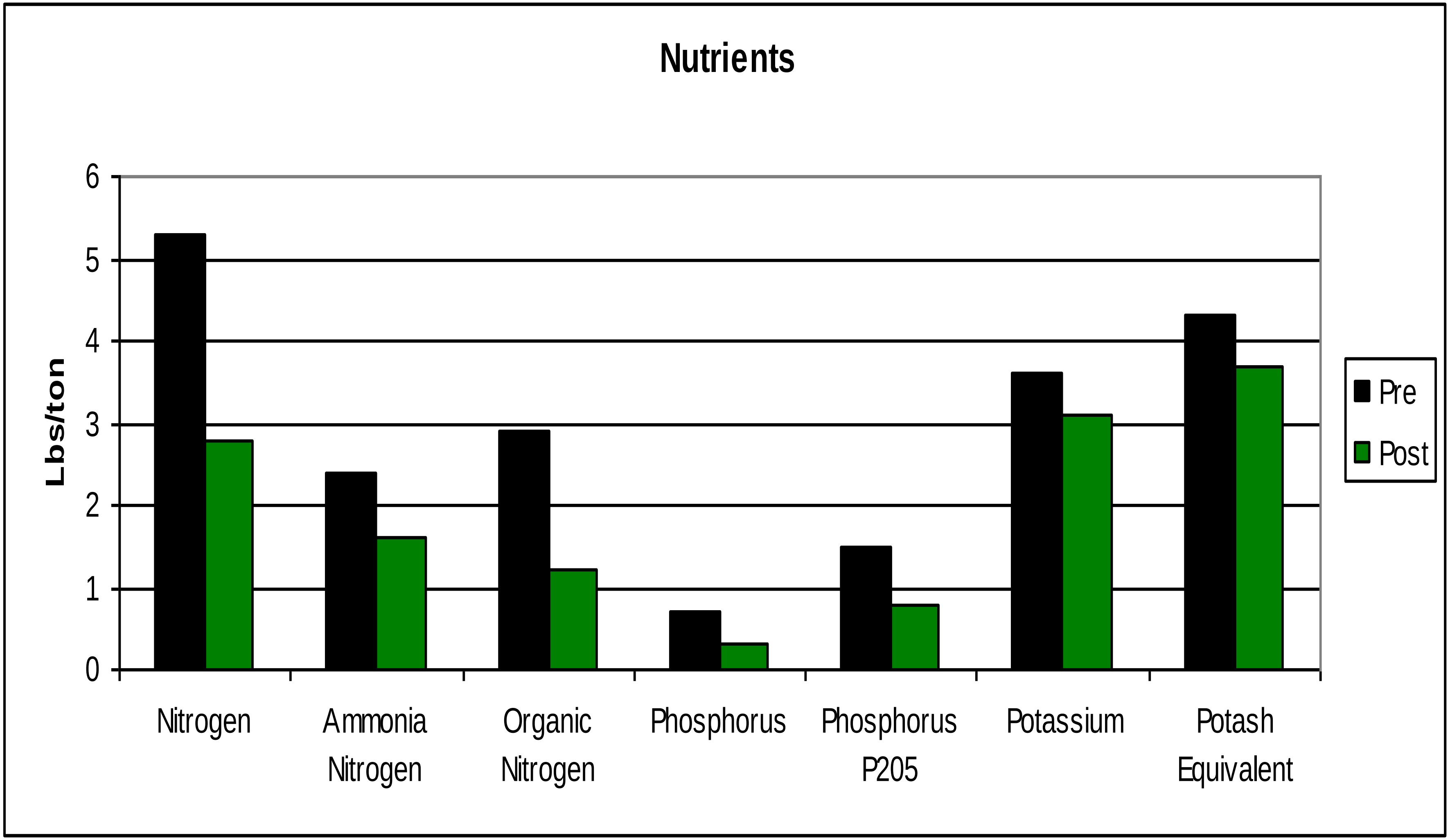


# Maneuver at work (bubbling). Note crust reduction.

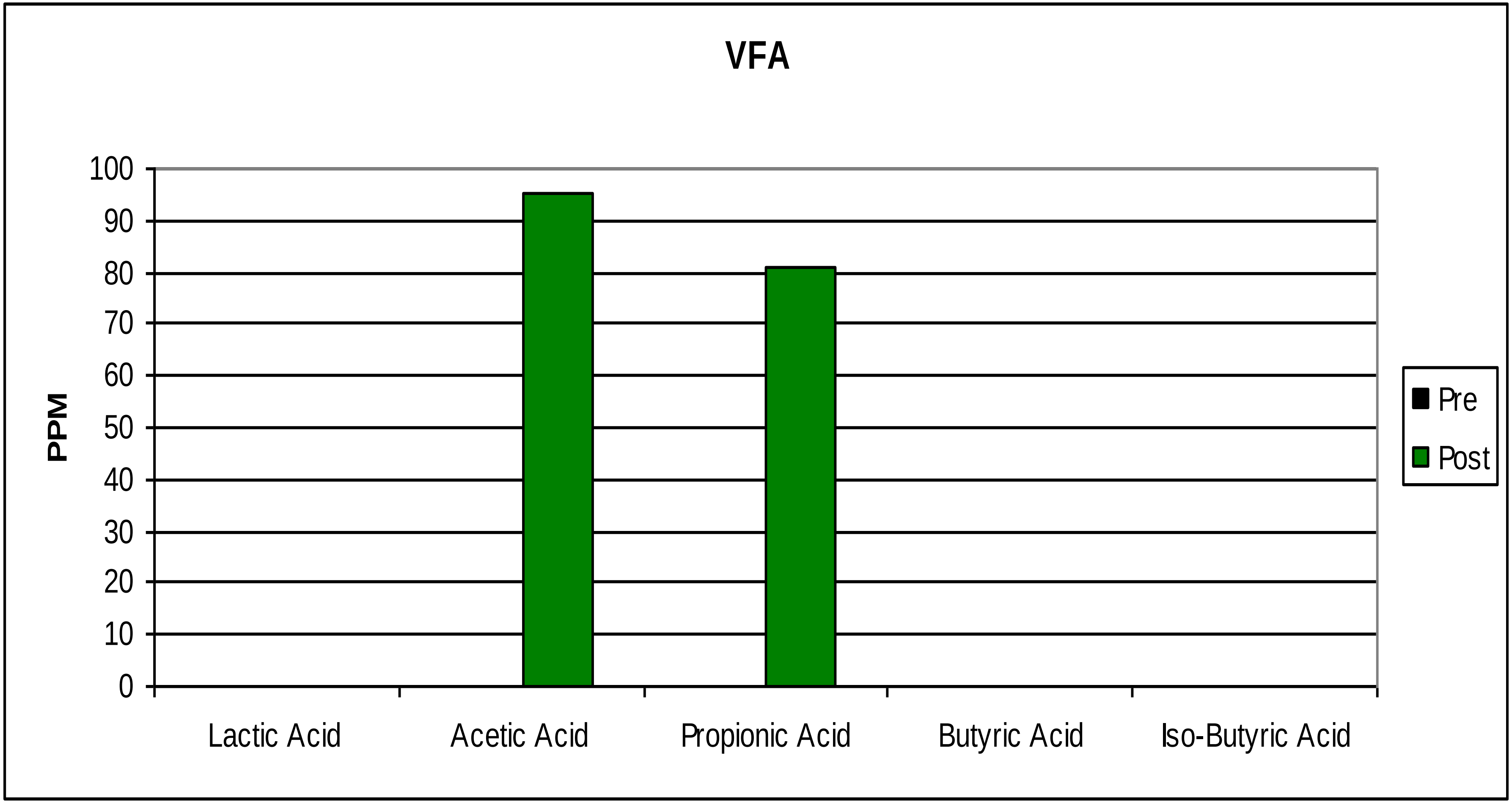
# Maneuver at work. Note fence reflected on the cleanliness of surface

**In this tank, a reduction in odor was noticeable (neighbors stopped complaining). Also, upon emptying, it was easier due to a reduction in solids. This picture of the bottom is after it had been emptied.**

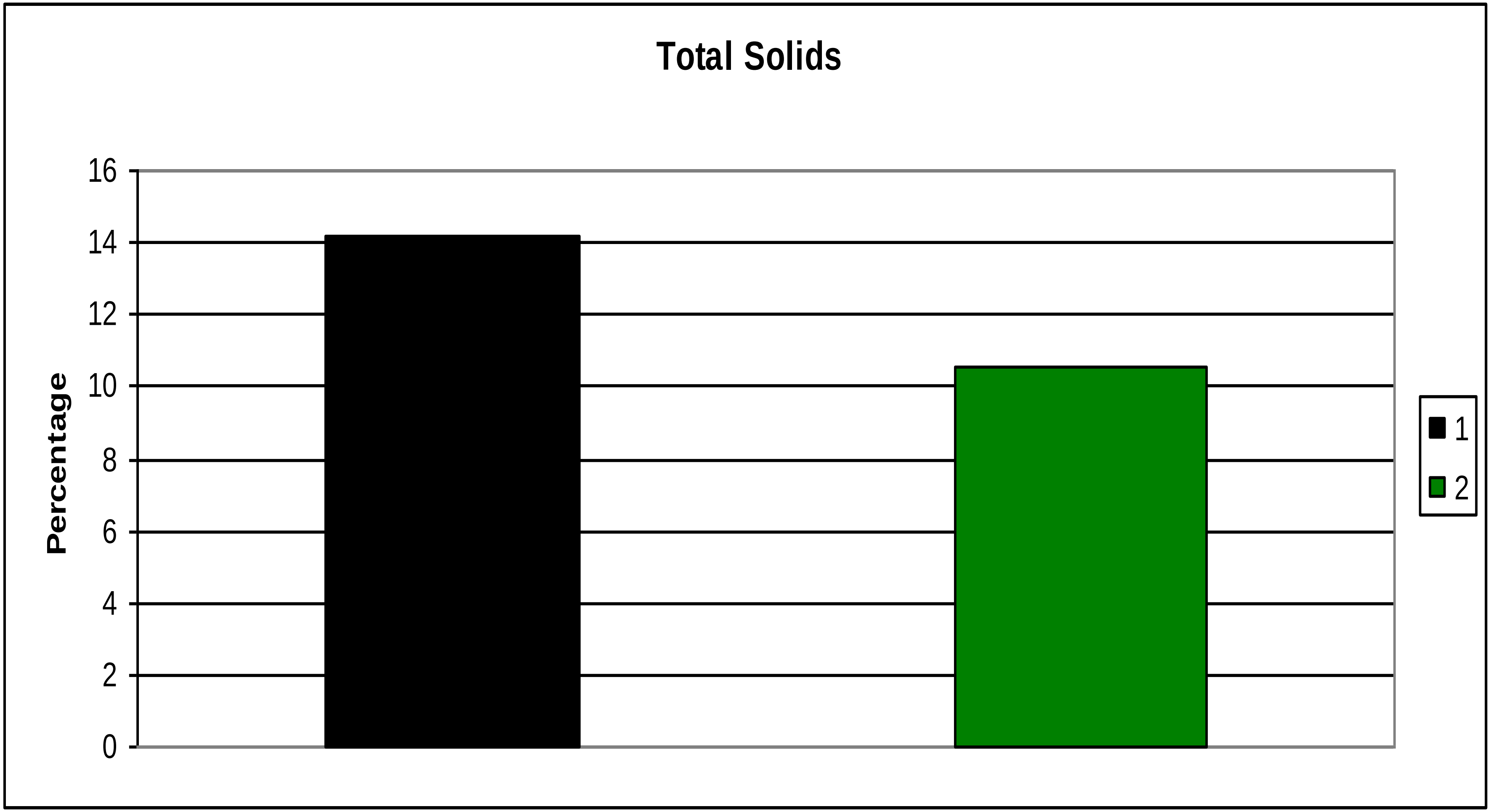
# Dairy 1: liquid phase



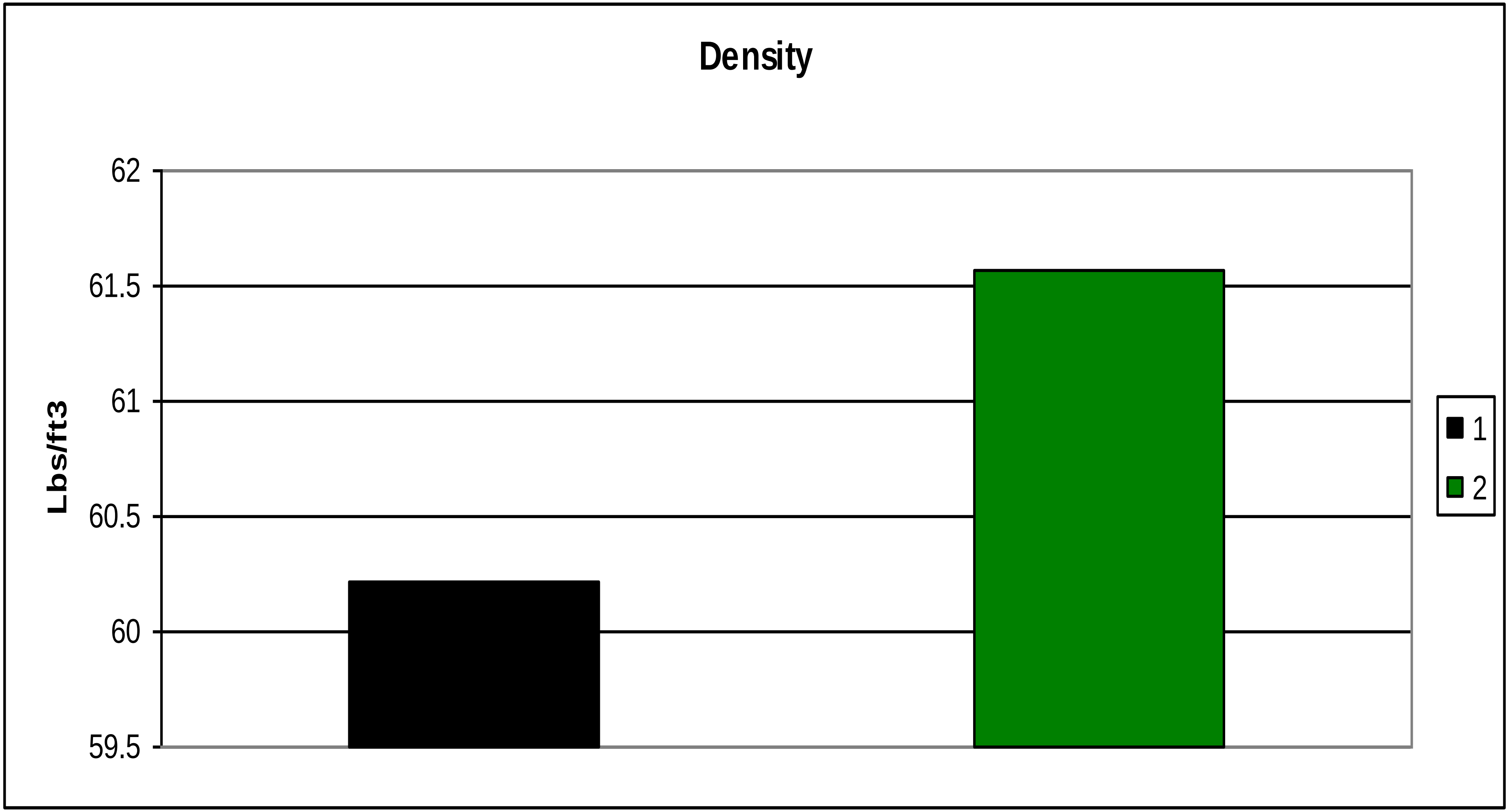
# Dairy 1: liquid phase



# Dairy 1: Liquid phase

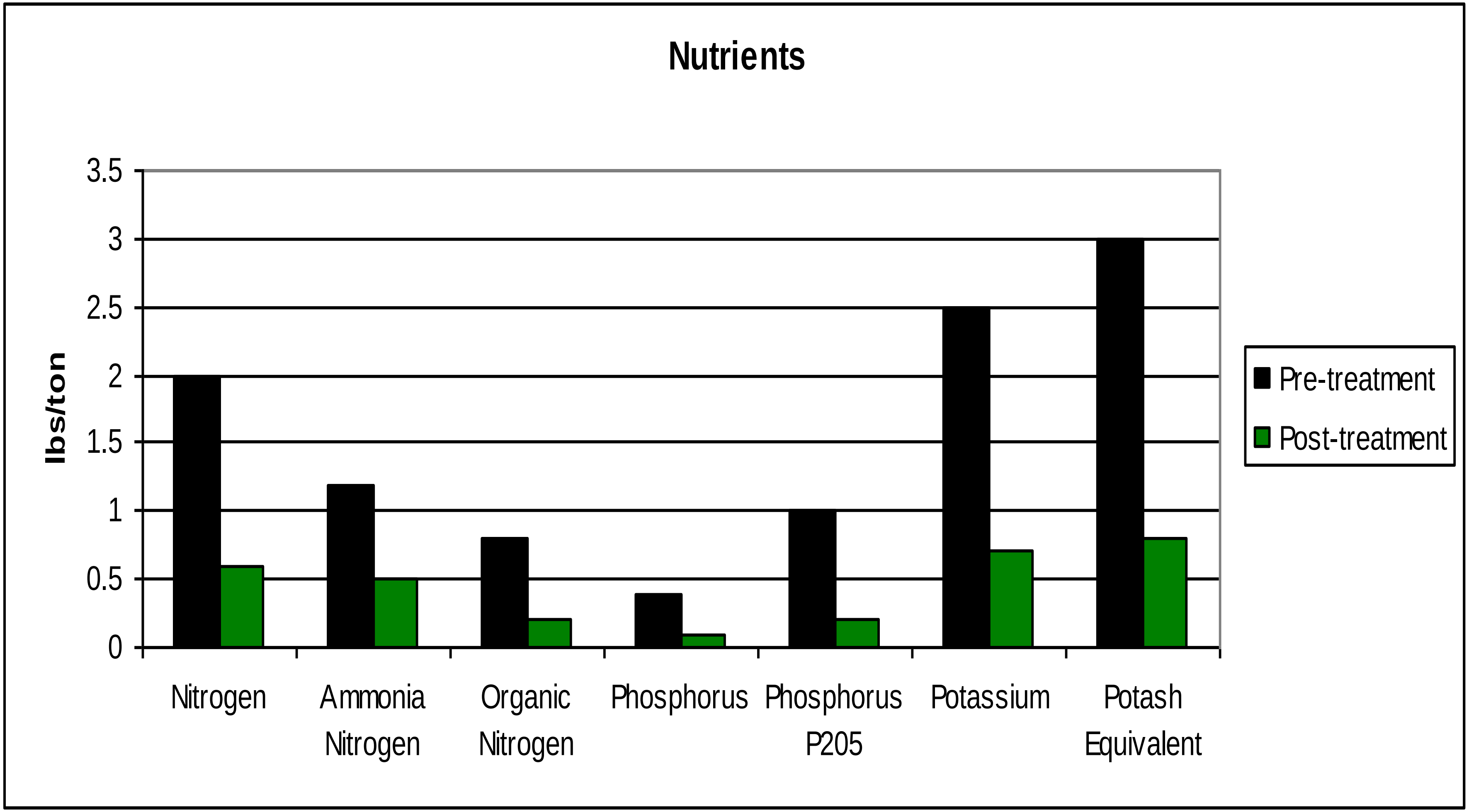


# Dairy 1

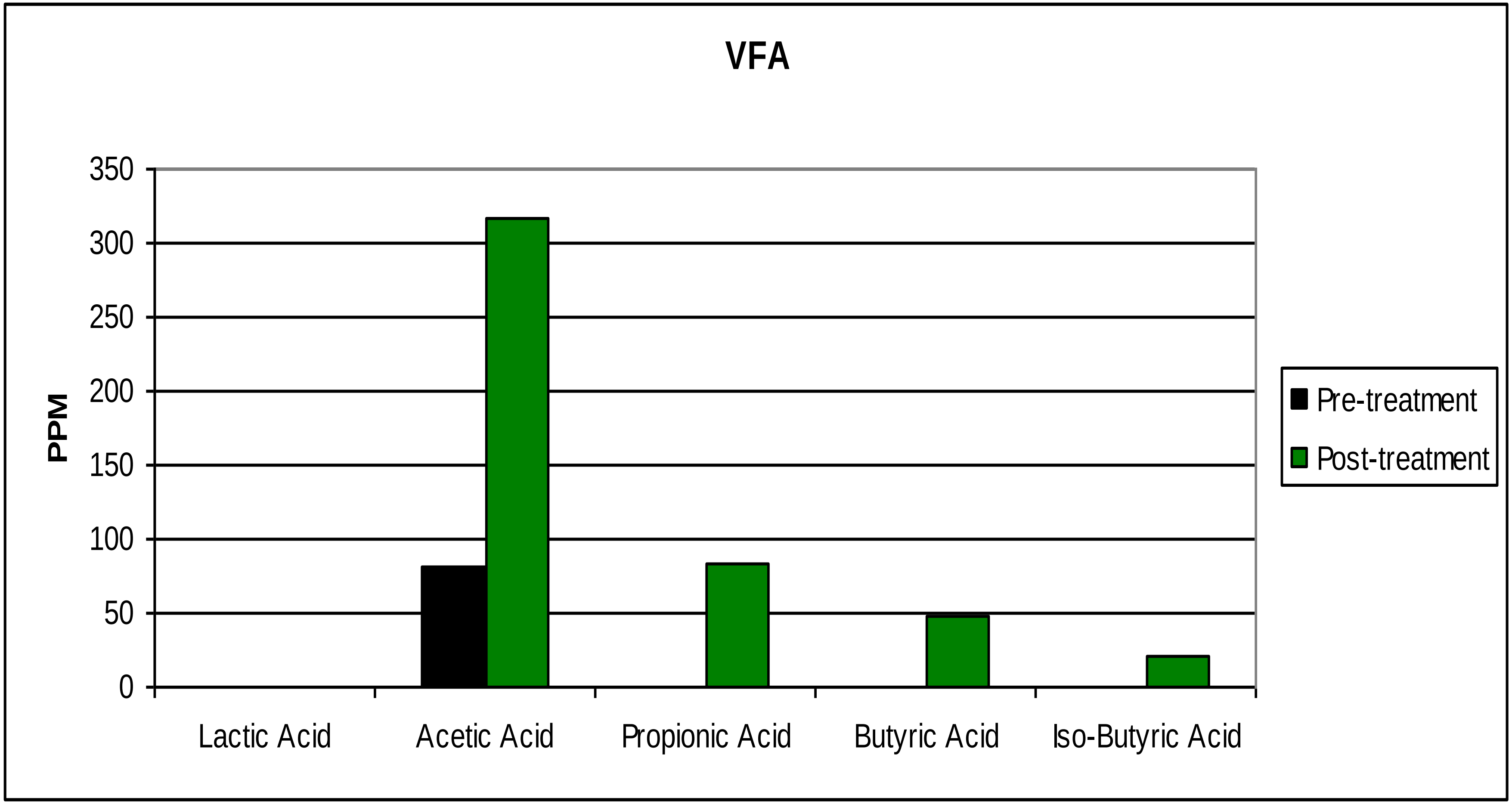



CHR HANSEN

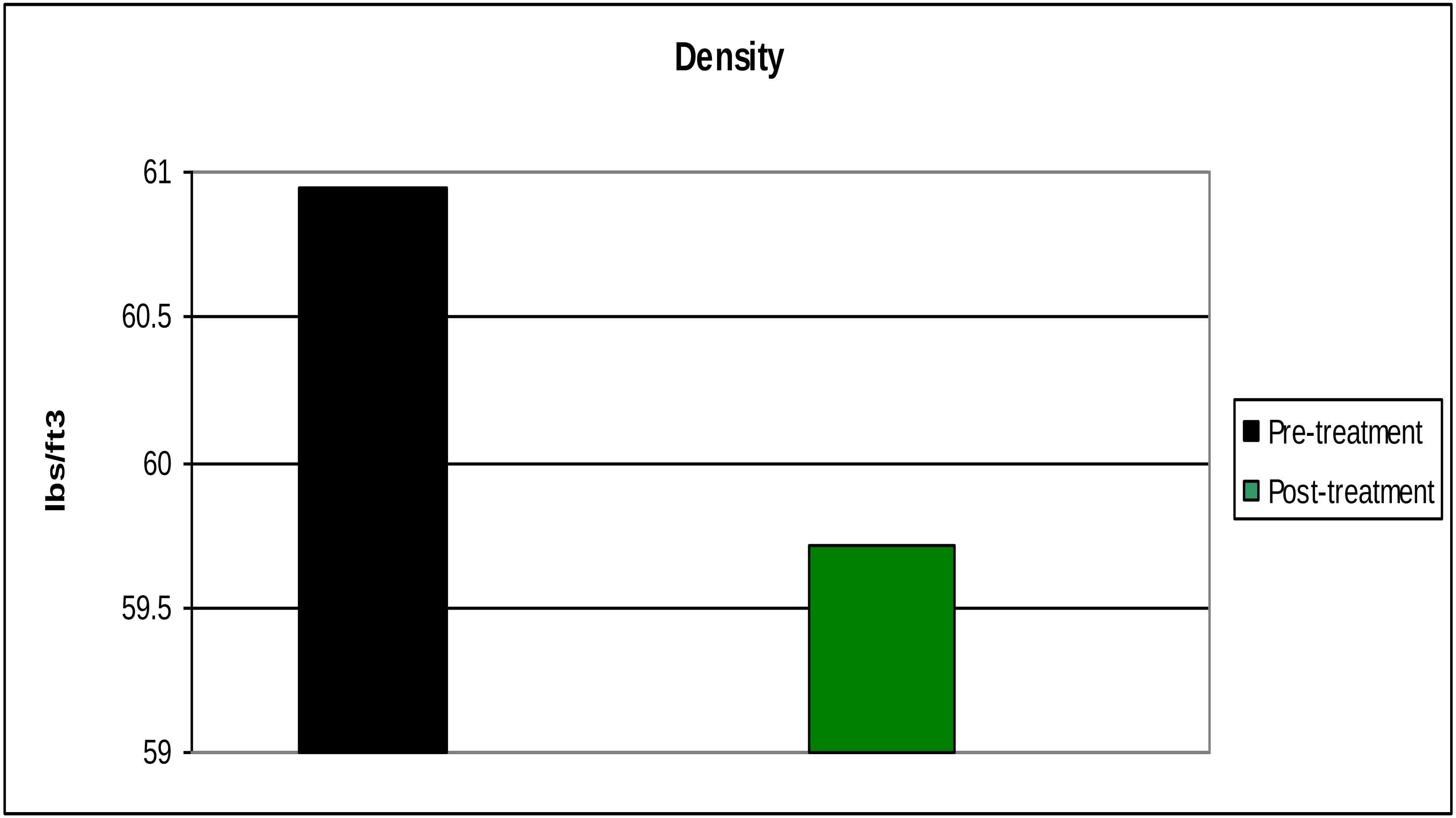
# Dairy 2: liquid phase



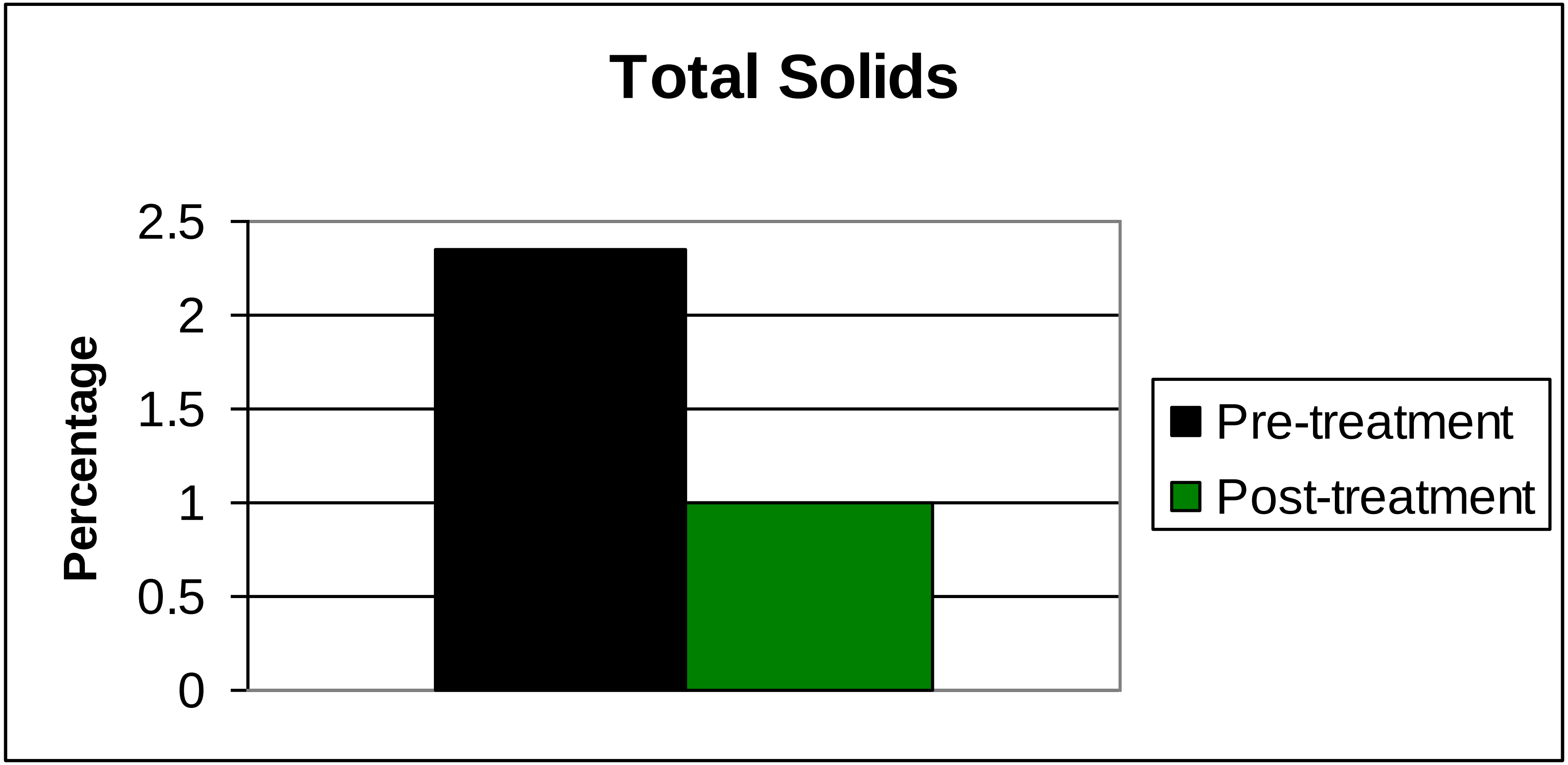
# Dairy 2: liquid phase



# Dairy 2: liquid phase



# Dairy 2: liquid phase

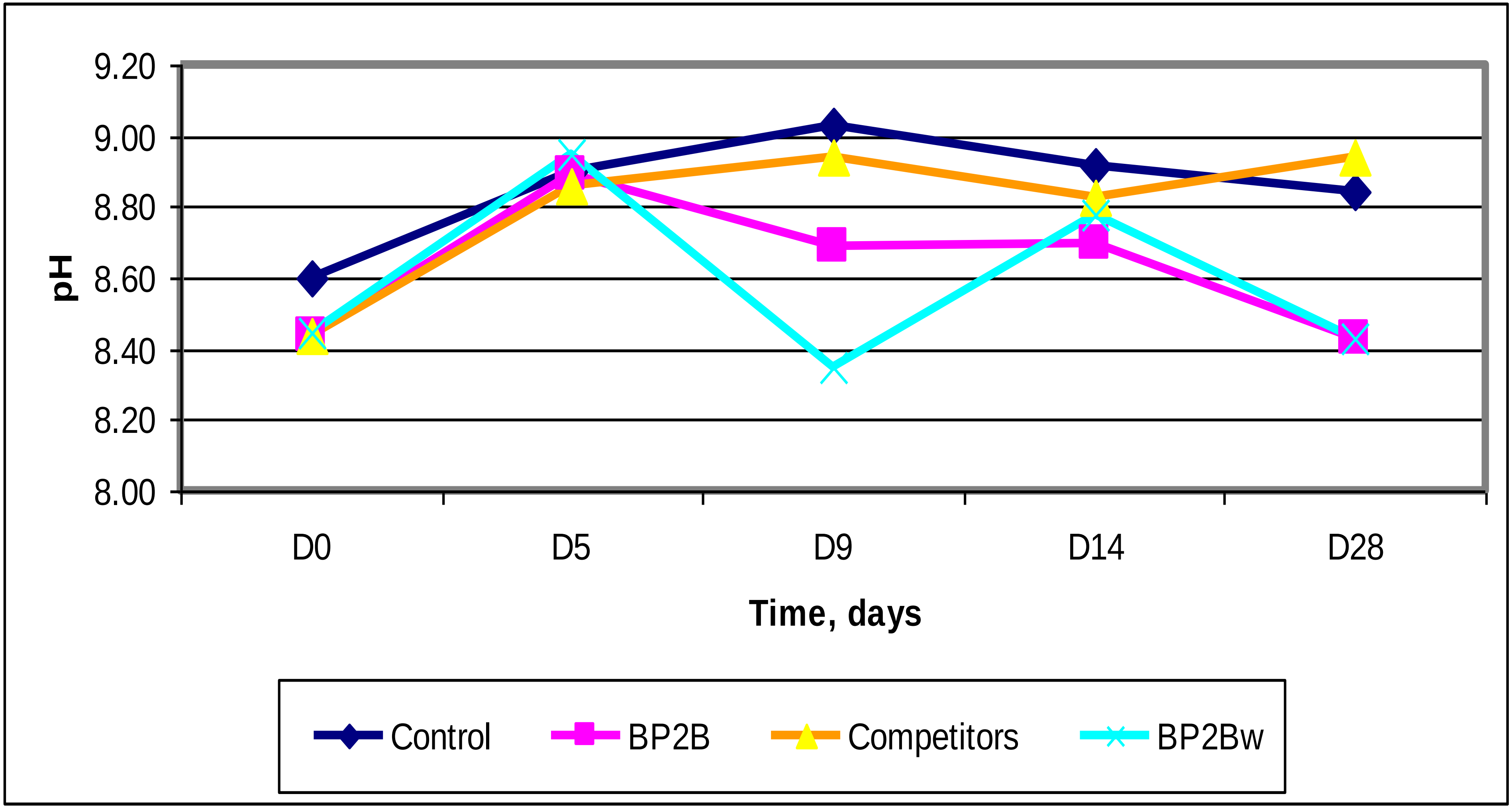


# Usage Rates

- Shock treatment of 2 lbs/250,000 gal (~70 x $10^6$ CFU/gal)
- Every other week treatment 1.5 lbs/200 cows (68 x $10^9$ CFU/cow)

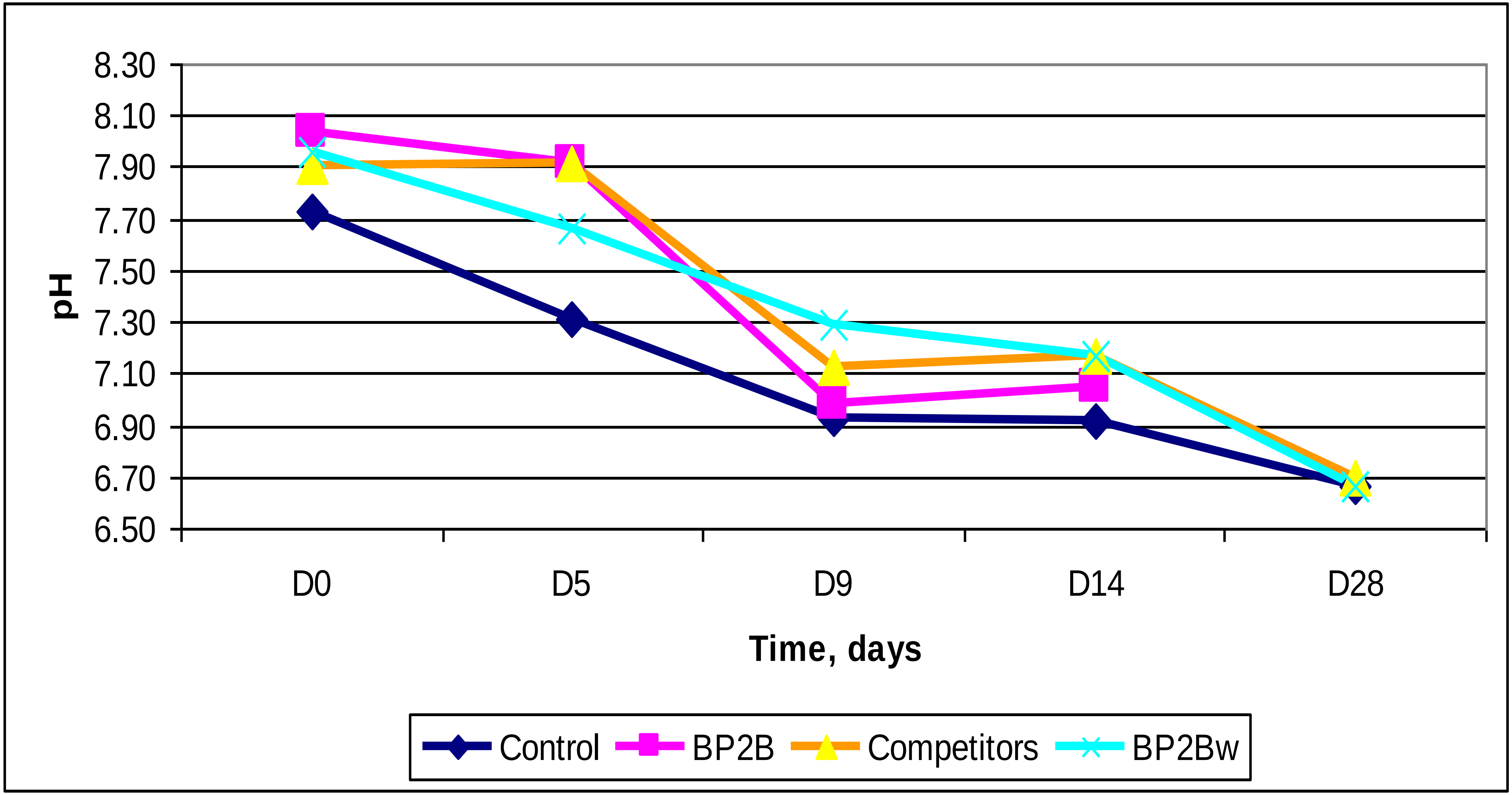
# Lab Bench Work

# pH of Manure Sludge Treated with Bacteria




CHR HANSEN

# pH of Manure Crust Treated with Bacteria



# Visible changes in manure CRUST treated with BioPlus 2B, BioPlus 2Bw vs. Competition

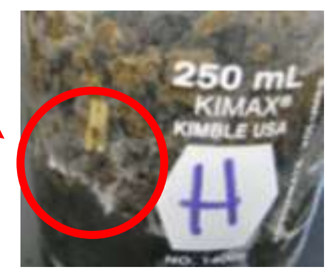


By day 28, crusts treated w/ BioPlus 2B and BioPlus 2Bw were moist.

By day 9, control and Competitor's treated crust was visibly drying out…

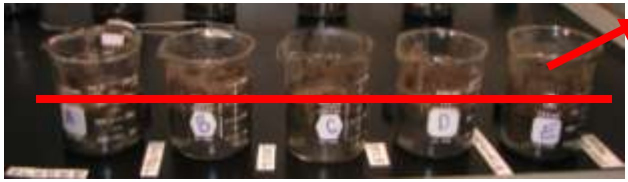
…and continued drying out through D28


Condensation on BP2B treated crust, D28

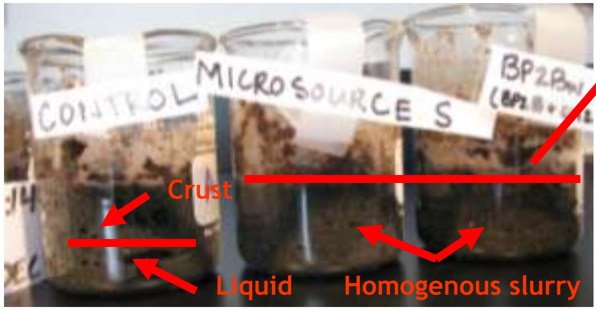


# Visible changes in manure SLUDGE treated with BioPlus 2B, BioPlus 2Bw and Competition


**D5**: gas bubbles produced from all samples when disturbed (to take temp, pH).

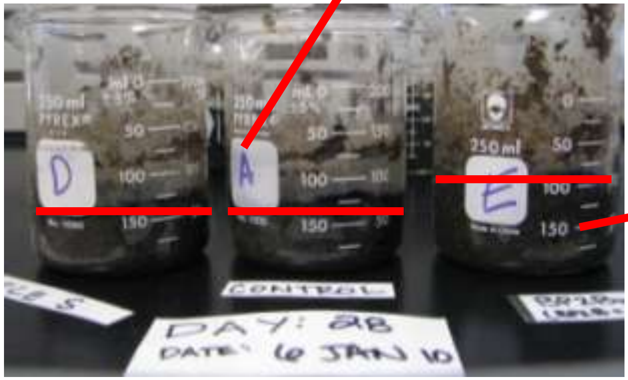


**D9**: all samples had risen (from gas pockets) to approx. same height




**D14**: Control, BioPlus 2B and BioPlus 2Bw samples had separated into liquid & crust. Competitors and BP2Bw samples were homogenous, viscous. All samples had gas pockets.


**D28:** Control & Competitor's has deflated. Thick, solid, cake-like consistency. No bubbling…




…BioPlus 2B & BioPlus 2Bw samples still gassy, bubble when disturbed.

# Comments from Microbiologist on the Crust

- Control crust was dry by D9; flies present at D28
- Competitor’s product treated crust was dry by D9; very little difference from control but w/o flies
- **CH BP2B moistest, no flies and rotten egg smell**
- **CH BP2Bw 2nd moistest, no flies, no smells**

# The effect of probiotic BioPlus 2B® on growth performance, dry matter and nitrogen digestibility and slurry noxious gas emission in growing pigs

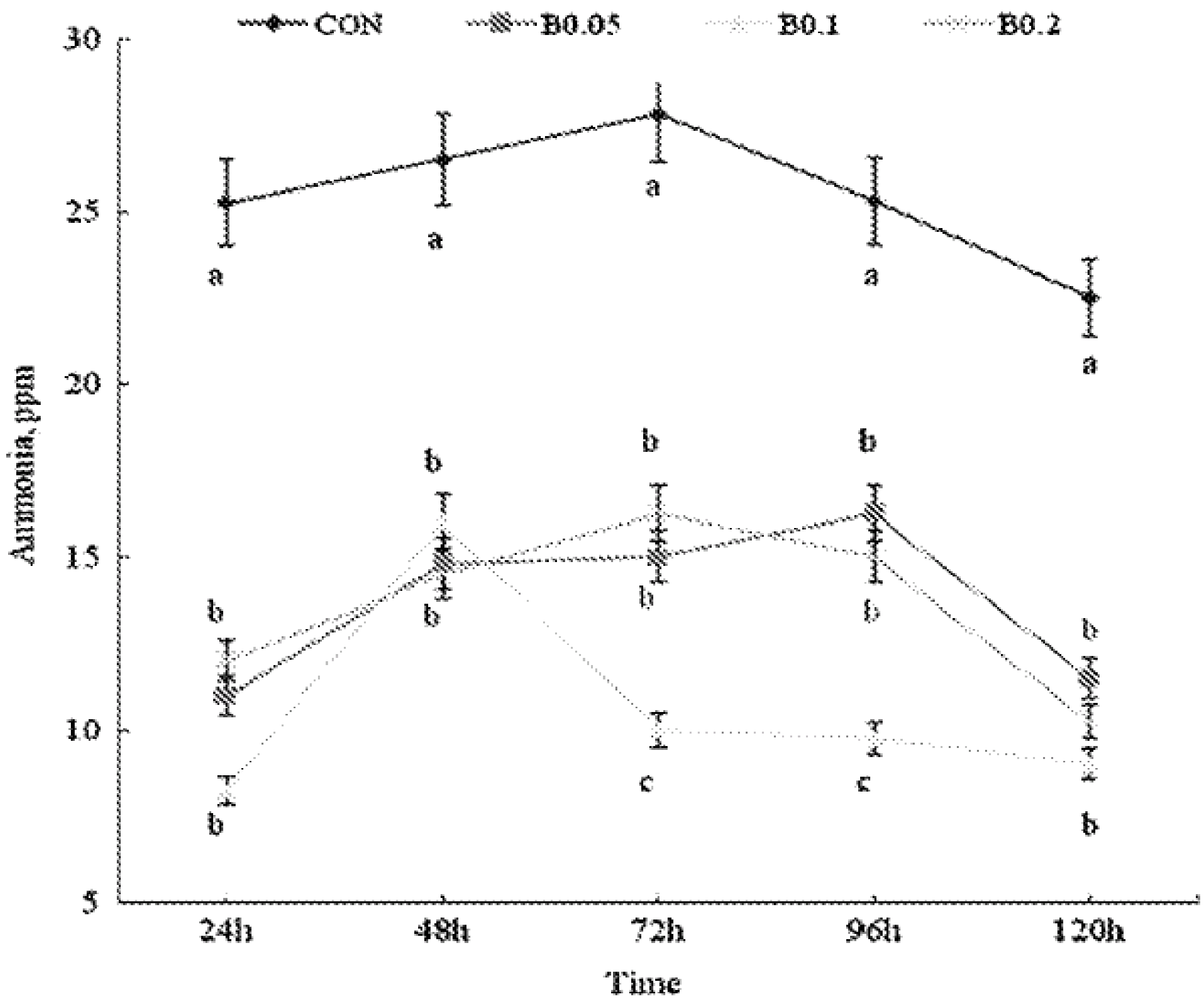
Y. Wang, J.H. Cho, Y.J. Chen, J.S. Yoo, Y. Huang, H.J. Kim, I.H. Kim*

Livestock Science 120 (2009) 35–42

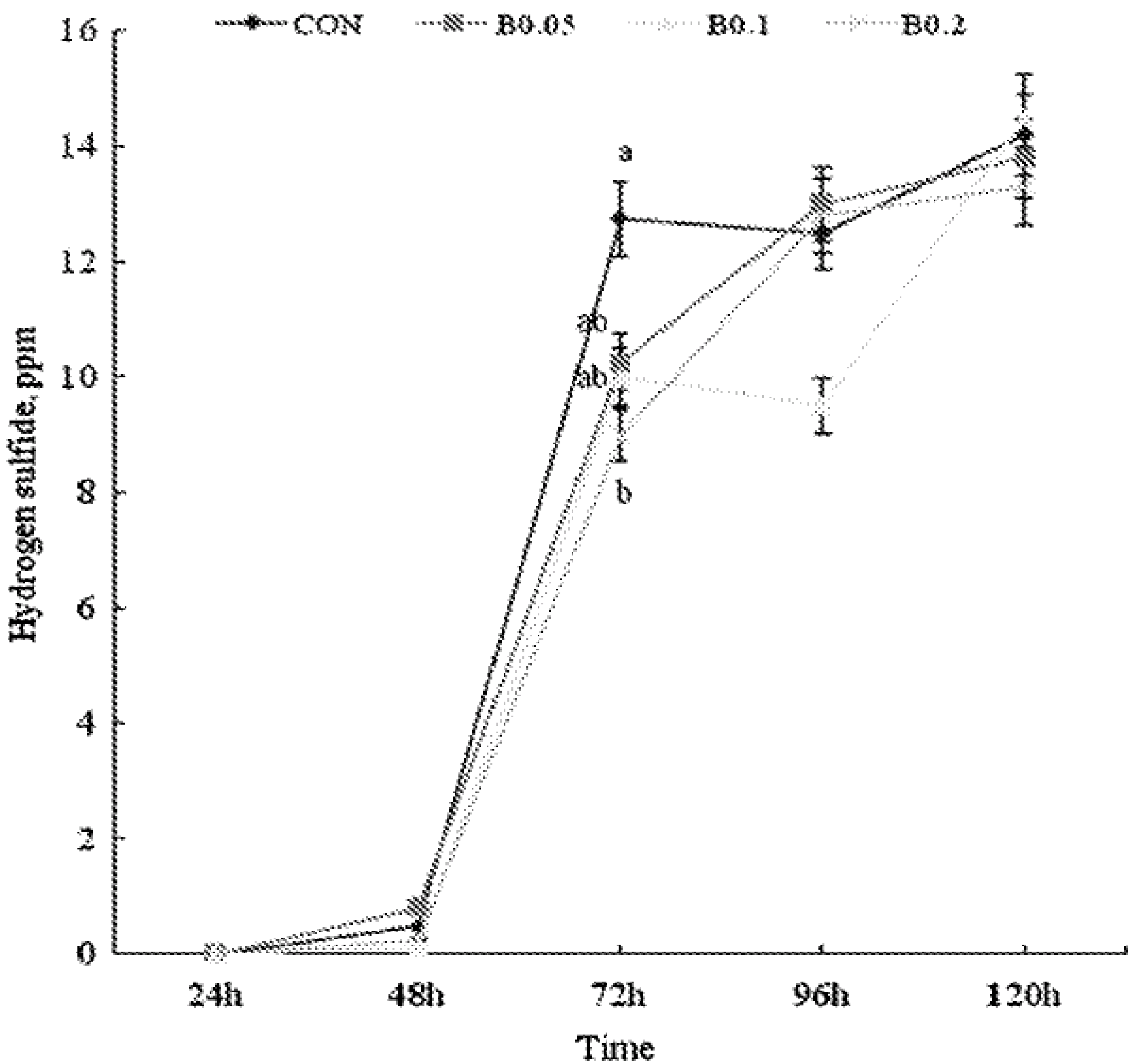
# Effect of Bioplus 2B on performance

| Item | CON[a] | B0.05[a] | B0.1[a] | B0.2[a] | SE[b] | P-values[c] | |
|---|---|---|---|---|---|---|---|
| | | | | | | *L* | *Q* |
| ADG, kg | 0.769 | 0.785 | 0.782 | 0.798 | 0.0221 | 0.08 | 0.53 |
| ADFI, kg | 1.491 | 1.499 | 1.536 | 1.560 | 0.0232 | 0.03 | 0.72 |
| G:F | 0.516 | 0.524 | 0.509 | 0.516 | 0.0167 | 0.12 | 0.57 |
| DM | 0.821 | 0.817 | 0.813 | 0.811 | 0.0062 | 0.23 | 0.94 |

# Effect of Bioplus 2B on Sludge Ammonia

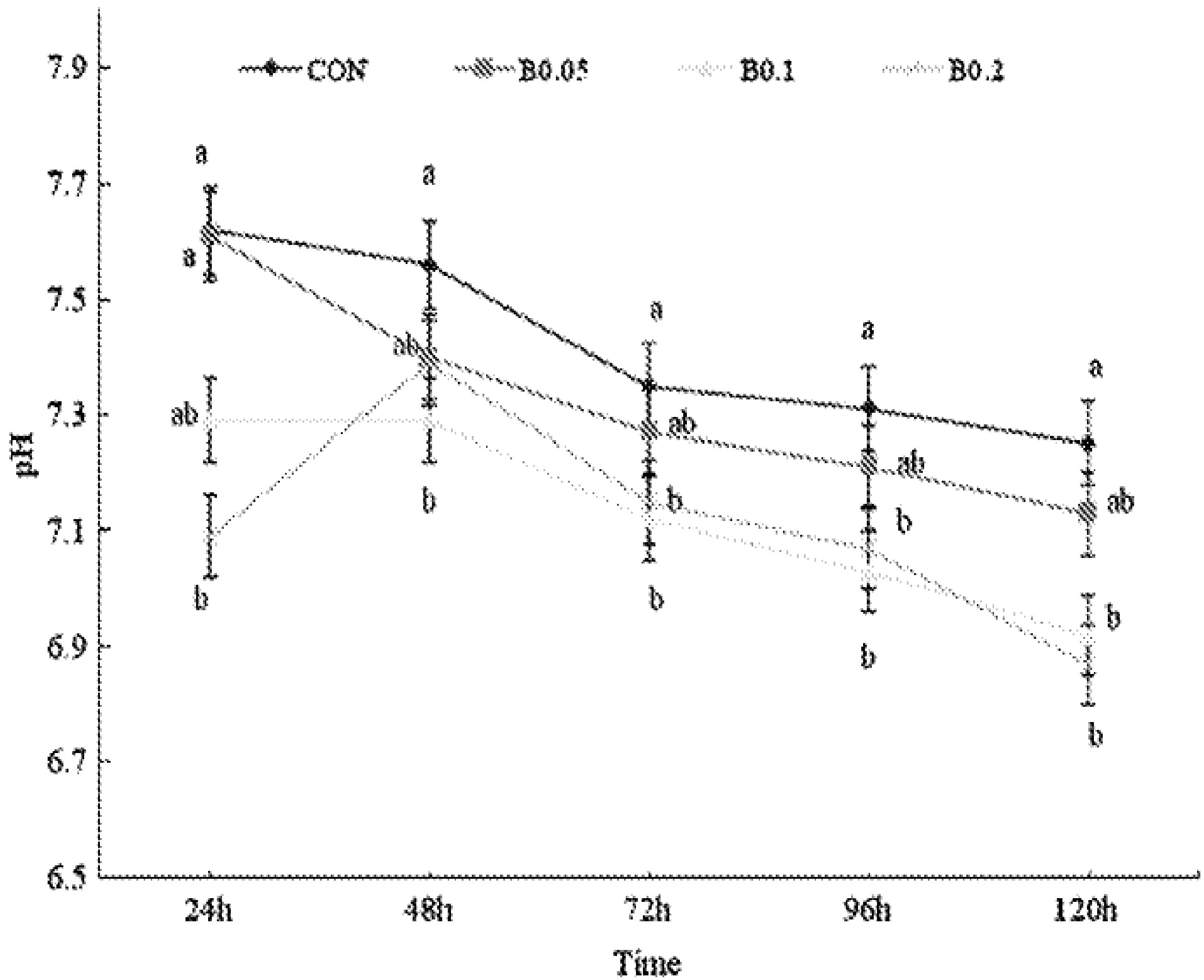


# Effect of Bioplus 2B on $H_2S$ in Manure Sludge




CHR HANSEN

# Effect of Bioplus 2B on Slurry pH




CHR HANSEN

# Conclusions

- Improvements in pig performance
- Decreased ammonia content
- No changes in hydrogen sulfide or mercaptan

# Take Home Messages

- Bacteria are a tool to manage manure
- Management conditions, including animal diet, influence success of microbial aids
- Research indicates:
  - Ammonia control
  - Reduction in DM
  - Re-distribution of P
  - Fly control
  - Odor reduction
- May be supplemented as a DFM in monogastrics

# THANKS!!

USLSO@CHR-HANSEN.COM