**Palatability of tannin-rich sericea lespedeza fed to broilers.**

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**SUMMARY**

As parasites become resistant to available anthelmintics, new methods of control are needed. New drugs take a long time to develop in addition to being expensive; therefore, there is increasing interest in finding and using natural alternatives. Additionally, natural remedies are needed for the organic sector as synthetic drugs are not allowed and birds with outdoor access are likely to encounter parasites. Sericea lespedeza [SL, Lespedeza cuneata (Dum. Cours.) G. Don.] is a common perennial legume found in pastures across the southern USA that has been shown to be effective at controlling parasitic nematodes in small ruminants due to its condensed tannins content. Diets high in condensed tannins are often unpalatable to poultry; however, growers report that chickens maintained on pastures will consume SL. These reports and the level of consumption have not been verified. Therefore, before determining its potential in controlling parasites in poultry, a preliminary study confirmed that birds on pasture consumed SL (92% of birds examined had SL in crops), and in a subsequent study, dried SL leaves were added to a commercial broiler feed to determine the palatability of SL at various concentrations. Diets included 0% (Control), 5% (SL5), 10% (SL10) or 20% (SL20) SL (dry matter weight), and fed from hatch until harvest at six weeks of age. Male broilers (n=80) were randomly divided into eight groups and fed one of the four diets in replicate. Weight gains were similar between Control and SL at 5%. Including more than 5% SL in the diet reduced individual body weight (P<0.05). At the end of the feeding period, the digestive organs as a percent of body weight of SL20 birds were larger than Control birds. Feed conversion was higher in SL20 (2.31) than in Control (1.63; P < 0.05). Palatability of SL did not appear to be a problem as all treatment groups consumed a similar amount of feed. Therefore follow-up studies will evaluate the effects of SL on parasite control.

**Key Words:** Sericea lespedeza, Broilers, Pasture Poultry, Range management

**DESCRIPTION OF PROBLEM**

Sericea lespedeza [SL; *Lespedeza cuneata* (Dum. Cours.) G. Don.] is a herbaceous, perennial legume native to Southeast Asia. It was introduced into the United States as a forage crop, and for soil conservation and erosion control purposes. It can tolerate acidic soils, high levels of aluminum and marginal soil fertility, and it continues to produce forage during the hot and humid summer months of the Southeastern United States [1]. Sericea lespedeza has also shown potential for the production of ligno-cellulosic biomass [2] and as an anthelmintic plant for goats [3, 4].

SL contains condensed tannins, long-chain polyphenolic compounds, in its leaves and stems [5] which are produced by plants to help prevent predation [6]. Condensed tannins have been reported to have beneficial dietary effects at low levels and detrimental effects at high levels in small ruminants [7, 8, 9]. Studies have also found that feeding SL hay can be an effective method of controlling parasitic nematodes in goats and sheep [10, 11]. While no scientific literature investigating the use of SL in poultry was found, Todd and McSpadden [12] reported in 1947 that birds that had access to pasture which included SL were better able to “withstand greater parasitic burdens”.

*Ascaridia galli* is the most common roundworm that affects poultry throughout the world. It is a parasitic nematode worm found in the lumen of the intestine, and occasionally in the esophagus, crop, gizzard, oviduct, and body cavity. Infective eggs are consumed by the bird from the environment, hatch in the proventriculus or the duodenum, and the young larvae live freely in the lumen of the duodenum. *A. galli* infections result in a loss of production by reducing weight gains in younger birds and lower egg production in older birds [13, 14]. Additionally, severe infections can cause intestinal blockage, blood loss, and increased mortality.

While *A. galli* does not represent a health risk to humans, worms occasionally can be found in eggs which can raise concerns from consumers. Round worms can also build up in the soil in areas that are continually used by chickens and are able to persist in the environment for years [15]. Prevention of *A. galli* is difficult in free range poultry systems as birds can get exposed by consuming worms, grasshoppers and other invertebrates that have ingested the infective eggs and may encounter more parasites than they would if reared under conventional methods. Free range poultry systems are becoming more popular as small farmers increasingly offer specialty products such as organic poultry. *A galli* can be treated with chemical anthelmintics, but they are not permitted by the National Organic Program (NOP-USDA) in certified organic production. For those producers opting to minimize chemical and antibiotic treatments, alternative controls are needed.

Before evaluation of the ability of SL to control parasites, it needs to be determined if birds ingest SL and how it will affect production. This study was undertaken to evaluate the feed intake, and growth rate of broilers fed SL at various levels. In a preliminary trial, 12 free range laying hens were placed on pasture containing large amounts of SL for 17 days, and the content of their crops was evaluated for SL. In a follow up study 80 birds were fed various doses of SL in their feed and production performance was monitored. In addition to evaluating growth performance and feed consumption (to evaluate palatability) birds were necropsied to check for parasites and to measure digestive organs. Cecal samples were also collected to check for *Salmonella* and *Campylobacter* to determine if SL has any efficacy against these pathogens.

**MATERIALS AND METHODS**

*Experiment 1. preliminary trial*

Free range Light Brown Leghorn layers (28 weeks of age) were placed on pasture that contained large amounts of SL. Hens were rotated on the pasture so that they had a consistent supply of fresh SL available for consumption. Hens were in production during the time on pasture and were provided with 16% protein layer diet *ad libitum*. After 17 days on pasture, 12 hens were euthanized, crops were removed and the content was evaluated. The crop content was emptied into a container and weighed. The content was then visually sorted and the SL was removed and weighed (wet weight) to determine the amount of SL in each crop. Hens were collected in the late evening when they went into the mobile chicken house to roost.

*Experiment 2. palatability/dose titration*

Eighty Cobb day-of-age male chicks were weighed and divided into eight pens measuring 1.5m by 3m. Each pen was then randomly assigned one of four treatments. Treatment one (Control) was the control group receiving a standard broiler diet. The other treatments SL5, SL10 and SL20) received a standard diet diluted with 5%, 10%, or 20%, dried SL leaves (Sims Brothers, Inc. Union Springs, AL; Table 1). Each treatment group was replicated. SL was included in diets to simulate pasture conditions, as broilers have been reported to consume SL under range management [personal communications with growers]; in addition, results from the preliminary trial showed that mature birds consumed SL when accessible in the pasture.

Birds were provided with feed and water *ad libitum* for the duration of the trial. Grit was provided twice weekly. Birds were reared for 6 weeks with no artificial light after the second week. At the conclusion of the trial the birds were euthanized using CO2. Ceca samples were collected from half of the birds in each pen to evaluate for the presence of *Salmonella* and *Campylobacter*. The remaining birds were necropsied and the heart, liver, gizzard, ceca and intestines were removed and weighed individually. The portion of the intestine that was used was from the gizzard to the cloacae; the ceca was removed and weighed separately. The pancreas was not separated from the intestine and was weighed together with the intestines. At the time of weighing the intestines were visually checked for evidence of parasitic infection.

*Campylobacter* evaluation was performed using the following procedure. At the time of collection, the ceca from each bird were placed into sterile plastic bags. The cecal contents were then squeezed into 15-ml tubes, serially diluted (1:10) with Butterfield’s phosphate diluent, and then inoculated onto *Campylobacter* line agar plates*. Campylobacter* line agar plates were incubated for 48 h at 42ºC under microaerophilic conditions. After incubation, the number of *Campylobacte*r colonies on each plate were enumerated.

*Salmonella* was evaluated by placing one cecum, and its contents, into sterile containers containing Tetrathionate Broth with iodine (Hajna), and incubated 18-24 hr at 42˚C. A 10 µl of enrichment was then plated on BGS (Brilliant Green Sulfa) agar and XLT4 agar plates, which were incubated overnight at 37˚C. Plates were then examined for characteristic *Salmonella* colonies and for enumeration.

All segments of this project complied with the provisions of the Institute Animal Care and Use Committee as specified by the Animal and Plant Health Inspection Service, USDA in 9 CFR Part 1(1-91). Data were subjected to ANOVA procedures using JMP (SAS Institute Inc. Cary, NC), with significance determined between means with a P-value of less than 0.05. Values are presented as the mean ± 1 SEM. R value was determined using the fit model procedure in JMP. As there were no differences between replicates, they were combined for the analyses and presentation.

**RESULTS AND DISCUSSION**

In the preliminary trial, eleven of 12 free range layers (92%) had SL in their crops. The average weight of SL consumed was 1.55g ± 0.70g or 3.42% of the crop content by weight and had a range of up to 6.90g of SL. Additionally, bugs, feathers, grass, bark, rocks and egg shell were also observed in the crop content.

In the second study, birds consumed the diets regardless of the percentage of SL added to the diet. Initially all birds in in the study had a similar body weight (average 42g). Final body weight was reduced as percentage of SL increased in diet (R2= 0.61, P < 0.001; Table 2). In the final week of the study, birds in the SL10 treatment were 14% lighter (1,721g) than Control (1,996g) while SL20 birds were 24% lighter (1,521g). Since these birds consumed relatively the same amount of feed (Table 3) this would indicate that SL at these levels lacked the nutrients to support optimal growth. Control and SL at the lowest dose were not significantly different at any time during the trial indicating that inclusion of 5% SL in the diet, at least at this concentration, was not detrimental to growth (Table 2). Additionally there was no mortality during the study and no apparent health problems were observed, suggesting that high levels of SL did not have any apparent adverse health effects on the birds.

The effect of the diets on the digestive organs is presented in Table 4. To account for the differences in body weights, organ weights results are reported as a percentage of body weight. Birds fed the SL20 had the largest percentage of digestive organs in every category. While not a digestive organ, the heart was weighed too to determine if feeding SL had any effect on heart size. The heart: body weight ratio was lowest in the Control (0.44%) treatment and highest in the SL10 (0.51%) treatment, with no difference between the SL5 and SL20 groups (0.465 and 0.495 respectively). SL20 had the highest liver: body weight ratio at 2.62%, which was significantly higher than the other treatment groups. The percentage of liver was similar for the remaining treatments. The SL20 birds had the largest gizzards as measured by percentage of body weight at 3.97%. SL10 birds had a gizzard percentage that was larger the SL5 and Control. There was no difference between the Control and SL5 treatments. SL20 birds had a higher percent of ceca, 0.52% than all of the other treatments (0.39%, 0.38% and 0.44%). Finally the intestines: body weight ratio was again highest in the SL20 (4.88%) and lowest in the Control (2.89%) and SL5 (3.35%) treatments with the SL10 (4.00%) being intermediate. These results are similar to those of Savory [16] who reported that feeding grass led to an increase in the size of the small intestine due to the increase in fiber, therefore potentially increasing the absorption rate. This increase in size appears to be an adaption by the chick to optimize nutrient absorption from the feed [17].

A comparison of feed conversion is shown in Table 3. There was no difference (P>0.05) between the Control (1.63), SL5 (1.75) and SL10 (1.85); however, SL20 (2.31) was higher than the other treatments. This increase in feed conversion is an important consideration for growers as it increases the cost of production. The results of the tests for *Salmonella* and *Campylobacter* showed that none of the birds were positive for *Salmonella* while only one bird from SL10 tested positive for *Campylobacter*. None of the birds showed any grossly visible signs of parasites in the intestines.

Dose titration studies conducted in small ruminants suggest that the greater the percentage of SL in the diet, the more effective the control of gastrointestinal parasites [10, 11]. Chickens consume SL and its inclusion in the diet does not appear to affect food intake, further research is needed to determine its ability to control internal parasites.

**CONCLUSIONS AND APPLICATIONS**

1. Free range chickens will consume SL when provided with the opportunity.
2. Feeding diets containing SL at levels higher than 5% dry matter weight could potentially lower the body weight gains of broilers.
3. The inclusion of SL in the diet of broilers, did not limit feed intake when fed at levels as high as 20% of the diet.
4. Feeding high levels of SL led to an increase in the size of the gizzard, ceca, and intestines as it happens with grass and other high fiber diets.

**REFERENCES**

1. Mosjidis, J.A. 1997. Lespedeza cuneata. pp. 170-173. In: Faridah Hanum, I., and L.J.G. van der Maesen (eds.) Plant Resources of South-East Asia No. 11, Auxiliary plants. Backhuys Publishers, Leiden,The Netherlands. 389 pp.
2. Mosjidis, J. A. 1996. Variability for biomass production and plant composition in sericea lespedeza. *Biomass and Bioenergy* 11:63-68.
3. Min, B. R., W. Pomroy, S. P. Hart, and T. Sahlu, 2002. Effect of forage condensed tannins on gastro-intestinal parasite infection in grazing wether goats. *J. Anim. Sci*. 80, Suppl.1: 31-32.
4. Shaik, S.A., T.H. Terrill, J.E. Miller, B. Kouakou, G. Kannan, R.K. Kallu, J.A. Mosjidis, 2004. Effects of feeding sericea lespedeza hay to goats infected with Haemonchus contortus. *SAJ Anim. Sci*. 34, 234–236.
5. Mosjidis, C.O'H., C.M. Peterson, and J.A. Mosjidis, 1990. Developmental differences in the location of polyphenols and condensed tannins in the leaves and stems of sericea lespedeza, Lespedeza cuneata. *Ann. Bot.,* 65:355-360.
6. Hagerman A. E. and L. G. Buttler, 1981. The specificity of proanthocyanidin-proteininteractions. *J. Bio. Chem*., (256), 4494-4497.
7. Terrill, T.H., W.R. Windham, C.S. Hoveland, H.E. Amos, 1989. Forage preservation method influences on tannin concentration, intake, and digestibility of sericea lespedeza by sheep. *Agron. J*. 81, 435-439.
8. Aerts, R.J., W.C. McNabb, A. Molan, A. Brand, J.S. Peters, T.N. Barry, 1999. Condensed tannins from Lotus corniculatus and Lotus pedunculatus affect the degradation of ribulose 1,5- bisphosphate carboxylase (Rubisco) protein in the rumen differently. *J. Sci. Food Agric*. 79, 79–85.
9. Barry, T.N., D.M. McNeill, W.C. McNabb, 2001. Plant secondary compounds; their impact on nutritive value and upon animal production. In: Proceedings of the XIX International Grassland Conference, Sao Paulo, Brazil, pp. 445–452.
10. Shaik, S.A., T.H. Terrill, J.E. Miller, B. Kouakou, G. Kannan, R.M. Kaplan, J.M. Burke, J.A. Mosjidis, 2006. Sericea lespedeza hay as a natural deworming agent against gastrointestinal nematode infection in goats. *Vet. Parasitol*. 139: 150-157.
11. Lange, K.C., D.D. Olcott, J.E. Miller, J.A. Mosjidis, T.H. Terrill, J.M. Burke, M.T. Kearney, 2006. Effect of sericea lespedeza (*Lespedeza cuneata*) fed as hay, on natural and experimental *Haemonchus contortus* infections in lambs. *Vet. Parasitol*. 141: 273-278.
12. Todd, A. C., and B. J. McSpadden, 1947. Pastures for chickens and their relation to the parasitic fauna. *Poult. Sci*. 26: 576-581.
13. Reid, W. M. and J. L. Carmon, 1958. Effects of numbers of Ascaridia galli in depressing weight gains in chicks. *J. Parasitol*. 44:183–186.
14. Martín-Pacho, J. R., M. N. Montoya, T. Aranguena, C. Toro, R. Morchon, C. Marcos-Atxutegi, and F. Simon, 2005. A coprological and serological survey for the prevalence of Ascaridia spp. in laying hens. J*. Vet. Med. B* 52:238–242.
15. Ackert, J. E. and L. O. Nolf, 1931. Resistance of chickens to parasitism affected by vitamin B. *Am J Hygiene* 13:337-340.
16. Savory, C. J., 1992. Gastrointestinal morphology and absorption of monosaccharaides in fowls conditioned to different types and levels of dietary fibre. *Br. J. Nutr*. 67: 77-89.
17. Bedford, M. R., 1996. Interaction between ingested feed and the digestive system in poultry. *J. Appl. Poultry Res*. 5:86-95.

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Table 1. Analysis of sericea lespedeza (SL) leaf meal.

|  |  |
| --- | --- |
| **Test** | SL Leaf Meal % |
| **Dry Matter** | 93.9 |
| **Protein** | 12.9 |
| **Ash** | 5.28 |
| **Fat** | 2.21 |
| **ADF** | 35.6 |
| **NDF** | 49.4 |
| **calories/gram** | 4,359 |

Table 2. Bird weight in grams by week. Control (C) received a standard broiler diet. SL treatments were the standard diet diluted with 5% (SL5) 10% (SL10) and 20% (SL20) SL leaf meal, n=10 birds per treatment in replicate.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Treatment | Week #2 | Week #3 | Week #4 | Week #5 | Week #6 |
| C | 310.0±16.2a | 601.0±25.9a | 951.5±30.5a | 1,575.8±42.5a | 1,996.0±41.7a |
| SL5 | 295.5±11.0ab | 580.0±15.9a | 930.3±19.7a | 1,517.3±25.7a | 1,958.8±32.3a |
| SL10 | 266.1±6.6b | 518.0±10.0b | 802.0±15.9b | 1,313.8±19.9b | 1,721.3±19.7b |
| SL20 | 222.3±7.7c | 422.5±11.7c | 689.0±14.6c | 1,153.5±26.7c | 1,521.3±31.3c |

Different letters in a column denote significant differences at P<0.05

Table 3. Total feed consumed by treatment and feed conversion. Control (C) birds received a standard broiler diet. This diet was diluted with 5% (SL5), 10% (SL10), or 20% (SL20) sericea lespedeza (SL) leaf meal. Feed conversion was determined by dividing total feed consumed by final body weight, n=10 birds per treatment in replicate.

|  |  |  |
| --- | --- | --- |
| **Treatment** | **Feed Consumed** | **Feed Conversion** |
| **C** | 3250.4 ±245.9 | 1.63 ±0.02b |
| **SL5** | 3421.5 ±94.5 | 1.75 ±0.06b |
| **SL10** | 3180.8 ±141.3 | 1.85 ±0.06b |
| **SL20** | 3213.5 ±21.5 | 2.31 ±0.18a |

Different letters in a column denote significant differences at P<0.05

Table 4. Percent of body weight of internal organs. Percent intestine is the weight of the intestine from the gizzard to the cloaca without the ceca. Birds had feed withdrawn 12+ prior being euthanized. Control (C) birds received a standard broiler diet. This diet was diluted with 5% (SL5), 10% (SL10), or 20% (SL20) sericea lespedeza (SL) leaf meal, n=10 birds per treatment (five birds per replicate).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Treatment** | % Heart | % Liver | % Gizzard | % Ceca | % Intestine |
| **C** | 0.44 ±0.01c | 2.33 ±0.05b | 2.77 ±0.13c | 0.39 ±0.02b | 2.89 ±0.15c |
| **SL5** | 0.46 ±0.01bc | 2.34 ±0.05b | 2.98 ±0.11c | 0.38 ±0.02b | 3.35 ±0.17c |
| **SL10** | 0.51 ±0.01a | 2.33 ±0.06b | 3.45 ±0.15b | 0.44 ±0.02b | 4.00 ±0.19b |
| **SL20** | 0.49 ±0.02ab | 2.62 ±0.10a | 3.97 ±0.17a | 0.52 ±0.03a | 4.88 ±0.32a |

Different letters in a column denote significant differences at P<0.05