Potential Rumen, Vascular and Production Benefits of Isoflavones in Ruminant Diets

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Non-ruminant
"monogastric"

Esophagus

Gastric stomach

Small intestine

Large intestine

Main fermentation sites



Ruminant

Esophagus

Rumen

Gastric stomach

Small intestine

Large intestine

Rumen

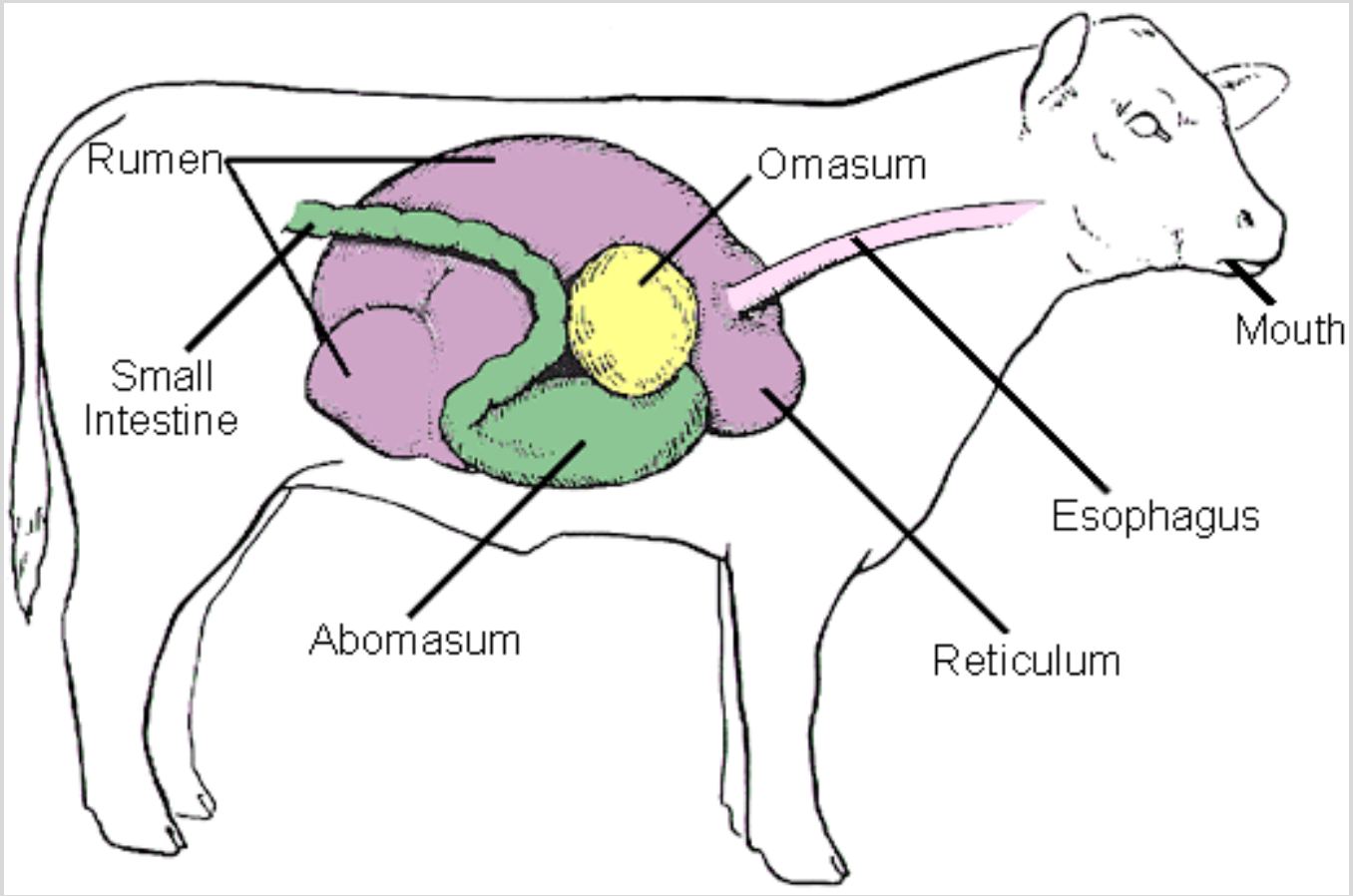
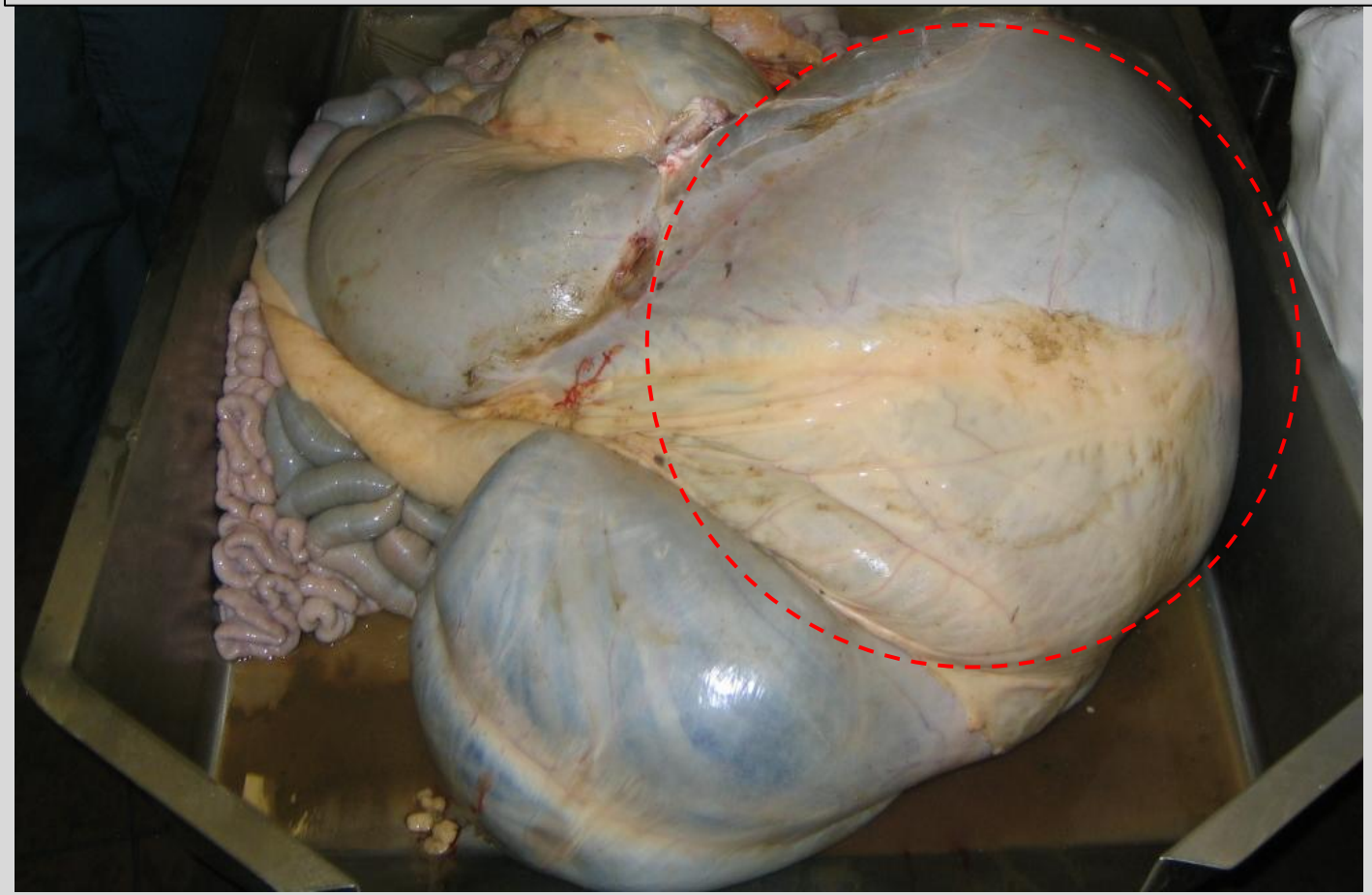


Diagram by Michelle Ogden

Bovine gastrointestinal tract

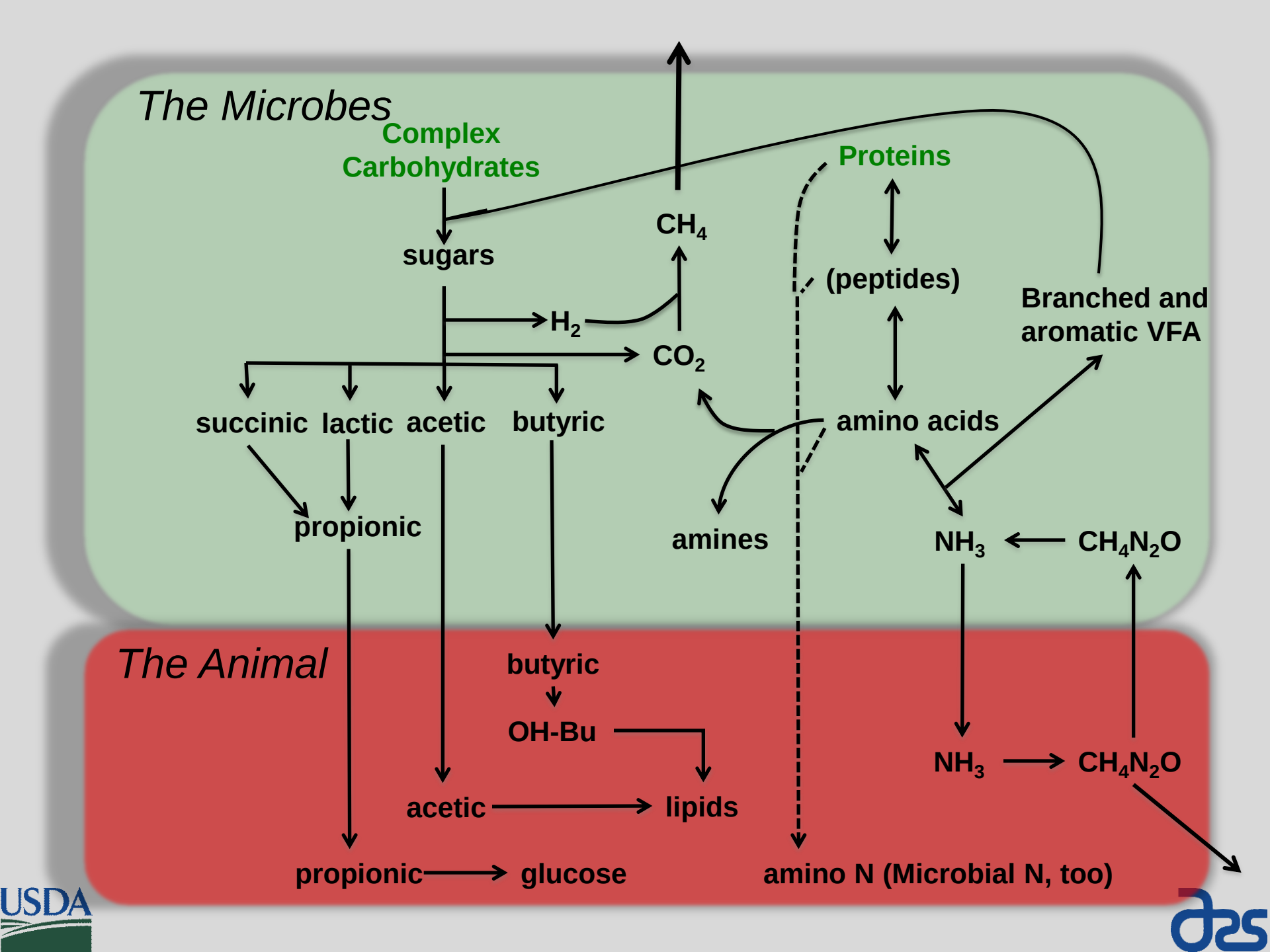


Inhabitants of the Rumen

- Archaea
  - mostly *Euryarchaeota*
- Protozoa
  - mostly *Ciliophora*
- Fungi
  - mostly *Neocallimastigomycota*
- Bacteria
  - mostly lots of things



SEM courtesy of Andre Dennis Wright


The Microbes
Complex Carbohydrates
sugars
CH4
H2
CO2
Proteins
(peptides)
Branched and aromatic VFA
amino acids
succinic
lactic
acetic
butyric
propionic
amines
NH3
CH4N2O
The Animal
butyric
OH-Bu
acetic
lipids
propionic
glucose
amino N (Microbial N, too)
NH3
CH4N2O

Theory of Applied Rumen Microbiology

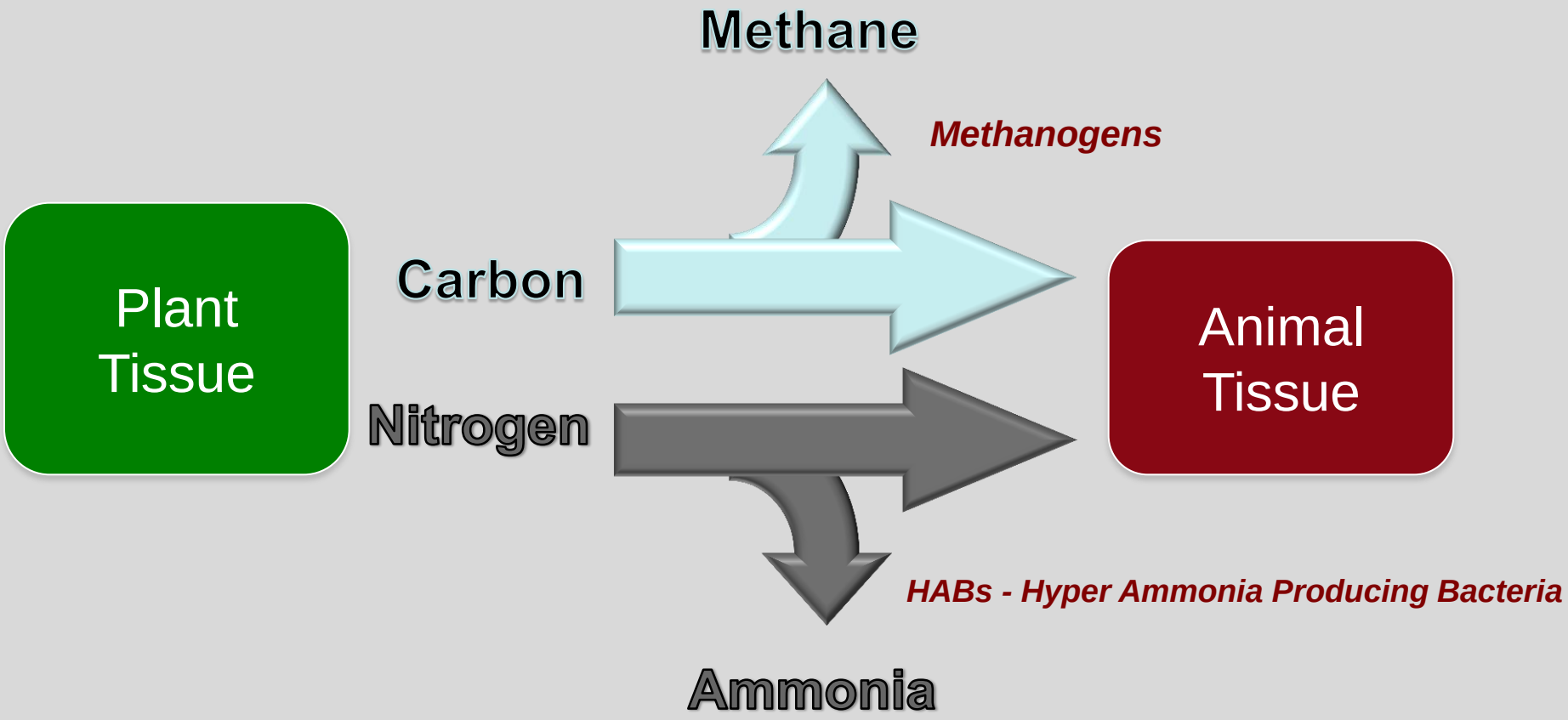
1. The rumen is a natural fermentation

2. Fermentation can be altered by changing conditions that affect microbial physiology

1. Therefore, the rumen fermentation can be optimized like any other fermentation

1. Optimization of rumen fermentation will result in improved feed utilization and animal performance

Wasteful Processes Mediated by Commensal Rumen Microorganisms



How do we control HAB and prevent amino nitrogen loss?

Antimicrobial Growth Promoters

Ionophore Antibiotics - Rumensin® and Bovatec ®

The cattle industry has used ionophores for over 30 years.

Bovatec® = Lasalocid

Rumensin® = Monensin = 1.4 million tons of feed per year

- Kills coccidia
- Prevents rumen acidosis
- Kills HAB and decreases rumen ammonia production

Pharmaceuticals from plant secondary metabolites

Aspirin



Morphine



Artemisinin



Quinine



Resveratrol



Our Goals

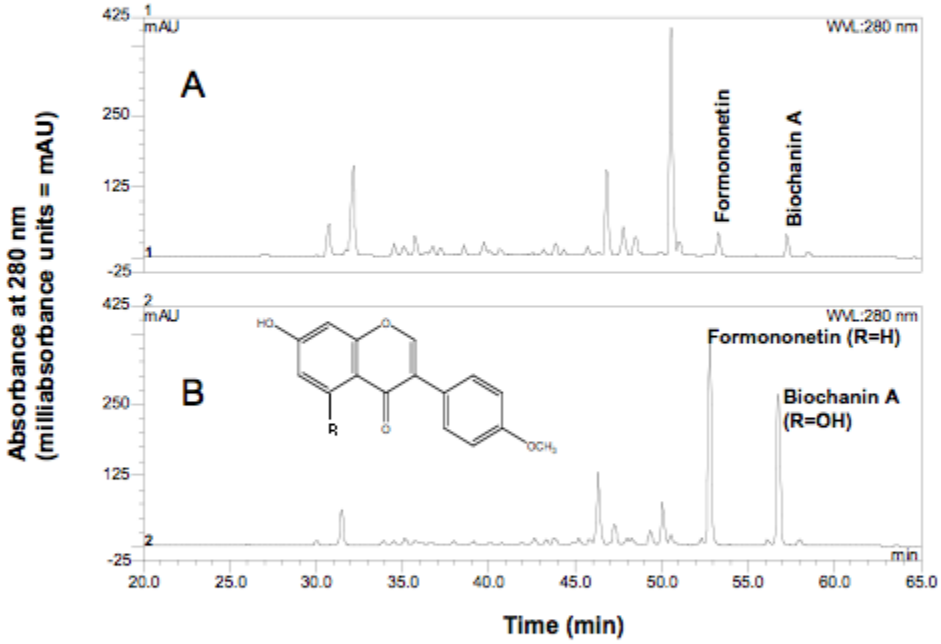
Discover a secondary metabolite from a forage plant that has antimicrobial activity against HAB

Determine if that compound can decrease ammonia production by rumen bacteria

Test the compound to determine if it promotes weight gain in ruminants

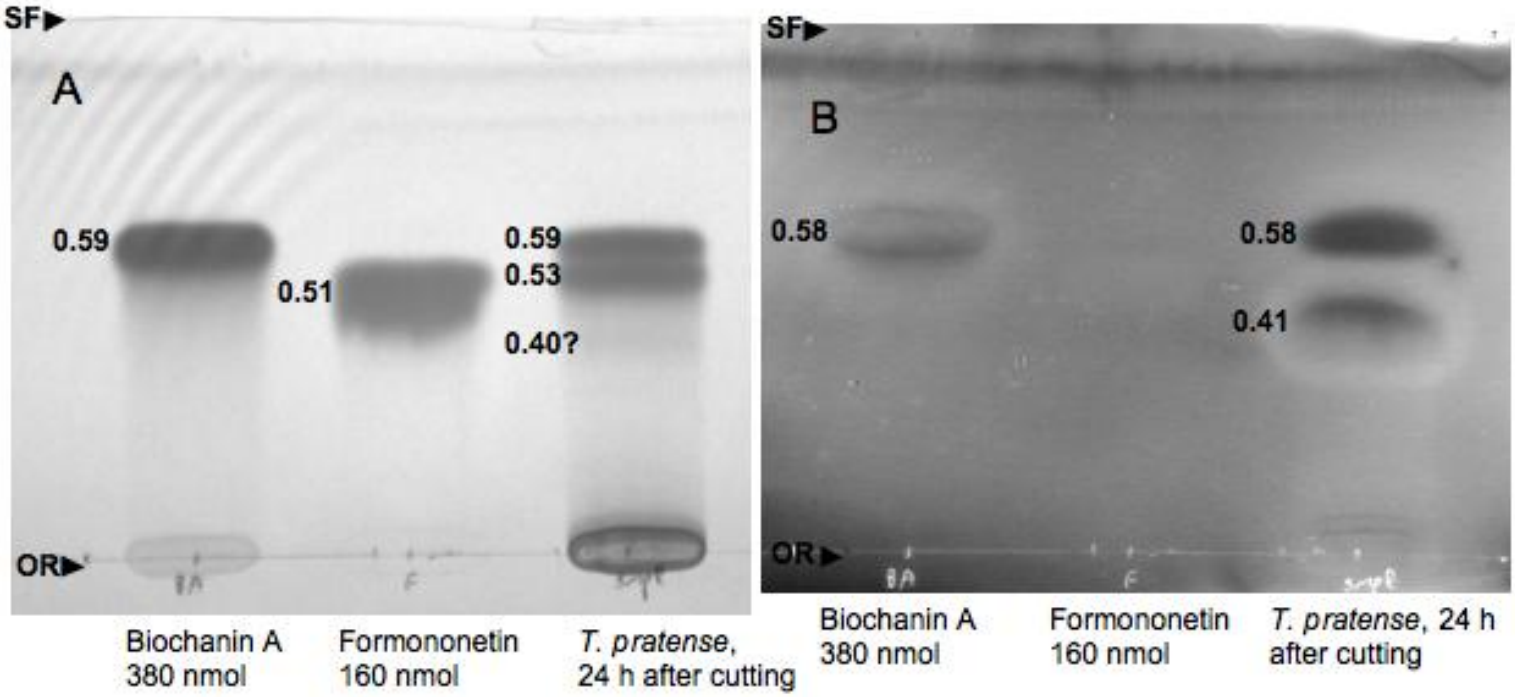
Fig.1



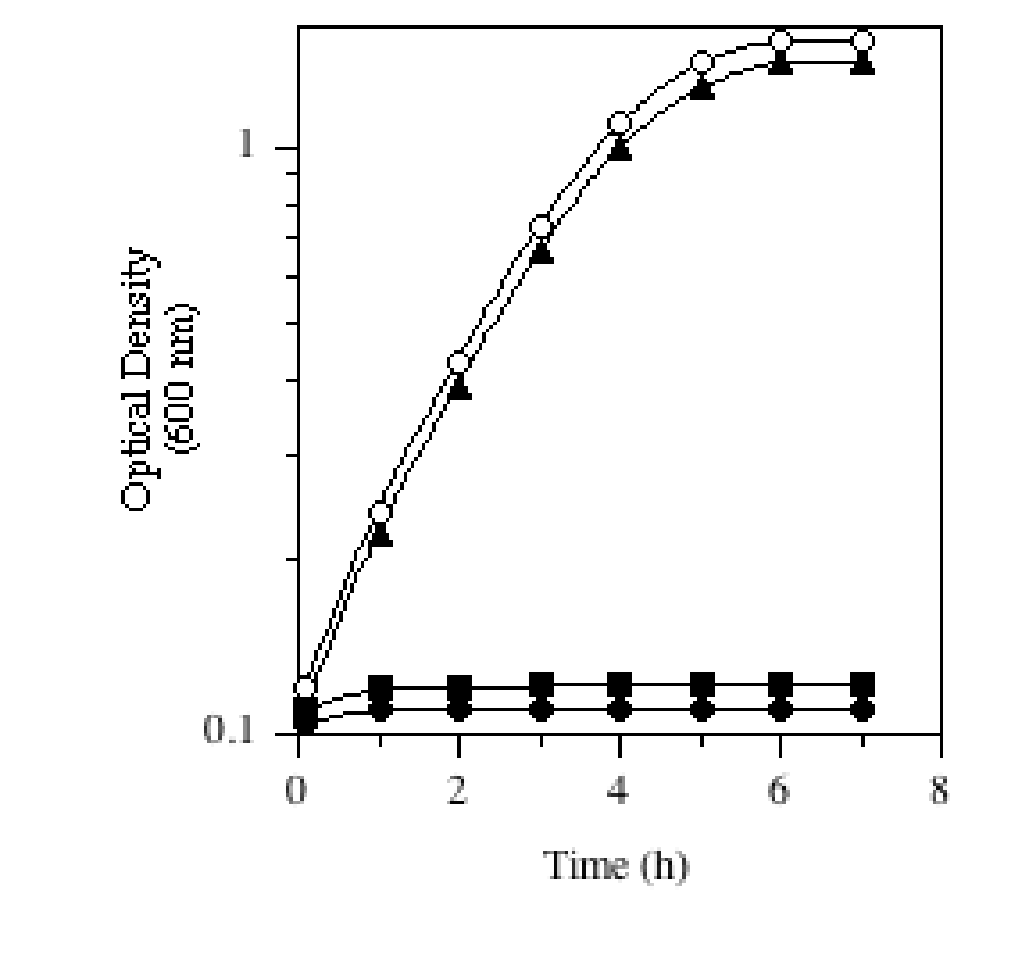


Chromatograms of soluble phenolic extract of *Trifolium pratense* cv. Kenland, harvested 0 h (A) and 24 h (B) after clipping. No peaks eluted prior to 30 min.

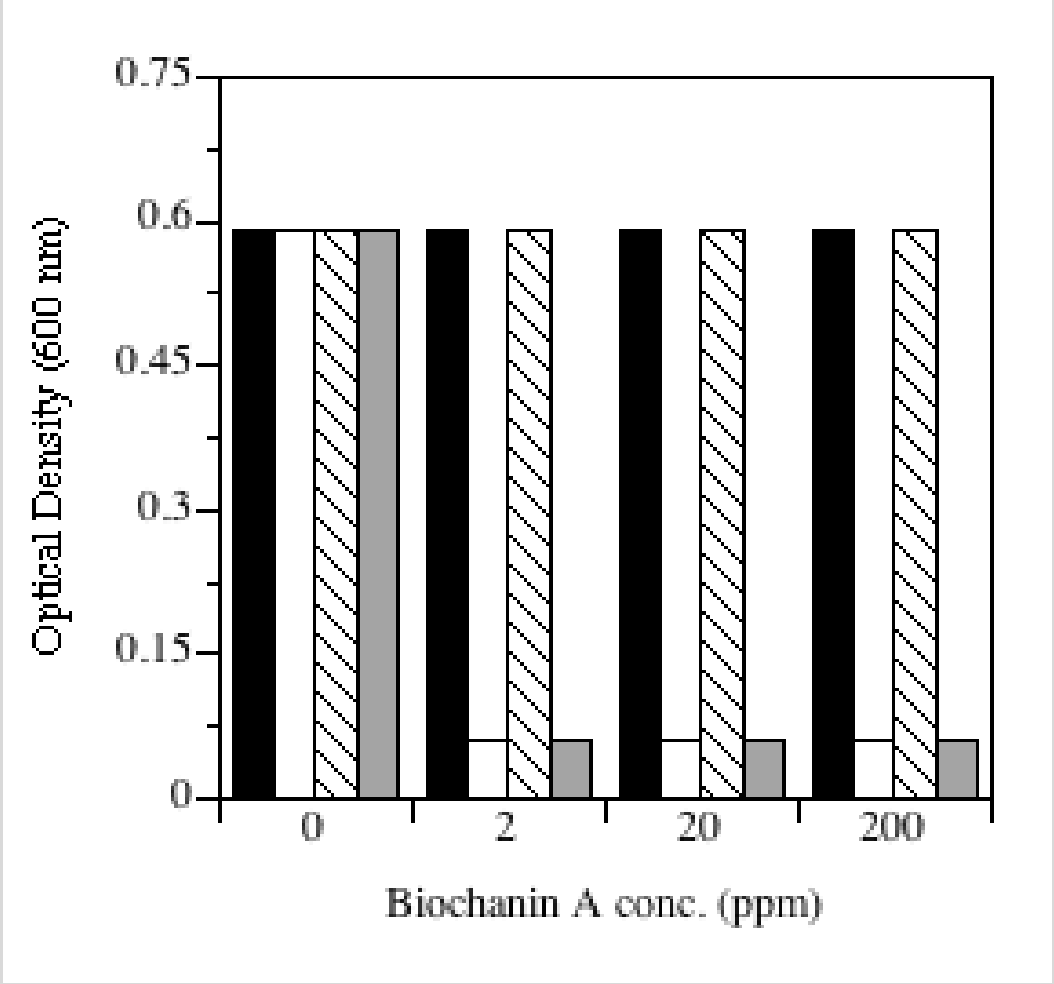
Fig. 2



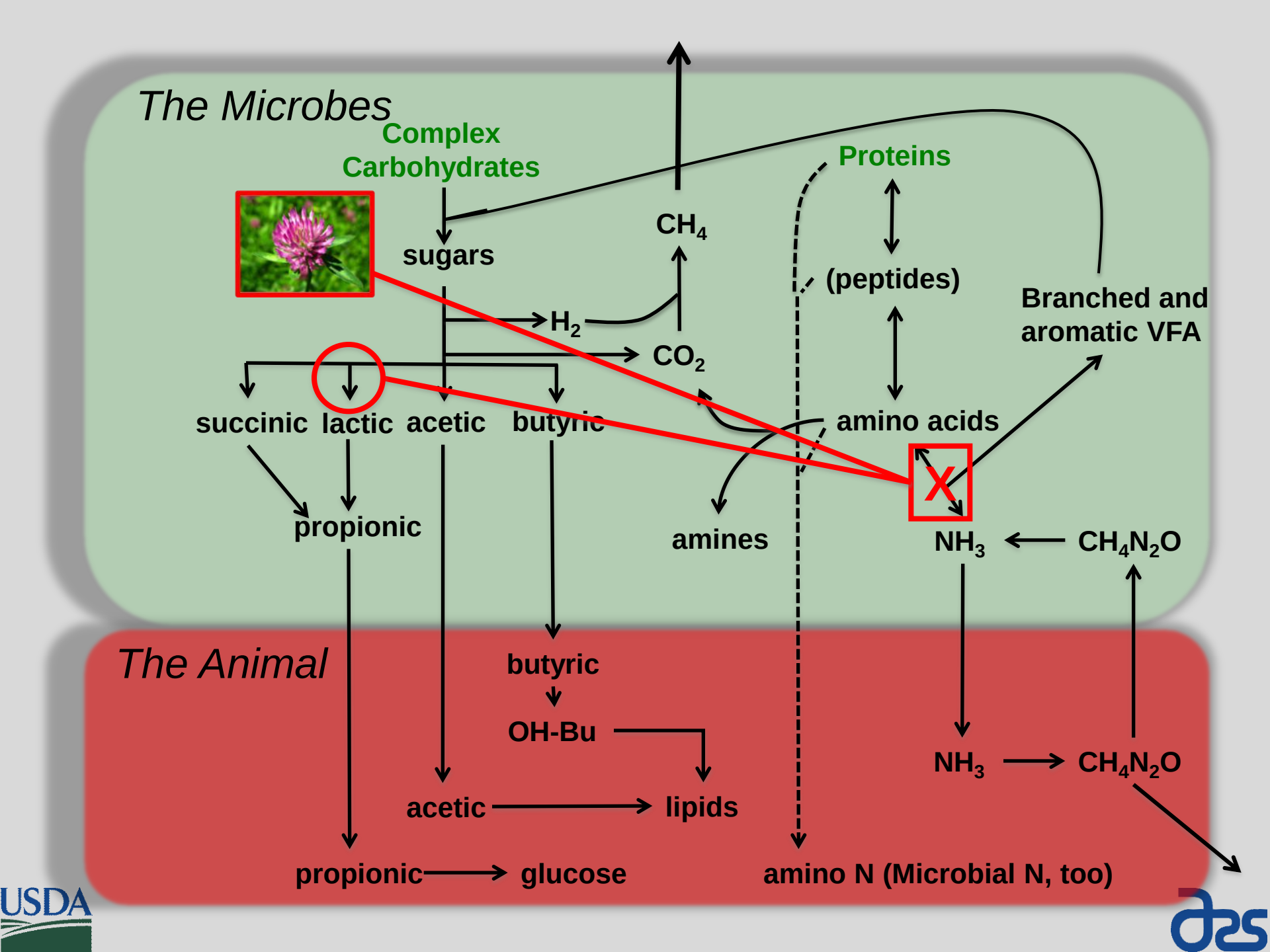
Thin-layer chromatogram viewed under short-wave UV light (A) prior to bioassay, and under visible light (B; inverted image) after bioassay with *Clostridium sticklandii*.

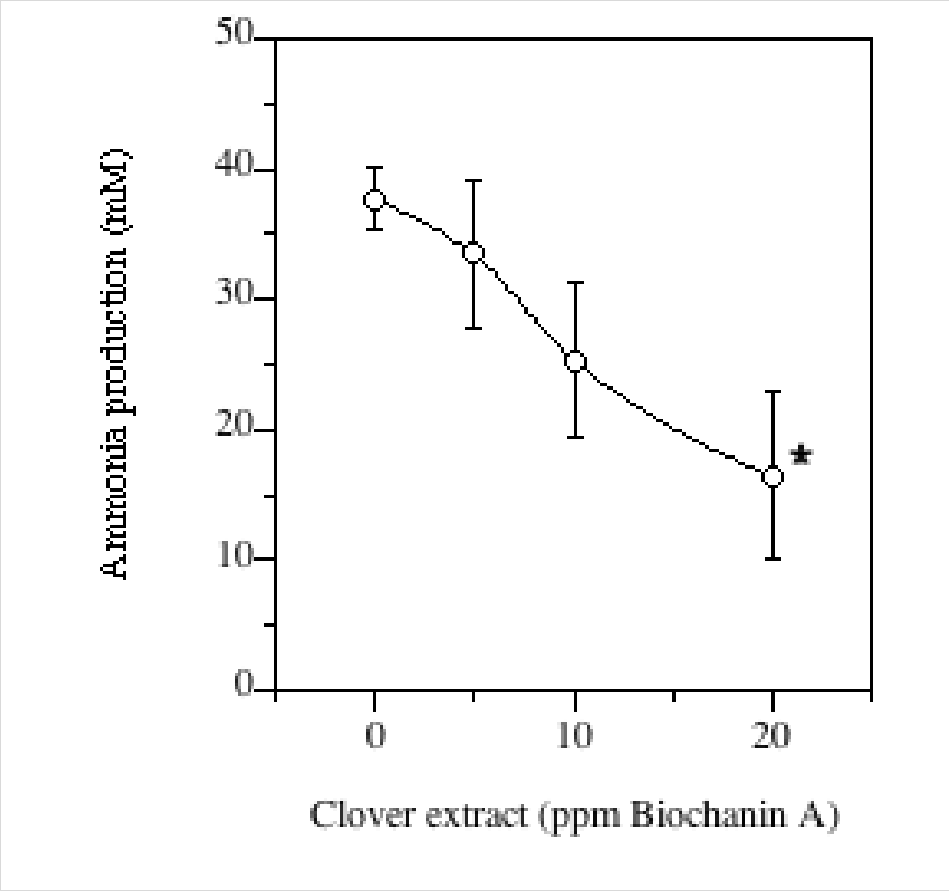


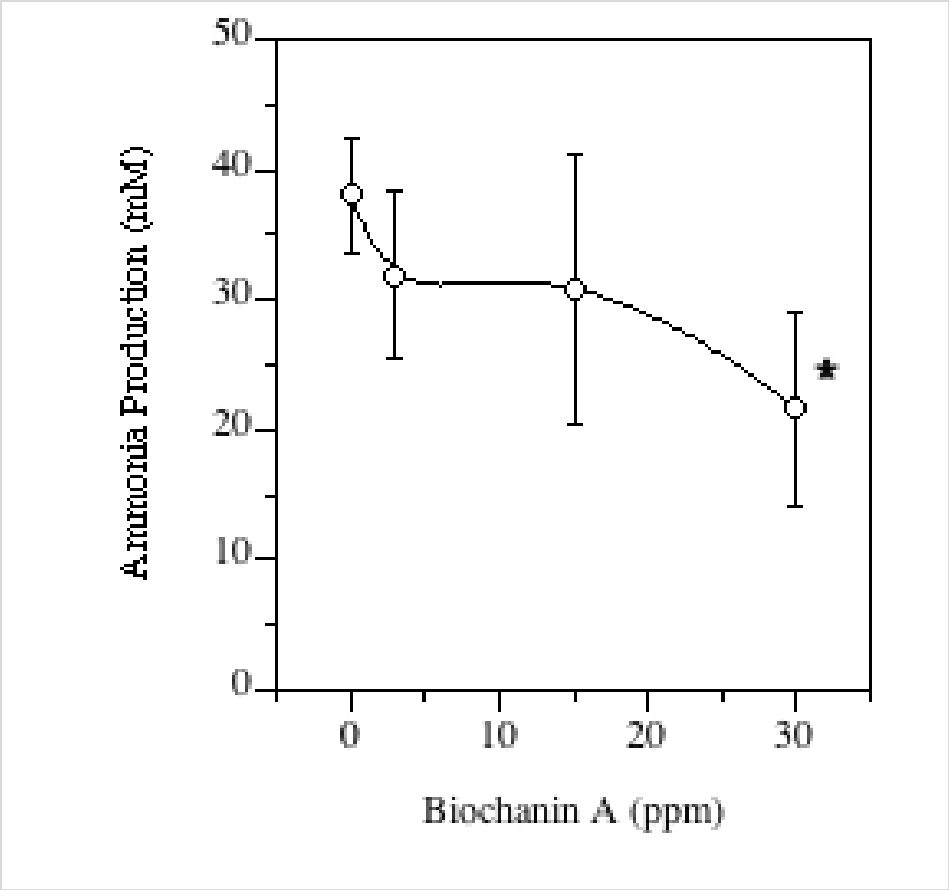
The growth of *Clostridium sticklandii* (open circles). Closed symbols indicate the addition of clover extract (circles), 100 nmol ml^{-1} biochanin-A (squares), or 100 nmol ml^{-1} formononetin (triangles) prior to the zero time point.



Effect of biochanin A on the growth of the Hyper Ammonia-Producing bacterium, *Peptostreptococcus* spp. BG1.The medium was supplemented with no addition (black bars), rumen fluid (white bars), a volatile fatty acid mixture (hatched bars) or the supernatant of a bacteriocin-producing *Streptococcus bovis* (gray bars).


The Microbes
Complex Carbohydrates
Proteins
sugars
CH_4
(peptides)
Branched and aromatic VFA
H_2
CO_2
succinic
lactic
acetic
butyric
amino acids
X
propionic
amines
NH_3
CH_4N_2O
The Animal
butyric
OH-Bu
NH_3
CH_4N_2O
acetic
lipids
propionic
glucose
amino N (Microbial N, too)



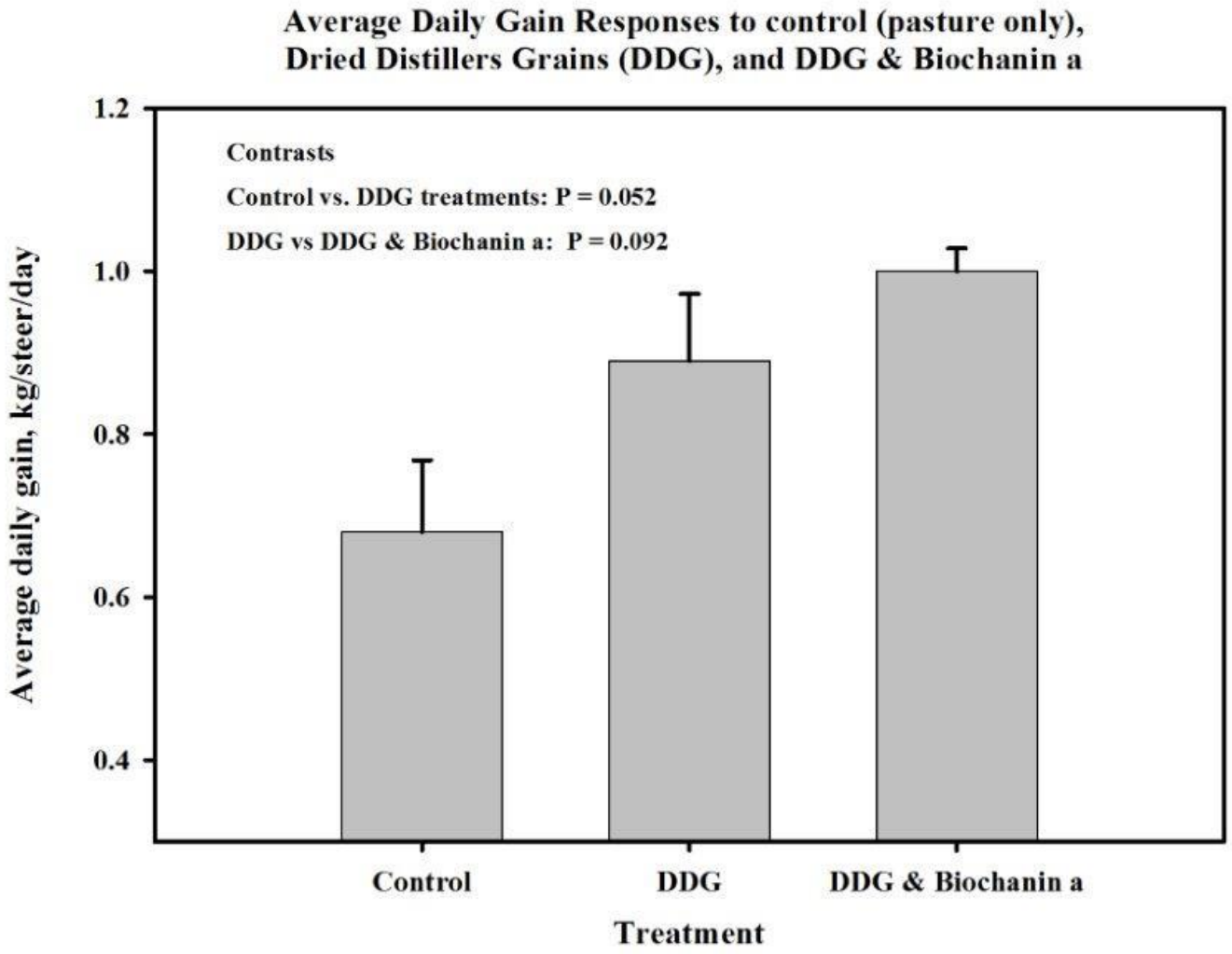


Effect of clover extract or biochanin A on ammonia production by mixed microbes from the rumen of a goat.

Biochanin-A Feeding Trial

- 48 calves, 4/pasture, 3 pastures/treatment
- Treatments
  - Unsupplemented
  - Dry distiller's grains
  - Dry distiller's grains + biochanin A

- Biochanin A 7 g/head/day
- 63 day trial


Average Daily Gain Responses to control (pasture only), Dried Distillers Grains (DDG), and DDG & Biochanin a
Contrasts
Control vs. DDG treatments: P = 0.052
DDG vs DDG & Biochanin a: P = 0.092
Average daily gain, kg/steer/day
1.2
1.0
0.8
0.6
0.4
Control
DDG
DDG & Biochanin a
Treatment

Biochanin-A Feeding Trial

The dry distiller's grains did not contain an antibiotic

Biochanin-A 7 g/head/day is not a super-physiological or unrealistic dose

We are currently repeating the study

Additionally

We discovered beneficial vascular effects of clover isoflavones.

Please attend Glen Aiken's talk to tomorrow

No Silver Bullets









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Photo Credits

Laura Strasinger, André Dennis Wright, Iris Flythe, Michael Flythe, *Photobucket.com* & other public content

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