Studying the Use of Copper to Raise Healthier Goats

Final report for FS18-309

Project Type: Farmer/Rancher
Funds awarded in 2018: $10,000.00
Projected End Date: 09/15/2020
Grant Recipient: Farmer
Region: Southern
State: South Carolina
Principal Investigator:

Judy Langley
Windy Hill Farm

Project Information

Abstract:

Practically all goat farms have unsustainable devastating animal losses from internal parasites, in particular, *Haemonchus contortus* (H. contortus) and copper deficiency. A high percentage of goat farms are becoming resistant to dewormers and have begun to turn to copper boluses to treat H. contortus. Now more than ever, goats are becoming deficient or toxic in copper.

The SARE grant require communications with several goat associations, and having lab tests run on goat livers to prove deficiency or toxicity in their goat herd. Most farmers do not do necropsies nor send liver samples due to the extra expense it would add to their budget. Getting liver samples from harvested animals is the only logical, safe way to make the determination of toxicity or deficiency. When goats die prematurely, the cause is almost always assumed to be internal parasites, but if they knew their animals were copper deficient or toxic in copper, rather than overloaded with internal parasites from resistant dewormers, it would be a cheap fix to change treatment procedures to give copper boluses to prevent premature deaths. Currently, there is an overuse of dewormers on goat farms and overuse creates several issues: chemical contaminants in manure which is bad for the soil; reduction of dung beetles; and unsustainable and unnecessary expenses to the producers. But the most important is resistance to dewormers.

Our scientific solution to the problem of copper deficiency versus toxicity and the overuse of dewormers will require working with the South Carolina Veterinary Office to oversee the research, acquire liver samples from harvested goats, and invite members of several goat associations to be part of the research.

Michigan State University performed the liver panel tests. The lab results were delayed several months due to the University's work with Covid-19 pandemic issues during the summer and fall. The results were evaluated and the veterinarian's report is attached to this narrative. We missed our goal of getting over a hundred goat livers due to unfortunate reasons beyond our control: 1) the two abattoirs that we worked with to save goat livers for us actually closed their doors during 2019

and 2020, 2) several of the frozen liver samples thawed prematurely, lost their identification information and were ruined, and 3} bad weather events -hurricanes, torrential rains and tornadoes prevented producers from traveling and participating. The samples that we did submit represent an average farm.

All of the steps mentioned in the original proposal, included many visits to farms, connections throughout the goat industry, several workshops and meetings, and mailings. The Southern Goat Producer Association facilitated three workshops for the conversations about copper toxicity versus
copper deficiency and deworming regimens. Those workshops were held on January 7, 2019, June 7, 2019 and December 12, 2019; there were about ninety-five attendees in total that received information in 2019 and at least that many people in 2018 through events that were held. There were many more events planned, but bad weather events and the Covid-19 Pandemic prevented them from happening.

For this final report, Dr. Patty Scharko with Clemson University Livestock Poultry Health, analyzed and summarized the MSU data. Langley's summary of Dr. Scharko's analysis reveals that the liver is the major storage organ for copper. Copper {Cu) is an essential micromineral for all small ruminant species, and that copper oxide wire particles (COWP) may be an alternative to anthelmintics to control nematode parasites in goats. It was good news to learn that there were no mineral toxicities in the animals presented. Goats have a higher tolerance for Cu and higher requirements compared to other small ruminants and are more prone to present with deficiency disease. One goat had deficient (low) copper level and the others were low normal, not close to being toxic. This group of goats were severely selenium deficient.

Project Objectives:

Acquired samples will be sent to a private laboratory and the SC Veterinary Office will assess the samples and give a report of the results. The results will show the levels of copper, and levels of compelling and antagonistic minerals. The results will substantiate suspected beliefs, and the report will provide proof to producers what they should be doing regarding deworming versus dosing or not dosing copper to eliminate H. contortus parasites.

Cooperators will send invitations and newsletters to let goat farmers know about the study and get them on board to get liver samples and attend workshops to learn how to do a simple necropsy.

The producers that participate in the research project will be required/asked to keep accurate records of monies spend on dewormers, copper boluses, and dosing supplies. Producer records and the Excel document information will be used to compare year one to year two.

Cooperators

- Patty Sharko (Researcher)

  pschark@clemson.edu

  Extension, field veterinarian

  Clemson University (1862 Land Grant)

  500 Clemson Road

Columbia, SC 29224

Research

Materials and methods:

The process is quite simple but time consuming, simply find producers that are about to have a goat harvested, get a run down of their recordkeeping information, and get a liver sample from the abattoir so that the sample can be sent to the Research Laboratory to run a liver panel to determine if the goat is toxic or deficient in copper.

Research results and discussion:

The study of the use of copper is an excellent use for research funds, especially for the goat industry because the goat industry is the only commodity that does not have a national “Checkoff” routine for research and promotion.

In order to get the copper study started, I needed to create a plan and complete the different steps to it and send liver samples to a laboratory for running test for accurate results.

Data Evaluation:

Patty Scharko, DVM, MPH, DACVPM, Clemson University Livestock Poultry Health, extension/field veterinarian

For the study, seven (7) liver samples were submitted to Michigan State University Veterinary Diagnostic Laboratory (MSUVDL) for trace mineral analysis. Complete trace mineral analyses completed by MSUVDL on these samples included copper, selenium, iron, cobalt, manganese, molybdenum, zinc, arsenic, cadmium, lead, mercury, and thallium.

No mineral toxicities were noted in the samples. The sample were reported on a dry weight. The dry weight fraction on 2 goats were high (above normal); this may represent either dehydration or fatty infiltration (fatty liver).

Copper tissue results ranged from 18 to 360 µgig dry weight with normal goat copper tissue at 20-650 µg/g. One goat had low (deficient) copper level and the other 6 were low normal, not close to being toxic. With the deficient to low normal copper levels in these goats, it appears that the producers could use copper oxide wire particles for *Haemonchus contortus* ("barberpole" worm, commonly causing anemia and death).

Two (2) goats were severely selenium deficient. These same goats were also low in iron, molybdenum and cobalt; interesting that they were also were the animals identified with high dry weight matter. Selenium is an important trace mineral (see information provided below). South Carolina and southeastern states' soils are selenium deficient, so pasture and hay provide minimal to no selenium. The results indicate that the goats are not receiving enough selenium in their diet.

Iron was low in 4 goats. Iron deficiency is usually associated with anemia, less red blood cells in the animal, usually associated with *Haemonchus contortus.*

Note from Judy Langley that the farms are on city water, not on well water. There

are antagonists in the water, grass, hay and feed that tie up the mineral. Usually have less antagonists are in city water.

Trace Mineral	Normal	Low	Deficient
Copper	6	1	0
Selenium	5	0	2
Iron	3	4	0
Zinc	4	3	0
Molybdenum	5	2	0
Manganese	7	0	0
Cobatl	5	2	0

BACKGROUND INFORMATION
EFFECTS OF TRACE MINERALS ON GOAT HEALTH COPPER

Copper (Cu) is an essential micromineral for all small ruminant species, although differences in the species Cu requirement results in different risks for deficiency or toxicity disease. Goats have a higher tolerance for Cu and higher requirements compared to other small ruminants and are more prone to present with deficiency disease. Proper Cu supplementation requires that all feed ingredients be analyzed not only for their Cu content, but the content of important interfering substances (also known as "antagonists") to Cu availability, including iron, molybdenum and sulfur. Ongoing monitoring of animal mineral status is an important component of a small ruminant health program.

Copper absorption is more important than the concentration in the feed. Absorption can be influenced by type of diet and level of molybdenum, sulfur, iron, and to a lesser degree, calcium and zinc. Young animals may absorb up to 90 percent of dietary copper.

Copper requirements for goats have been established for be 8-10 mg/kg diet DM. Data suggests that meat goats may require more copper for optimal growth. NRC 2007 recommends copper requirement of lactating goats to 15 mg/kg DM, mature goats and bucks to 20 mg/kg, and growing goats to 25 mg/kg diet DM. The maximum tolerable copper level for goats is not established.

The liver is the major storage organ for copper. Liver normally contains 200-300 mg Cu/kg dry matter (DM). Copper concentrations of< 20 mg/kg liver DM (5 mg/kg wet weight) indicate copper deficiency. Copper level in plasma fluctuates only to a limited extent and is regulated by biliary and fecal excretion and level of liver copper storage. Deviations from the average are not detectable, even during copper deficiency. Liver sample is the appropriate procedure for accurate measurement of copper status.

Copper deficiency is manifested as hypochromic microcytic anemia in all species if copper inadequacy is severe and prolonged. The main manifestations of copper deficiency include anemia, diarrhea, depressed growth, bone disorders, reproductive failure, neonatal ataxia (swayback), cardiovascular disorders, achromotrichia, keratinization failure in hair resulting in harsh appearance ("steely wool") and increased susceptibility to disease. Newborn kids from copper-deficient does manifest neonatal or congenital ataxia because of insufficient myelin synthesis in the brain. A delayed ataxia also affects kids at one to two months after birth. This ataxia affects the rear quarter due to insufficient myelin synthesis after birth for

proper development of spinal cord nerves.

Dietary factors may influence copper requirement including Fe, Mo, S, Zn, Pb, cadmium (Cd), and the protein source. Ruminants are more likely to develop a Cu deficiency when grazing lush pastures.

Copper supplementation strategies include mineral supplements with sulfate, chloride, or oxide fonns, dosing or drenching with copper compounds, injections of organic complexes of Cu, Cuoxide needles placed in a bolus, and/or copper fertilization of pastures (poultry and swine waste) can improve copper in soils. Supplemental chemical forms of available Cu that can be provided include Cu sulfate, oxide, carbonate, chloride, chelates, and proteinate. Copper sulfate is the most commonly used. The copper in Cu oxide is largely unavailable and ineffective when compared to Cu sulfate. Amino acid chelates or proteinates have greater bioavailability than Cu sulfate. Copper oxide wire particles (COWP) may be an alternative to anthelmintics to control nematode parasites in goats.

Selenium

Selenium (Se) is an essential trace mineral that is regulated as a food additive by the Food and Drug Administration due to its potential for toxicity. The NRC establishes a daily Se requirement for goats at O. 7 mg/head/ day.

Selenium deficiency occurs most commonly in kids whose mothers were fed a selenium-deficient diet. Most cases occur in animals younger than 6 months old and in neonates. Kids are believed to be more susceptible than lambs. Sudden muscular activity in deficient animals unaccustomed to exercise may trigger an episode of nutritional muscular dystrophy. Muscles with high metabolic activity are most susceptible, e.g. heart and diaphragm. Selenium deficiency may also impair the immune system.

Selenium status can be accurately detected by measuring either serum or whole blood Se concentrations. Liver Se content is a good determinate of Se status, but one must obtain a liver tissue sample either by biopsy on a live animal or from a dead animal. It is well worth the cost to have liver mineral analyses completed on any animal that dies (young or old) as a routine monitor of nutritional status.

Prevention of Selenium Deficiency

Pasture, hay and grain supplements should be assayed to determine the amount of selenium. Dietary supplementation
appears to be the least expensive and most efficient method. Current regulations in US limit selenium supplementation to 0.7 mg/head/day. Supplementation during pregnancy is important because Se is transferred across the placenta and present in colostrum and milk. Vitamin E may also need to be supplemented.

Zinc

Zinc deficiency- related disease has been reported in goats. Zinc deficiency clinical signs include: dermatitis and parakeratosis, depressed milk production, impaired appetite, poor feed utilization, slowed growth, increased susceptibility to foot rot, diminished hair growth on legs and head, swollenjoints, poor growth, decreased reproductive perfonnance, reduced testicular development, impaired vitamin A metabolism and increased
vitamin E requirements. Male goats appear to be more sensitive to the potential for adverse effects of marginal zinc intake.

Diets containing 20 to 50 ppm of zinc usually are sufficient, except for animals consuming high percentage of legumes.

Trace minerals with 0.5 to 2% zinc usually prevent deficiency.

Liver samples produce the best measurement of zinc status. Diagnosis may be achieved by response to treatment. A traditional dose of 1 gram zinc sulfate orally per day has been used with good success. Improvement should be noted within 2 weeks of therapy.

Veterinary Results Defined

Recommendation for Copper (Cu) usage: The producers could use copper oxide wire particles for *Haemonchus contortus* ("barberpole" worm, commonly causing anemia and death). It is also important to small ruminant health programs to understand that Cu supplementation requires that all feed ingredients be analyzed not only for their Cu content, (Copper absorption is more important than the concentration in the feed - see analysis report), but to take into account the important interfering substances (also known as "antagonists") to Cu availability, including iron, molybdenum and sulfur.

Copper Analysis: The farms in the MSU study are on city water as opposed to well water - there are antagonists in well water, grass, hay and feed that tie up the mineral. Liver copper (Cu) content is a good determinate of Cu status, but one must obtain a liver tissue sample either by biopsy on a live animal or from a dead animal. Absorption can be influenced by type of diet and level of molybdenum, sulfur, iron, and to a lesser degree, calcium and zinc. Young animals may absorb up to 90 percent of dietary copper. Dietary factors may influence copper requirement including Fe, Mo, S, Zn, Pb, cadmium (Cd), and the protein source. Ruminants are more likely to develop a Cu deficiency when grazing lush pastures. In lieu of obtaining a liver sample, there are symptoms that producers can look for to determine if an animal is deficient in copper: anemia, diarrhea, depressed growth, bone disorders, reproductive failure, neonatal ataxia (swayback), cardiovascular disorders, achromotrichia, keratinization failure in hair resulting in harsh appearance ("steely wool") and increased susceptibility to disease. Newborn kids from copper-deficient does manifest neonatal or congenital ataxia because of insufficient myelin synthesis in the brain. A delayed ataxia also affects kids at one to two months after birth. This ataxia affects the rear quarter due to insufficient myelin synthesis after birth for proper development of spinal cord nerves.

Copper supplementation: Copper supplementation strategies include mineral supplements with sulfate, chloride, or oxide forms, dosing or drenching with copper compounds, injections of organic complexes of Cu, Cu-oxide needles placed in a bolus, and/or copper fertilization of pastures (poultry and swine waste) can improve copper in soils. Supplemental chemical forms of available Cu that can be provided include Cu sulfate, oxide, carbonate, chloride, chelates, and proteinate. Copper sulfate is the most commonly used. The copper in Cu oxide is largely unavailable and ineffective when compared to Cu sulfate. Amino acid chelates or proteinates have greater bioavailability than Cu sulfate. Copper oxide wire particles (COWP) may be an alternative to anthelmintics to control nematode parasites in goats.

SELENIUM: Although selenium (Se) was not specifically stated as part of the research, none the less, selenium is an important trace mineral, and is very important for Dr. Scharko to mention this important mineral in her analysis. South Carolina and southeastern states' soils are selenium deficient, so pasture and hay provide minimal to no selenium. The results indicate that the goats are not receiving enough selenium in their diet. Selenium deficiency occurs most commonly in kids whose mothers were fed a selenium-deficient diet. Most cases occur in animals younger than 6 months old and in neonates. Sudden muscular activity in deficient animals unaccustomed to exercise may trigger an episode of nutritional muscular dystrophy. Muscles with high metabolic activity are most susceptible, e.g. heart and diaphragm. Selenium deficiency may also impair the immune system.

Selenium status can be accurately detected by measuring either serum or whole blood Se concentrations. Liver Se content is a good determinate of Se status, but one must obtain a liver tissue sample either by biopsy on a live animal or from a dead animal. It is well worth the cost to have liver mineral analyses completed on any animal that dies (young or old) as a routine monitor of nutritional status.

Prevention of Selenium Deficiency: Pasture, hay and grain supplements should be assayed to determine the amount of selenium. Dietary supplementation appears to be the least expensive and most efficient method. Current regulations in US limit selenium supplementation to 0.7 mg/head/day. Supplementation during pregnancy is important because Se is transferred across the placenta and present in colostrum and milk. Vitamin E may also need to be supplemented.

IRON: Although_iron was not specifically stated as part of the research, iron is directly related to keeping a healthy goat. Dr. Scharko's analysis narrative shows that iron was low in 4 goats. Iron deficiency is usually associated with anemia, less red blood cells in the animal, which often occurs with *Haemonchus contortus*, as Hoemonchus is a blood sucking parasite that is detrimental to goats' survival if not treated early.

ZINC: Although_zinc was not specifically part of this research, the MSU report included zinc in their analysis. This writer was impressed with Dr. Scharko's information about zinc. It will be good information to report to producers as zinc issues are not normally discussed or thought of as a problem. Zinc deficiency can cause many issues producers are faced with in keeping healthy, vigorous goats: dermatitis and parakeratosis, depressed milk production, impaired appetite, poor feed utilization, slowed growth, increased susceptibility to foot rot, diminished hair growth on legs and head, swollen joints, poor growth, decreased reproductive performance, reduced testicular development, impaired vitamin A metabolism and increased vitamin E requirements. Male goats appear to be more sensitive to the potential for adverse effects of marginal zinc intake.
Copper, selenium, and zinc levels should be raised through injections, copper boluses, supplements, or through growing legumes in pasture to increase zinc intake. Diets containing 20 to 50 ppm of zinc usually are sufficient, except for animals consuming high percentage of legumes. Trace minerals with 0.5 to 2% zinc usually prevent deficiency.

Liver samples produce the best measurement of zinc status. Diagnosis may be achieved by response to treatment.

Participation Summary

3 Farmers participating in research

Educational & Outreach Activities

3 Consultations

1 Curricula, factsheets or educational tools

1 Published press articles, newsletters

4 Webinars / talks / presentations

2 Workshop field days

PARTICIPATION SUMMARY:

95 Farmers

4 Ag professionals participated

Education/outreach description:

Much of this Copper Project was done through the Southern Goat Producers Association (SGPA) and its membership. Mrs. Langley and the SGPA have hosted two major events that featured copper. Veterinarians and vet technicians presented to SGPA membership plus other goat farmers and three ag related events.

All of the steps mentioned in the original proposal included many visits to farms, connections throughout the goat industry, several workshops and meetings, and mailings. The Southern Goat Producer Association facilitated three workshops for the conversations about copper toxicity versus
copper deficiency and deworming regimens. Those workshops were held on January 7, 2019, June 7, 2019 and December 12, 2019; there were about ninety-five attendees in total that received information in 2019 and at least that many people in 2018 through events that were held. There were many more events planned, but bad weather events and the Covid-19 Pandemic prevented them from happening.

An Essential Micromineral Fact Sheet for small ruminant species will be produced in December 2020 and sent to available persons.

Learning Outcomes

1 Farmers reported changes in knowledge, attitudes, skills and/or awareness as a result of their participation

Key changes:

- When the results of the analysis are completed, at least one hundred producers will receive the findings.

Project Outcomes

Project outcomes:

I love to talk about the history of goats to debunk the notion that "goats can eat anything" so that there is a better understanding of the livestock. The Goat Industry is the least researched commodity on the planet and the only commodity and livestock that does not have a national "Check Off' system to promote the livestock. Yes, I called the goat livestock ... most people do not look upon goats as livestock, because so many wannabe backyard hobby farmers have made them pets, probably because they are so darn cute. The backyard and hobby farm phenomenon have

caused many problematic practices. The phenomenon has made the goat so popular that most people who are raising them I)have no idea of how to take care of them 2) very few veterinarians are schooled in complete goat husbandry, 3) most people believe the myth that they can be treated like little cows, 4) their cuteness and love for them make them too cute to be considered a meat animal, and 5) if goat raisers do not have a mentor or good animal husbandry skills, they are doing a grave injustice to the animal.

With that lead in, taking care of goats is fun because they have such delightful personalities, but at the same time, a very complicated matter. I have raised goats for twenty years, fortunately, I learned from the best. My mentor had been raising goats for more than twenty years and was one of the first in the US that began upgrading her herd with the new "Boer" goat that was imported during the early 1990's. Prior to the early 90's, the lowly "briar goat" was only appreciated for land clearing and was slowly, but steadily replaced by the new imports. Producers wanted to protect their new "good-looking" investment, so they began to update their management style by spending more money to take better care of them to keep them alive. Keep in mind that prior to the new "pretty" imports, the briar goat basically had no value other than eating weeds and if they got sick, they died ... no vet would be called.

In conclusion, I want to thank SARE and UGA for giving this producer the opportunity to do research for the goat industry so that good information can be disseminated to help producers become more sustainable by having less animal losses.

"The Study of the Use of Copper" is a good option for the use of research funds, especially for the goat industry because the goat industry is the only commodity that does not have a national "Checkoff' program for research, promotion and marketing. This writer is grateful for the chance to have been awarded funds to work on a research for the goat industry. There are very few programs that actually give the producer or farmer a chance to make a difference. I was honored to work and visit with goat producers, the people with boots on the ground ... the people that know where the answer to the problem is or at least know what the problem is on a first-hand basis. The study helped producers realize that many producers are experiencing the same issues and how important it is to link farms with outreach information.

Recommendations:

Recommendation for Copper (Cu) usage: The producers could use copper oxide wire particles for *Haemonchus contortus* ("barberpole" worm, commonly causing anemia and death). It is also important to small ruminant health programs to understand that Cu supplementation requires that all feed ingredients be analyzed not only for their Cu content, (Copper absorption is more important than the concentration in the feed - see analysis report), but to take into account the important interfering substances (also known as "antagonists") to Cu availability, including iron, molybdenum and sulfur.

US Department of Agriculture

This site is maintained by SARE Outreach for the SARE program and is based upon work supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture, under award No. 2019-38640-29881. SARE Outreach operates under cooperative agreements with the University of Maryland to develop and disseminate information about sustainable agriculture. USDA is an equal opportunity provider and employer.
