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The Effect of Tannins In Korean Lespedeza and Other Feeds On Milk Production

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SUMMARY

Korean lespedeza was found to undergo a seasonal decline in tannin content. Analysis showed that samples which contained 6-8 percent tannin in July and September had decreased to less than 3 percent by October 20. Tannin is a product of the most actively growing tissues of the plant, with the leaves known to contain most of the tannin at a given time. Thus, tannin content of plants follows the seasonal progress of growth and is highest during spring and summer months and declines to a low level by fall.

Alfalfa hay, beet pulp (dry), and silage were found to contain even higher levels of tannin than lespedeza, with hedge apples (26 percent) containing the highest level of the plants analyzed.

The possibilities of physiological disturbances in cattle from excessive intake of tannin is believed unlikely because of the rapid conversion of tannic acid into nonastringent gallic and pyrogallic acids.

Digestive disturbances due to decreased absorption and constriction in the digestive tract, caused by an excessive intake of tannic acid, were not obtained in feeding trials with two cows. Apparently there is a rapid conversion of tannic acid to tannates in the mouth, throat, and upper portions of digestive tract. As tannates it passes through the digestive tract and probably is broken down into nonastringent gallic and pyrogallic acid.

This bulletin is a report on department of Dairy Husbandry research project number 139 entitled, "Milk Production".

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PURPOSE OF INVESTIGATION

Korean lespedeza is an important hay and pasture crop to the Missouri dairyman. Over 9,000,000 acres of Korean lespedeza are grown annually in Missouri. The high feeding value of Korean lespedeza has been shown in comparative feeding trials; even the seed has been found to be an excellent source of protein for dairy animals.

However, many reports of dissatisfaction are heard from the field where dairy cows are pastured on matured Korean lespedeza. Herman and Ragsdale[4] stated that it is a common observation that cows on matured lespedeza often tend to fall off in milk production. Cause of the decline in milk flow seemed to be associated with the following factors: Lowered feeding value of plants with increased maturity, decrease in palatability; and, possibly, the development of varying amounts of tannic acid.

A general feeling among dairy farmers is that tannic acid accounts for Korean lespedeza "drying up cows" during fall months. Swanson and Herman[13] found that early cut Korean lespedeza hay contained nearly 25 percent more total digestible nutrients than late cut (mature) lespedeza. Tannic acid content of plants used in these trials was not determined. Further investigation seemed desirable to determine whether tannic acid content at varying stages of growth was sufficiently great to affect nutritive value of Korean lespedeza.

PREVIOUS WORK

Tannins (or tannic acid) are a group of widely distributed vegetable principles whose structure is not fully known. Yet, their presence in plants has long been known; their use in medicine dates back into our earliest history. Tannins were classified as Fe-blueing (pyrogallol) and Fe-greening (Catechol) tannins as early as 1772[8]. They are used now chiefly by the leather industry for tanning hides.

Substances extracted from plants may be termed tannins or tannic acid if they: have an astringent taste; precipitate proteins, gelatin and connective tissues; are composed of weak acids; and form blue or green ink colors with iron salts. The official tannic acid is obtained from nutgalls.

In the course of its absorption by the body, tannic acid is decomposed into the nonastringent gallic or pyrogallic acid. Ordinary tannic, or gallotannic, acid is derived chemically by elimination of a molecule of H_2O from two molecules of gallic acid (trihydroxy-benzoic acid, $(HO)_3C_6H_2COOH$). There are many forms of tannins and the composition of many is unknown. Some are compounds of gallic acid with sugar or phlorhizin[8].

Few investigations have been made of the tannin content of Korean lespedeza. Most of the literature deals with tannin content of Sericea lespedeza. Interest centers on this variety because cows show preference for other forage when first turned out to pasture. Helm and Etheridge[3] reported the cause might be due to the fact that Sericea, when growing rapidly, contains from 5 to 9 percent tannin. They noted, however, that milk flow from cows pastured on Sericea was equal to milk flow obtained from sweet clover pasture.

Clark[2] reported a seasonal variation of tannin in Sericea lespedeza. In one season, May 29 to July 31, the total tannin in leaves increased from 7.5 to 18 percent. Not only the quantity of tannin in the leaves but also the astringency of the tannin increased during spring and summer months. Tannin content of the stems was low, varying from 1 to 1.6 percent.

Stitt and Clark[10] reported the percentage of tannin in the whole plant was 8.5 percent on May 5 and increased to 13.1 percent by June 30, followed by a progresssive decline until October 6 at which time it was 4.9 percent.

In 1942 Stitt[9], seeking a method of selecting and breeding Sericea for lower tannin content, found a progressive increase in tannin until midseason, then a decline.

Stitt and Hyland[11] stated that the tannin content of Sericea lespedeza leaves was low when protein content was high and that there was no relationship between tannin and protein in stems.

Stitt, Hyland, and McKee[12] observed that a large part of the tannin variation in Sericea was due to difference in soil type and variations in the amount of sunlight.

Manley and Olson[6] of the Georgia Agriculture Experiment Station reported that fertilization reduced tannin content of Sericea lespedeza.

MATERIALS AND METHODS

Korean lespedeza for this study was secured from ungrazed pasture at the University South Dairy Farm. The soil is known to be of medium fertility. Plants were in a vigorous, green, leafy condition. Average height of the plants was 13 inches. Cuttings were made about 2 inches above the ground. They were secured at approximately one week intervals, placed in paper bags, and stored in a well ventilated room. When the cuttings had air dried they were ground finely and stored in glass jars until analyzed. Average leaf stem comparison on September 24 was 52 percent leaf and 48 percent stem. By October 20 the percentage was around 50 percent for both.

Tannin content of the whole plant was determined by the hide-powder

method of the American Leather Chemists Association[1]. This method is used to determine what is termed "total tannin". No tests, other than the above mentioned, were made with the objective of isolating and identifying the true tannin.

Tannin extraction was obtained with water at 95°C. and decanted. The extract was then diluted to 1 liter. The amount of wet chromed hide powder used for the analysis was 46 grams.

RESULTS

Tannin content of the whole plant of Korean lespedeza on a dry matter basis was 8.94 percent on September 24, 1949, but decreased to 2.93 percent on October 20, as shown in Table 1. Samples obtained in July ranged from

TABLE 1 -- PERCENTAGE OF TANNIN IN KOREAN LESPEDEZA (1949).

Date Harvested	Part of Plant	No. of Determinations	Range %	Average % Dry Matter Basis	Average % In Sample When Fed
Late July	Whole	5	4.55 - 8.82	6.34	5.62
Sept. 24	Whole	3	6.68 -12.15	8.94	7.76
Sept. 27	Whole	3	7.26 - 8.9	7.88	7.03
Oct. 7	Whole	4	5.27 - 8.24	7.16	6.35
Oct. 13	Whole	3	1.65 - 4.98	3.51	3.13
Oct. 20	Whole	3	2.70 - 3.09	2.93	2.6
Oct. 26	Whole	3	2.41 - 3.33	2.89	2.53
Oct. 7	Leaves	1	6.5	7.3	6.5
Oct. -	Leaves	5	6.2 - 7.2	6.54	5.84
Oct. -	Seed	1	10.0	10.0	9.3
Oct. -	Stems	1	1.1	1.1	1.0

4.55 to 8.82 percent with an average of 6.34 percent on a dry matter basis.

The percentage of tannin in leaves and stems of plants cut on October 7 was determined with the proportion of leaf and stem. At this time the proportion was approximately 50 percent for both. Tannin content of the leaves was 7.3 percent and that of the stems 1.1 percent. Lespedeza seed was found to contain 10 percent tannin on a dry-weight basis.

Analysis for tannins in other plants and feed available to dairy animals also was determined. Results are presented in Table 2. Analysis of the con-

TABLE 2 -- PERCENTAGE OF TANNIN IN VARIOUS FEEDS.

Kind of Sample	No. of Determinations	Range % Tannin Dry Matter Basis	Average % Dry Matter Basis	Average % In Sample When Fed
*Alfalfa Hay	3	11.0 - 12.3	11.5	10.4
*Silage	4	22.9 - 32.0	26.5	7.0
*Grain Mixture	3	5.0 - 7.1	6.1	5.3
*Beet Pulp (Dry)	2	15.0 - 16.9	15.9	14.4
Alfalfa (Special cuttings)	8	12.9 - 17.0	13.9	12.4
Hedge Apple	1	26.0	26.0	6.50

*Ration Fed

centrate ration fed to the University milking herd showed it contained 6.1 percent tannin. The grain mixture referred to was 40 percent corn, 23 percent oats, 20 percent bran, 15 percent soybean oil meal, 1 percent steamed

bone meal, and 1 percent salt.

Baled alfalfa hay contained a minimum of 11 percent tannin, silage 22.9 percent, beet pulp (dry) 15.9 percent, grain mixture 6.1 percent, all on dry weight basis.

Cows have been observed to consume hedge apples in the fall. It is universally known that hedge apples, and acorns, will reduce milk flow of cows if they eat them. Hedge apples were found to contain the highest amount of tannin of the substances analyzed. The average amount of tannin present was about 26 percent. Values obtained from analysis of the herd ration (see Table 2) indicated that 12 to 13 percent was tannin. This value applies to the total ration and includes alfalfa hay, sorgo silage, beet pulp and the concentrate mix.

These levels, although seemingly high, were supplemented with additional tannic acid (U.S.P. Fluffy) to two cows in the University herd. The supplemental tannic acid was increased as high as 5 percent, which increased the total tannin intake to almost 18 percent. During the experimental feeding period, records of milk and fat production, body weight, and feed consumed were obtained. The high level of tannin intake did not seem to affect the cows in any way. The two experimental animals, as well as the animals used as controls, showed an increase in body weight. The feed consumed varied but slightly. Milk and fat production was maintained at the normal level. Results of these trials are presented in Table 3.

DISCUSSION

The tannin content of Korean lespedeza was found similar to that reported for Lespedeza Sericea. Data were not available on the seasonal content, but by the close species relationship to Sericea it can be assumed that Korean lespedeza follows much the same seasonal pattern. There is a progressive increase of tannin until mid-season, followed by a decrease.

Astringency of the tannin also is known to increase during spring and summer months. Therefore, if tannin is an important factor in palatability, cattle should find the leaves of Korean lespedeza progressively less desirable during these periods. Also, any adverse effects upon the health of cattle or decline in milk production caused by the intake of excessive quantities of tannin should occur when the plant is tender and green. This does not happen. It is during these periods that cows benefit most from Korean lespedeza, as evidenced by the maintenance of high levels of production.

Nevens[7], as early as 1935, reported feeding trials with Korean lespedeza hay for milk production. He found that lespedeza hay fed to dairy cows was practically equal, pound for pound, to alfalfa hay when judged by milk yields and gains in weight. Holdaway[5] obtained comparable results for milk production with both Korean and Sericea lespedeza. Herman and Ragsdale[4] supplied ground Korean lespedeza seed as a protein supplement in a ration fed to lactating cows and found them to be an excellent source of protein. No adverse effects or lowered palatability of the ration was observed.

Swanson and Herman[13] studied digestibility of Korean lespedeza hay

TABLE 3 -- EFFECT OF TANNIN FEEDING TO DAIRY COWS.

Days in Period	Average F.C.M.		Average Body wt. lbs.		Total Feed Average Consumed lbs.		Average % Tannin in Ration		% Tannin Added		Total Tannin	
	Control	Exp	Control	Exp	Control	Exp	Control	Exp	Control	Exp	Control	Exp
						First Trial						
Preliminary 5 days	29.65	35.58	1289	1101	66.7	44.7	12.3	12.5	0	0	12.3	12.5
First period 4 days	28.52	33.20	1267	1094	66.2	45.5	12.3	12.5	0	1.7	12.3	14.2
Second period 7 days	29.93	33.34	1314	1105	72.3	45.3	12.3	12.5	0	1.0	12.3	13.5
Third period 8 days	28.05	31.51	1325	1109	72.2	47.6	12.3	12.5	0	1.7	12.3	14.2
Fourth period 4 days	28.21	30.24	1290	1073	73.0	44.6	12.3	12.5	0	5.0	12.3	17.5
						Second Trial						
Preliminary 2 days	18.36	25.86	----	----	48.2	73.0	12.8	12.3	0	0	12.8	12.3
First period 3 days	17.11	24.27	1308	1327	56.1	72.3	12.8	12.3	0	3.0	12.8	15.3
Second period 3 days	18.63	25.39	1330	1335	60.3	68.1	12.8	12.3	0	5.0	12.8	17.3

and ground Korean lespedeza seed for dairy heifers. The most conclusive evidence of decline of milk production when cows were pastured solely on Korean lespedeza in the fall was not from decrease in protein content but from lignification as the plant matured. With increased maturity there was a decrease in digestibility of practically all nutrients.

Although tannins are produced in leaves of Korean lespedeza, physiological disturbances due to their precipitating action on proteins apparently is not a major factor. The fact that cows tend to decline in milk production on late lespedeza pasture cannot be explained on the basis of tannin content. Many other valuable dairy feeds, such as alfalfa hay, contain more tannin than Korean lespedeza. Comparative analysis of Korean lespedeza and alfalfa hay cut at approximately the same time and stored as baled hay, showed alfalfa to contain nearly 10 to 11 percent tannin and Korean lespedeza only about 5 to 6 percent.

Seed from Korean lespedeza was found to contain 10 percent tannin but no harmful results were reported when it was fed to lactating cows. Even when tannin intake approached 18 percent in the experiment reported in Table 3, milk production continued at the normal level without noticeable physiological upsets. If it were possible for cows to consume excessive quantities of tannin daily, which is improbable with normal feeds, its effect would be limited.

While the metabolism of tannic acid is not fully understood, it is completely decomposed into gallic and pyrogallic acid before being excreted. These acids appear in urine and feces. Only the insoluble tannates travel, partially unbroken, into the feces.[8] Probably little tannic acid reaches the rumen or stomach as such, but is changed to tannates as rapidly as it touches the mucous membranes of the mouth and throat. It passes through the digestive tract as a tannate and is decomposed into the nonastringent gallic and pyrogallic acid. This reaction was observed in the two experi-

mental animals receivng supplementary tannin in their ration. While the cows were eating their tannin supplemented ration, they exhibited symptoms of difficult tongue and chewing action. This disappeared a short time after they ate their grain mixture. There was no sign of constipation in either of the cows. This undoubtedly would have appeared if tannic acid had reached the true stomach or abomasum.

From these considerations, it seems logical that tannins are not a factor in the decline in milk flow when cows are pastured on Korean lespedeza in the late fall. More likely the lowered nutrient value and high lignin content caused a lack of available nutrients. Reduced milk flow is a natural result of the lowered feed intake.

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