Copper wire particles
- Lambs and Kids
  - Studied under natural infection.
  - History of grazing on same pastures, but different times.
  - Grazed same area during study.
  - Kids - Spanish breed
  - Lambs - Wool and hair ancestry
  - Wethers

The Truth about Copper?
Why Sheep Ewenique?
- Complicated and Complex
  - Variable
  - Unpredictable

WHAT IS COPPER?
- Nutrient
  - Dietary Essential Trace or Micromineral
  - Needed in Small Amounts for Essential Functions
  - Generally Acquired through Feedstuffs
  - Both Deficiency and Excess are Concerns

FURTHER POINTS IN UNDERSTANDING CU
Dietary essential
- Amount is a key
- Chemical form determines bioavailability.
- Liver is the primary storage tissue for Cu.
- Stress factors have a major role in release.
- Most Cu absorbed in preintestinal area.

Forms of Copper
- Copper sulfate (CuSO₄)
- Copper lysine (CuLys)
- Copper proteinate (chelation of Cu with amino acids)
- Copper oxide (CuO)
Key Points on Copper Homeostasis

- Normal levels of Cu in blood plasma are
  - 0.8 - 1.5 mg Cu/L.
- Copper absorption is more important than its concentration in the feed.
- Copper requirement in sheep is 7 - 11 mg/kg (ppm) dry matter.

Homeostasis, cont.

- In sheep, copper absorption is relatively poor (1.4 - 12.8%) but influenced by ...
  - Type of diet, including forage type.
  - Level of Mo, S, Fe ... and to a degree Ca, Zn.
  - Protein level of the forage or feed.
  - Age of animal.
    - Young animals (lambs) may absorb up to 90% of dietary copper.

Copper Absorption Levels for Sheep (NRC, 2007)

<table>
<thead>
<tr>
<th>Absorption Coefficient</th>
<th>Lamb, preweaning</th>
<th>5 kg (~11 pounds)</th>
<th>10 kg (~22 pounds)</th>
<th>20 kg (~44 pounds)</th>
<th>Lamb, postweaning (pasture)</th>
<th>Lamb, postweaning (feedlot)</th>
<th>Ewe, gestation</th>
<th>Ewe, lactation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.90</td>
<td>0.33</td>
<td>0.20</td>
<td>0.045</td>
<td>0.06</td>
<td>0.06</td>
<td>0.045</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Copper Toxicosis in Sheep

- Phase I - Prehaemolytic. Copper accumulates in the liver to exceed 1,000 mg Cu/kg. Can last for a few weeks to more than a year.
- Phase II - Haemolytic crisis. Copper is released from the liver in lysosomes and blood copper value rises. Followed by haemoglobinuria, haemoglobinemia, and jaundice. Lasts from hours to days.
- Death - may be "sudden"

Toxicosis, cont.

- Variables include:
  - Breed and perhaps genetic type.
  - Environmental stresses
- NRC (2007) suggests maximum tolerable Cu concentration for sheep is 15 mg/kg dry matter when dietary Mo and S are at normal levels.

Why Copper Oxide Does not Kill Sheep?

- Bioavailability very low.
- Form has an influence - particles vs powder.
- Duration of exposure may be short.
- Resides in one location so not multiple sites for absorption.
**PROTOCOL FOR COPPER OXIDE IN INTERNAL PARASITE MANAGEMENT**

- Role in control of *H. contortus* which reside in abomasum.
- Bolus containing 0.5 g copper wire particles.
- Administer bolus up to need up to 2-4 g.
- Most effective in younger animals and during seasons when challenge is greatest.
- See [www.SCSRPC.org](http://www.SCSRPC.org) reference for details.

**What is the Truth Then?**

- Copper is essential for sheep body functions.
- Level of consumption is usually adequate from forages (Soil influences level in plants)
- Supplemental copper may be toxic
  - Absorbed and accumulated in the liver.
  - Release triggered primarily by stress events.
- Certain supplemental forms can be used for *H. contortus* control w/o toxic outcome.
- Bioavailability is a key.

**Small Ruminant Species Differences re COWP**

- Indication that COWP useful short-term intervention.
- Indications of differences between lambs and kids
  - Level of response
  - Timing of response
  - Duration of response
**SL, COWP, and Sheep**

- Animals (sheep) highly susceptible to GIN infection will have high FEC regardless of (SL) grazing treatment.
- In experiments these animals i.d. via FAMACHA and treated w/ COWP.
- When removed, SL treatment very visible.
- SL pellets effective w/ moderate infection but may not be so useful under overwhelming ...
- Concept of integrated approach being validated.

**Summary**

- Tools for an integrated approach including:
  - Pasture and grazing management
    - Rotation
    - Stocking rate
  - "Medicinal" plants
    - Condensed tannin-containing
      - *Sericea lespedeza* and others
  - Novel approaches
  - Copper wire particles, fungi trapping ...
  - Anthelmintics
  - Sheep genetics