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WOOD MOLASSES FOR LAMBS AND STEERS

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AGRICULTURAL EXPERIMENT STATION
THE UNIVERSITY OF TENNESSEE
KNOXVILLE

DIGESTIBILITY AND FEEDING STUDIES USING WOOD MOLASSES IN RATIONS FOR LAMBS AND STEERS

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DIGESTIBILITY AND FEEDING STUDIES USING WOOD MOLASSES IN RATIONS FOR LAMBS AND STEERS

SUMMARY

The results of these digestibility studies and feeding trials using 36 wether lambs and 12 steers show that: (1) wood molasses may be added at levels of 0.5 to 1.0 lb. to roughage rations for lambs; (2) the addition of wood molasses to a fattening type ration of hay and grain was of little value at low levels of 0.5 lb. and was detrimental when added at high levels of 1.5 lb. or more, as evidenced by less nitrogen retention and less weight gains by the lambs; (3) the addition of wood molasses to fattening rations at the level of 1.0 lb. per day was of value only when additional protein was fed to the lambs; (4) when wood molasses was substituted for grain, feed consumption and nitrogen retention was reduced; (5) the addition of wood molasses to the rations studied depressed the apparent digestibility of crude protein on the average of 8 percent; (6) when wood molasses was fed to lambs at the rate of 0.5 lb., 1.0 lb. and 1.5 lb., the higher levels produced the greatest depression in crude protein digestibility; (7) when wood molasses was compared with cane molasses, the wood molasses depressed the apparent digestibility of crude protein by 8 percent while cane molasses caused a depression of only 5 percent; (8) lambs fed wood molasses gained 0.24 lb. per day compared with 0.35 lb. for those fed cane molasses; (9) the average daily gain for steers fed wood molasses was 1.01 lb., compared with 1.27 lb. for steers fed cane molasses.

INTRODUCTION AND REVIEW OF LITERATURE

Wood molasses has been produced on an experimental basis as reported by Gilbert *et al.* (1952) to explore the use of non-marketable waste woods for the production of alcohol, yeast, and molasses for livestock feed. Ruttan and Hubbuch (1953) discussed the economics of production and uses of various kinds of molasses including wood molasses. They pointed out that in times of shortages of cane molasses and other concentrate feeds, wood molasses offers a potential source of energy feed for livestock. The cost of production, however, has not been favorable for wood molasses in competition with cane molasses.

Wood molasses produced by the acid hydrolysis of wood has been shown to have value in rations for cattle. Colovas *et al.* (1949) found that either 4.4 lbs. of wood molasses or the energy equivalent of cane molasses added to a hay ration was of value to dairy heifers. However, wood molasses depressed the digestibility of crude protein about 8 percent more than did cane molasses. Blosser *et al.* (1951) demonstrated that wood molasses significantly increased the gain of dairy heifers when it was added to a growing ration at the rate of 2 to 4 lbs. Jones (1949) reported that wood molasses was as palatable as cane molasses for dairy heifers. He also reported that for milk production alfalfa silage pre-

served with wood molasses was of equal value to alfalfa silage preserved with cane molasses. Keyes (1953) at Montana obtained equivalent milk production from cows fed either cane molasses or wood molasses at the rate of 10 percent of the concentrate mixture. Waugh *et al.* (1954) studied the value of wood molasses from hardwoods in rations for 30 dairy cows. In these studies, wood molasses was substituted for grain, and when fed at the rate of 6 lbs. per day, 1.0 lb. of wood molasses was equivalent to 0.5 lb. of grain. Wood molasses substitution at any of the levels fed had no detrimental effect on milk production or weight gain.

Burkitt *et al.* (1954) at Montana compared wood molasses with cane molasses for lambs and steers and found the two kinds of molasses to be comparable when measured by weight gains and ration digestibility.

EXPERIMENTAL PROCEDURE

The investigation reported herein involved the use of wood molasses in rations for 36 feeder lambs and 12 steers. This investigation included data on digestibility, nitrogen balance, and weight gains. The objectives of this study were (1) to compare the effects of adding three levels of wood molasses to an all-hay ration for lambs; (2) to compare the effects of either adding wood molasses to a hay and grain ration for lambs or substituting molasses for the grain; and (3) to compare wood molasses with cane molasses for lambs and steers.

The wood molasses used in these experiments was produced by sulfuric acid hydrolysis of waste hardwoods by methods as described by Gilbert *et al.* (1952). The wood used consisted of 85 percent oak, 10 percent hickory and 5 percent miscellaneous hardwoods. The wood molasses had a pH of 4. One gallon of the wood molasses contained from 4.5 to 5.3 lbs. of reducing sugars, one-third of which were pentoses.

The roughages used in these studies consisted of variable quality grass and legume hay which was coarsely chopped to facilitate feeding. Number 2 corn was crushed to a medium fineness to facilitate mixing with other feed ingredients. The analyses of the feed ingredients are given in Table 1. All chemical analyses were made by procedures described by the Association of Official Agricultural Chemists (1950) or slight modifications of these methods. Statistical analyses were made according to methods by Snedecor (1946).

The lambs used in the digestion and nitrogen balance trials were lightweight grade wether lambs. A Latin square design was used for each trial so that each lamb was on each of the rations at one time during the trial. For each lamb, a preliminary period of at least 10 days was used with a collection period of seven days.

During the collection period, feces and urine were collected quantitatively using digestion stalls similar to those described by Briggs and Gallup (1949). Samples of feeds, urine and feces were obtained to determine the intake, digestibility and nitrogen balance data for each lamb on each treatment. The lambs were individually fed weighed amounts of feed and any refused feed was weighed, sampled and analyzed to determine an accurate feed intake. When molasses was fed, it was poured over the roughage portion of the ration.

Table 1.—Average Percentage Chemical Composition of Feed Ingredients

Ingredient Feed	Trial Number	Moisture	Crude Protein	Ether Extract	Crude Fiber	N.F.E.	Ash
Hay	I, II	11.4	14.6	1.6	29.5	36.9	6.0
Hay	III, IV	9.3	14.6	1.3	32.0	37.3	5.5
Hay	V, VI	8.3	11.1	1.3	36.7	37.1	5.5
Grain	II, IV	11.3	7.6	3.8	1.9	74.2	1.2
Grain	VI	12.7	8.1	3.8	1.9	72.2	1.3
Cottonseed meal	V, VI	8.5	39.8	6.7	12.6	27.1	5.3
Wood molasses	I, IV	38.7	0.8	---	---	55.2	5.3
Wood molasses	V, VI	37.6	1.0	---	---	57.2	4.2
Cane molasses	III, IV	27.6	6.3	---	---	58.1	8.0

In the feeding trials with lambs and steers, comparisons were made between cane molasses and wood molasses, added to rations of hay and grain. The lambs used in these trials were some of those which had been used in the digestion and nitrogen balance studies. The steers used in this experiment were calves which had been wintered in good condition.

RESULTS AND DISCUSSION

A. Digestion and Nitrogen Balance Trials

Trial I.—

The results of this trial are shown in Table 2. In this trial, wood molasses was added at the rate 0.5 lb., 1.0 lb. and 1.5 lb. to hay rations to determine the effects of these additions on digestibility and nitrogen retention by lambs. The consumption of dry matter was increased by the additions of wood molasses; however, there was considerable refusal of feed, especially at the high level of wood molasses feeding. The nitrogen balance data showed that additions of wood molasses increased nitrogen retention with the greatest increase occurring at the low level of feeding the molasses. However, the addition of wood molasses at these three levels resulted in a significant decrease in the digestibility of crude protein and a significant increase in the digestibility of nitrogen free extract. There were apparent but not statistically significant differences in the digestibility of other ration nutrients. The high level feeding of 1.5 lb. of wood molasses per day resulted in a decrease in the digestibility of crude fiber and ether extract by some of the lambs; however, this reduction was not consistent for all lambs used in the trial.

Trial II.—

In the second trial, wood molasses was added to a ration of hay and grain at the same levels used in Trial I. The results of feeding wood molasses at the three level are shown in Table 3. The addition of wood molasses at the levels of 0.5 lb. and 1.0 lb. provided only a slight increase in the dry matter intake. Addition of wood molasses at the rate of 1.5 lb. per day resulted in a reduction in dry matter intake. The addition of wood molasses significantly lowered the digestibility of crude protein, but it had no significant effect on the digestibility of other ration nutrients. The percentage digestibility of nitrogen free extract was maintained at all levels of feeding wood molasses added to a hay ration as reported in Trial I. The nitrogen balance data in Table 3 show that the addition of wood molasses to the grain and hay at the rates of 1.0 lb. and 1.5 lb. reduced the nitrogen retained.

Table 2.—Effects of Wood Molasses on the Digestibility of Hay Rations by Lambs in Trial I.

Ration	Number of Animals	Dry Matter Intake	Apparent Digestibility of				
			Crude Protein	Ether Extract	Crude Fiber	N.F.E.	Nitrogen Retained
		gms.	%	%	%	%	gms.
Hay	4	717	67.1	36.1	46.8	64.2	3.8
Hay + 0.5 lb. molasses	4	856	62.7*	36.4	45.5	71.2*	5.9
Hay + 1.0 lb. molasses	4	928	59.1*	46.6	46.3	76.2*	5.0
Hay + 1.5 lb. molasses	4	854	54.9*	17.1	43.9	75.0*	4.1

*P<0.05

Table 3.—Average Digestibility of Lamb Rations with Wood Molasses Added to Hay and Grain in Trial II.

Ration	Number of Animals	Dry Matter Intake	Apparent Digestibility of				
			Crude Protein	Ether Extract	Crude Fiber	N.F.E.	Nitrogen Retained
		gms.	%	%	%	%	gms.
Hay and grain	4	618	69.6	71.6	40.9	84.9	3.0
Hay, grain, 0.5 lb. molasses	4	735	59.3**	72.1	45.3	85.0	3.4
Hay, grain, 1.0 lb. molasses	4	638	56.3**	72.7	42.0	85.0	2.0
Hay, grain, 1.5 lb. molasses	4	564	48.2**	72.4	41.8	85.4	0.6

**P<0.01

Trial III.—

In Trial III, a comparison was made between cane molasses and wood molasses added to hay rations. The hay used was cut at three stages of maturity, and comparisons were made using each of the three types of hay. The differences among the hay treatments were slight; therefore, these data were pooled to compare the addition of wood molasses with the addition of cane molasses to an all-hay ration, as shown in Table 4. The addition of wood molasses to the hay ration is in agreement with previously reported data. The added cane molasses also reduced the digestibility of crude protein, but to a lesser extent than wood molasses. The addition of the wood molasses, on the average, increased the digestibility of ether extract, in contrast with the data on the two previous trials. However, there was considerable variation among the individual lambs. The apparent digestibilty of ether extract is of questionable significance in experiments with ruminants fed low fat rations. The digestibility of crude fiber was practically the same for all treatments. However, the digestibility of nitrogen free extract was increased considerably by the addition of either cane molasses or wood molasses. This is in agreement with other research which has shown that the addition of molasses to a roughage ration increases the digestibility of nitrogen free extract. The nitrogen balance data show that the retention of nitrogen was slightly increased by adding either wood or cane molasses with the greatest increase obtained by adding cane molasses. There was less feed refusal when cane molasses was added to a hay ration than when wood molasses was added.

Trial IV.—

In this trial, comparisons were made between cane and wood molasses, added at the rate of 0.75 lb. to rations consisting of hay and grain. These data show that the addition of either cane or wood molasses decreased the digestibility of crude protein, with wood molasses causing the greatest reduction (Table 5). These data are in general agreement with data presented by Briggs and Heller (1940) and Bell *et al.* (1953) who found that cane molasses reduced the digestibility of crude protein. Colovas *et al.* (1953) also showed that wood molasses fed to dairy heifers reduced the digestibility of crude protein to a greater extent than cane molasses. There were no significant differences among the digestibility data of the other ration nutrients. Nitrogen balance data varied with nitrogen retention on an average being slightly increased by adding cane molasses, and slightly decreased by adding wood molasses.

Table 4.—Average Digestibility of Lamb Rations with Either Wood or Cane Molasses Added to Hay in Trial III.

Ration	Number of Animals	Dry Matter Intake	Apparent Digestibility of				Nitrogen Retained
			Crude Protein	Ether Extract	Crude Fiber	N.F.E.	
		gms.	%	%	%	%	gms.
Hay	9	802	61.0	5.4	48.6	63.2	5.6
Hay + 0.75 lb. cane molasses	9	1004	56.8	4.1	46.6	72.0*	6.9
Hay + 0.75 lb. wood molasses	9	908	53.3*	19.2	47.1	70.1*	5.9

*P<0.05

Table 5.—Average Digestibility of Lamb Rations with Either Wood or Cane Molasses Added to Hay and Grain in Trial IV.

Ration	Number of Animals	Dry Matter Intake	Apparent Digestibility of				Nitrogen Retained
			Crude Protein	Ether Extract	Crude Fiber	N.F.E.	
		gms.	%	%	%	%	gms.
Hay and grain	9	594	62.0	66.0	45.1	83.8	4.2
Hay, grain, + 0.75 lb. cane molasses	9	840	56.6	71.3	43.6	84.7	5.4
Hay, grain, + 0.75 lb. wood molasses	9	691	53.1*	71.1	46.3	84.6	3.7

*P<0.05

Trial V.—

The results of Trial V are given in Table 6. This trial differed from Trial I in that cottonseed meal was added along with the three levels of wood molasses to provide a constant percentage of crude protein among the four rations. The results of this experiment agree closely with those of Trial I. Even when the percentage of protein was maintained by addition of cottonseed meal, the digestibility of the total crude protein in the ration was decreased by the addition of wood

molasses. Also, in agreement with the results in Trial I, there was a slight reduction in the digestibility of crude fiber only when 1.5 lb. of wood molasses was added. In this experiment, the total feed consumption was not depressed by feeding 1.5 lb. wood molasses as was found in Trial I. These data show the importance of adding extra protein when molasses is added to rations for ruminants. The average daily retention of nitrogen was increased by the addition of wood molasses. The increase, however, was not statistically significant.

Table 6.—Average Digestibility of Lamb Rations with Wood Molasses and CSM added to Hay in Trial V.

Ration	Number of Animals	Dry Matter Intake	Apparent Digestibility of				Nitrogen Retained
			Crude Protein	Ether Extract	Crude Fiber	N.F.E.	
		gms.	%	%	%	%	gms.
Hay	4	596	59.5	30.2	56.4	64.7	2.4
Hay + 0.5 lb. molasses + CSM	4	712	55.5	50.9	57.1	73.3	4.0
Hay + 1.0 lb. molasses + CSM	4	850	48.1*	60.4	57.7	79.2**	3.6
Hay + 1.5 lb. molasses + CSM	4	899	51.3	61.5	47.9	78.7**	4.0

*P<0.05
**P<0.01

Table 7.—Average Digestibility of Lamb Rations with Wood Molasses Either Substituted or Added to Grain in Grain and Hay Rations in Trial VI.

Ration	Number of Animals	Dry Matter Intake	Apparent Digestibility of				Nitrogen Retained
			Crude Protein	Ether Extract	Crude Fiber	N.F.E.	
		gms.	%	%	%	%	gms.
Hay, grain, CSM (a)	5	811	60.7	71.4	49.3	82.1	5.3
Hay, grain, 0.5 lb. molasses, CSM	5	994	56.7	78.3	49.2	83.1	4.7
Hay, grain, 1.0 lb. molasses, CSM	5	1122	51.8	80.7	44.3	82.3	5.4
Hay, grain, 0.5 lb. (b) molasses, CSM	5	837	60.5	72.4	51.2	80.5	3.8
Hay, 1.0 lb. molasses, CSM (c)	5	791	51.0*	66.0	53.4	79.1	1.0*

a. This ration was 50% hay. b. Molasses was substituted for one-half of grain.
c. Molasses was substituted for all of grain.
*P<0.05

Trial VI.—

The results of this trial are given in Table 7. In this experiment, wood molasses was added at two levels to a ration consisting

of hay and grain. In addition, wood molasses was substituted for one-half of the grain in the fourth ration, and was substituted for all of the grain in the fifth ration. Cottonseed meal was added to maintain a constant percentage of crude protein for the five rations. The results of this experiment are in agreement with those of Trial II except that the addition of the protein supplement along with the wood molasses resulted in a higher feed consumption by the lambs. The lambs used in Trial VI were older than those used in Trial II, which could account for some of these differences. The results show that the substitution of wood molasses for one-half of the corn did not affect the digestibility of the ration nutrients. However, the substitution of wood molasses for all of the corn caused a significant decrease in the digestibility of crude protein. There was considerable variation in the nitrogen retention, but the average retention was reduced when molasses was substituted for corn in these rations. These data indicate that, under these conditions, wood molasses was a poor substitute for all of the corn. These results also show that wood molasses added to a good ration under these conditions was of value in increasing the total dry matter intake.

B. Feeding Trials with Lambs and Steers

The results of the feeding trials using 27 lambs and 12 steers are given in Table 8. These results show that the addition of cane molasses to the lamb rations was of little value. The increase in the average daily gain was slight and there was also an increase in the pounds of feed needed per pound of gain. The addition of wood molasses to the ration of hay and grain was detrimental when measured by the average daily gain and the feed efficiency. Both kinds of molasses were added at the rate of 0.75 lb. per head per day. Cane molasses increased total feed consumption while wood molasses reduced total feed consumption. Even with the differences in the gains and feed efficiency between the wood molasses lot and the other lots, there were small differences due to treatment in the dressing percentages and grades of the lambs.

In the feeding trials with steers, comparing the *ad libitum* feeding of cane molasses and wood molasses, the daily consumption of wood molasses was 2.8 lbs. compared with 3.8 lbs. for cane molasses. The reduction in feed intake by steers fed wood molasses was reflected in a lower rate of gain as shown in Table 8. Wood molasses was less palatable and was of less value than cane molasses for feeding steers. These results are in contrast with the work of Jones (1949) and Burkitt *et al.* (1954) who found wood molasses to be as palatable as cane molasses for livestock. It might be possible that wood molasses used in these experiments contained some substance which hindered the utilization of the feed nutrients. One explanation for some differences between these data and data from Oregon and Montana may be due to sources of wood molasses. The wood molasses used in these experiments was made mostly from oak and hickory while that used in Oregon and Montana as reported by Jones (1949) and Burkitt *et al.* (1954) was made from fir and pine.

Table 8.—Feeding Trials with Lambs and Steers Fed Either Wood Molasses or Cane Molasses.

	Hay and Grair Mixture (Basal)	Basal + Cane Molasses	Basal + Wood Molasses
Lambs (60 days)			
Number of animals	9	9	9
Average weights (lbs.)			
Initial weight	79	79	79
Final weight	99	100	94
Daily gain	.34	.35	.24
Av. daily ration lbs.			
Hay	1.20	1.03	0.94
Corn	1.20	1.03	0.94
Cane Molasses		.53	
Wood Molasses			0.47
Salt	ad lib	ad lib	ad lib
Total	2.40	2.58	2.35
Average feed/lb. gain	7.14	7.38	9.85
	SLAUGHTER DATA		
Dressing percentage	51.9	53.1	53.6
Carcass grade	choice +	prime −	choice +

Steers (84 days)	Basal + Cane Molasses	Basal + Wood Molasses
Number of animals	6	6
Average weights (lbs.)		
Initial weight	574	578
Final weight	681	663
Daily gain	1.27	1.01
Average daily ration		
Mixed hay	7.4	7.4
Crushed corn	3.1	3.1
Soybean meal	1.1	1.1
Cane molasses	3.8	
Wood molasses		2.8
Salt	ad lib	ad lib
Total	15.4	14.4
Average lb. feed/lb. gain	12.11	14.36

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