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Coeditors

Paul V. Fonnesbeck, B.S., M.S., PhD., Assistant Professor, Animal Dairy and Veterinary Sciences Department, Utah State University, Logan, Utah

Lorin E. Harris, B.S., M.S., Ph.D., Director, International Feedstuffs Institute; and Professor, Animal, Dairy, and Veterinary Sciences Department, Utah State University, Logan, Utah

Leonard C. Kearl, B.S., M.S., Associate Director, International Feedstuffs Institute; and Research Associate, Animal, Dairy, and Veterinary Sciences Department, Utah State University, Logan, Utah

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UTILIZATION OF LEMON GRASS (*Cymbopogon sp.*) BAGASSE IN RUMINANT NUTRITION[1]

A. R. Ramírez[2], R. Bressani[3] and L. G. Elías[4]

Institute of Nutrition of Central America and Panama (INCAP), P.O. Box 1188, Guatemala City, Guatemala, C.A.

Summary

Preliminary information was obtained on the potential use of lemon grass (*Cymbopogon sp.*) bagasse in ruminant nutrition. Analysis of the fresh plant and its bagasse for their proximate chemical composition, amino acid and cell walls content revealed no appreciable changes.

Ensiling methods for preservation of the bagasse were studied. According to results, the best silage was obtained from mixtures of bagasse, molasses and a corn silage inoculun, the latter added in amounts of 8 and 10%, respectively.

Total digestible nutrients (TDN) of the bagasse, as determined in sheep, was 44.6% on a dry matter basis (1,962.4 kcal/kg of digestible energy).

In an 8-week feeding trial diets A, B, C and D were fed to four experimental groups of six steers each, distributed in a random-block design. Diet A was administered to the control group. In this experiment, the bagasse was supplemented with 2.9% of screwpress cottonseed meal. Diets B, C, and D were supplemented with 8.7, 6.8 and 5.5% cottonseed meal, in that order. Diets C and D were further supplemented with .34 and .52% of urea, on as-fed basis, to provide the equivalent amount of N contained in diet B. Daily weight increments per head were .346, .941, 1.04 and .808 kg in groups A, B, C and D, respectively. Significant differences in weight gain were found ($P < .01$) among and within animals fed the four diets studies. Diet C was superior to diets A, B and D ($P < .05$).

Results indicate that lemon grass bagasse can be used as roughage for ruminant nutrition. Further studies on this matter are strongly recommended.

Key Words: lemon grass bagasse, ruminant nutrition.

Introduction

The scarcity of forages is a handicap for adequate beef and milk production in certain areas of Guatemala, particularly during the dry season. In some parts of the country, especially along the Pacific coast, several thousand acres are cultivated with lemon grass; consequently, after extraction of its essential oil, many tons of bagasse become an available byproduct. For essential oil extraction, mature lemon grass is harvested and chopped before steam distillation to separate the essential oil, which represents about .4% of the weight. The grass is then subjected to temperatures of around 70 to 100°C for 30 to 60 minutes. Noland (1965) estimated that around 100,000 tons of bagasse are produced annually, and that this material constitutes a potential feed for ruminant nutrition.

Based on these facts a series of experiments were carried out with the bagasse to obtain preliminary information on: 1) chemical composition, amino acid and cell walls content; 2) methods of preservation; 3) total digestible nutrients (TDN) content and 4) response of animals to different diets containing bagasse as the only source of forage.

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[2]Principal Professor of Animal Nutrition, School of Veterinary Medicine and Animal Husbandry, University of San Carlos de Guatemala.

[3,4]Head and Scientist, respectively, of the Division of Agricultural and Food Sciences of INCAP.

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Materials and Methods

Laboratory studies

Samples of the green plant as well as of the processed material were dried in a laboratory oven at 80°C for 24 hours and then analyzed for their chemical composition. (AOAC 1965), amino acids using hydrolysates with a Technicon Amino Acid Analyzer, and cell walls by the technique of Georing and Van Soest (1970). In addition, the bagasse was ensiled according to the following procedure: small experimental silos were used to prepare different types of silages with lemon grass bagasse adding molasses in the approximate amount of 8%, and inoculum consisting of corn silage in the amount of around 10%, and a mixture of acid (Virtanen's formula) A.I.V. of 6.6% of weight (Bretigniere and DerKhatchadourian 1962). This acid mixture consisted of 6 parts of 32% hydrochloric acid and 4 parts of 70% sulfuric acid, diluted 6 times its own weight with water just prior to use. The resulting mixture showed a specific gravity of 1.295 to 1.298 which after dilution with water, fell to 1.045.

Combinations of bagasse, inoculum and AIV; bagasse, molasses, inoculum and AIV; bagasse, inoculum and water; and bagasse, inoculum and molasses were evaluated chemically, organoleptically and by measuring pH changes. Silos containing only bagasse with water, bagasse plus acid, or bagasse plus molasses showed poor fermentation and were discarded. The silage from bagasse alone had a pH of 5.6, with poor odor in spite of its dark green color.

Biological Trials

Digestibility of Lemon Grass Bagasse Lemon grass bagasse was sun-cured in the field and then administered to four Rambouillet rams approximately 2 years old, weighing from 46.8 to 59.5 kg, and kept in individual metabolic stalls. Preliminary study periods lasted 10 days and those of collection, 4 days. Feed and feces samples were then analyzed for their proximate chemical composition by AOAC method (1965). Digestion coefficients were determined following the conventional methods of Harris (1970) for this type of experiment.

Feeding Trials Four different types of diets: A, B, C and D, were administered to steers (Brahman x Criollo) randomly distributed into four experimental groups of six animals each. All were adult males, around 2 years of age, averaging 369.8 kg of weight. Before starting the trial, all the animals were treated for internal and external parasites, and then subjected to a preliminary adaptation period of 21 days followed by an experimental period of 56 days. Body weight was measured at the beginning of the adaptation period and then weekly in both the adaptation and experimental periods. Approximate feed consumption and refusals were also measured during the experimental time. All diets consisted of lemon grass bagasse offered in the amount of 14.5 kg per capita to each group, plus a fixed amount of 900 g of molasses and 57 g daily of a salt and commercial trace mineral mix. Diet A was administered to the control group. In this experiment, the lemon grass bagasse was supplemented with 454 g of screw-pressed cottonseed meal. Diets C and D were further supplemented with .6% and .9% of urea on a dry matter basis so as to provide the equivalent amount of nitrogen in diet B. Vitamin A was injected to the groups to supply the daily requirement level of 1,500 IU per pound (3307.5% IU/kg) of feed, following the recommendations of the NRC (1968). Statistical analyses of the results were performed according to the procedures of Steele and Torrie (1960).

Results and Discussion

Chemical Composition

The gross chemical composition of green lemon grass and its bagasse is summarized in Table 1. As the data reveal, composition is essentially the same for both samples. It is of interest to point out that the process of steam distillation of the volatile essential oils did not change ether extract content. The amount of crude fiber is high, suggesting that the material was mature at the time of harvesting, which is when the plant accumulates maximum levels of essential oil.

TABLE 1 Chemical Composition of Green Lemon Grass and of Lemon Grass Bagasse

Item[a]	Green lemon grass[b]	Lemon grass bagasse[c]
Proximate composition, %		
Crude protein	6.1	6.5
Ether extract	3.9	4.1
Crude fiber	36.9	34.1
Ash	7.8	9.2
Nitrogen-free extract	45.3	46.1
Minerals, mg/100 g		
Calcium	142	106-500[d]
Phosphorus	106	80-95[d]
Potassium	170	120-220[d]
Iron	----	13[d]
Manganese	----	1.6[d]
Sulfur	----	86[d]
Copper	----	0.3[d]
Sodium	16	15

[a]Values expressed on a dry (100% dry matter) basis.
[b]Lemongrass, aerial part, fresh, IFN 2-26-238.
[c]Lemongrass, bagasse, sun-cured, IFN 1-26-239.
[d]Values taken from ANACAFE Bul. No. 12, 1973 (Guatemala).

The proximate analysis is very similar to that of other pastures grown in the same area, not only with respect to gross composition but also for the macro-and micro-mineral content.

The structural carbohydrate composition of the bagasse is shown in Table 2. It is evident that the values reported for hemicellulose and cellulose fall within the range of values for other mature grasses. The same conclusion is applicable to lignin and lignocellulose content.

TABLE 2 Cell Walls Composition in Green Lemon Grass and Lemon Grass Bagasse

Item[a]	Green lemon grass (%)	Lemon grass bagasse (%)
Cell walls	62.5	67.2
Lignocellulose	40.0	41.9
Hemicellulose	22.5	25.3
Lignin	6.6	7.5
Cellulose	29.2	30.2
Insoluble ash	4.2	4.2

[a]Values expressed on a dry (100% dry matter) basis.

The amino acid content of fresh lemon grass and of its bagasse in one representative sample was analyzed by ion exchange chromatography of acid hydrolysates, and the results are given in Table 3. Values for the two samples are quite similar except for glutamic acid, cystine, leucine, phenylalanine and lysine content, amino acids which the bagasse contains in higher concentrations. Because of the heat treatment received by the bagasse, lower values for certain amino acids were expected, particularly for lysine. No explanation can be offered at the present time for this phenomenon. As happens with other grasses, total sulfur content is low.

Silage Studies

Lemon grass is harvested year round, but due to the length of the rainy season, it is not possible to dry lemon grass bagasse. Furthermore, extracted bagasse gets moldy after 3 or 4 days in the field. Therefore, the best way to preserve this material is in silage form. Preliminary observations have demonstrated that no drop in pH occurs in silages without the addition of an inoculum or acid. Taking this fact into account, selection of silage combinations was based on the best results obtained in terms of the pH reached by the silages after two months of being ensiled. The chemical composition of the silages obtained at the end of this period is given in Table 4. As may be observed, there were no significant differences in chemical composition among the different types of silage. Furthermore, composition of the various silages was similar to that of the bagasse except in ash content, which was higher in the former. From the data in the same table it is obvious that the lowest pH values were obtained in silages prepared with the addition of acid, or molasses plus acid. An important point to take into consideration is the addition of inoculum, since the bagasse is practically sterile due to the treatment with steam and high temperature used to extract the essential oils of the plant. In the present studies the inoculum consisted of corn silage; however, similar results are obtained by ensiling mixtures of lemon grass bagasse and green corn plants. The silage obtained by the addition of inoculum plus molasses was good, even though the pH was not as low as in the other silages evaluated. The second best silages were obtained with a mixture of bagasse, inoculum and AIV, and although acid production is better in this silage, it must be kept in mind that the addition of acid constitutes a serious limitation for silage-making under our field conditions. Silage made from bagasse and water showed very poor quality and was not used for comparative purposes with the other types of silages tested. On the other hand, silages prepared with bagasse

TABLE 3 Amino Acid Composition in Green Lemon Grass and Lemon Grass Bagasse

Item	Green lemon grass (g/100g)	Lemon grass bagasse (g/100g)
Aspartic acid	.505	.523
Threonine	.162	.176
Serine	.068	.053
Glutamic acid	.676	.795
Glycine	.359	.349
Alanine	.442	.441
Cystine	.068	.092
Valine	.379	.397
Methionine	.029	.039
Isoleucine	.328	.354
Leucine	.449	.560
Tyrosine	.149	.161
Phenylalanine	.278	.352
Ammonia	.093	.078
Lysine	.265	.344
Histidine	.129	.118
Arginine	.252	.278

[a]Values expressed on a dry (100% dry matter) basis.

TABLE 4 Chemical Composition and Organoleptic Characteristics of Experimental Silages Containing Lemon Grass Bagasse[a]

Item		Bagasse + inoculum + AIV	Bagasse + inoculum + AIV + molasses	Bagasse + inoculum + water	Bagasse + inoculum + molasses
pH		4 00	4 04	4 62	4 42
Odor		Acid	Acid(sweet)	Acid(weak)	Acid(weak)
Color		Dark green	Dark green	Dark green	Dark green
Dry matter	%	38 00	41 00	36 00	40.00
Crude protein	%	5.10	5 00	5 00	6.00
Crude fiber	%	34.00	34 60	34.00	33.30
Ether extract	%	3.50	3 50	4.10	4.80
Ash	%	15.00	15.00	10.60	11.40
Nitrogen-free extract	%	42.40	41.90	46.30	44 50

[a]Chemical analyses expressed on a dry (100% dry matter) basis.

plus acid, but no inoculum, did not develop an acceptable grade of fermentation because, as already mentioned, the bagasse obtained, after extraction of the essential oils, is practically sterile.

Digestibility of Lemon Grass Bagasse

Digestion coefficients of the different nutrients contained in the bagasse were calculated from the sheep studies. Evaluation of the resulting data established that the TDN averaged 44.6% (equivalent to 1962.4 kcal/kg of digestible energy), which makes this byproduct comparable to a poor-quality forage. Coefficients of digestibility for crude protein, ether extract, crude fiber and nitrogen-free extract were: 35.4, 61.4, 50.1 and 41.5%, respectively. The bagasse was well accepted by the animals during the experimental period, and consumption of dry matter reached an average of 2.6% of the live weight of the four animals used. It is important to mention at this point, that consumption decreased probably due to the low protein availability of the ration.

Feeding Trial

The percentage ingredient composition of the diets and their crude protein content are shown in Table 5, and changes in body weight of the adult male steers consuming lemon grass bagasse are presented in Figure 1. Weight increments reached daily per head levels of .346, .941, 1.04 and .808 kg in the groups consuming diets A, B, C and D, respectively. Analysis of variance of the results showed significant differences ($P < .01$) among and within the four diets studied with respect to weight gain. Diet C was significantly superior to diets A, B and D ($P < .05$). Ration A was

TABLE 5 Composition of Experimental Diets

Item	International feed number	Rations A (%)	B (%)	C (%)	D (%)
Ingredients[a]					
Lemongrass, bagasse, sun-cured	1 26 239	91.1	85.6	87.1	88.1
Cotton, seeds without oil, mech extd ground, 41% protein	5-01-617	2.9	8.7	6.8	5.5
Sugarcane, molasses, more than 46% invert sugars more than 79.5 degrees brix	4 04 696	5.7	5.4	5.4	5.5
Mineralized salt[b]		.36	33	34	34
Urea, 45% nitrogen 281% protein equivalent	5 05 070	----	---	34	52
Chemical analyses[c]					
Crude protein		7.2	10.8	11.4	11.5

[a]Percentage of ingredients on as-fed basis.
[b]Common iodized salt plus a commercial mix
[c]Chemical anlayses expressed on a dry (100% dry matter) basis.

inferior to the other three diets studied. No significant differences were found between rations B and D. Figure 1 also shows the drop in weight observed in some experimental groups during the adaptation period. No symptoms of toxic or deleterious effects were detected either during the preliminary adaptation or at the time of the experimental period. These results confirm those previously obtained by Ramírez and Chauvet (1971) and Manno and Ramírez (1971) when bagasse was fed to young and adult sheep. The drop in weight observed in the experimental groups can be explained on the basis of the change in handling and feeding conditions. As mentioned in the case of the digestibility trial, another cause could well be the low protein level and low availability of the protein of the bagasse. Both factors can negatively contribute to restrict the voluntary feed intake by the animals.

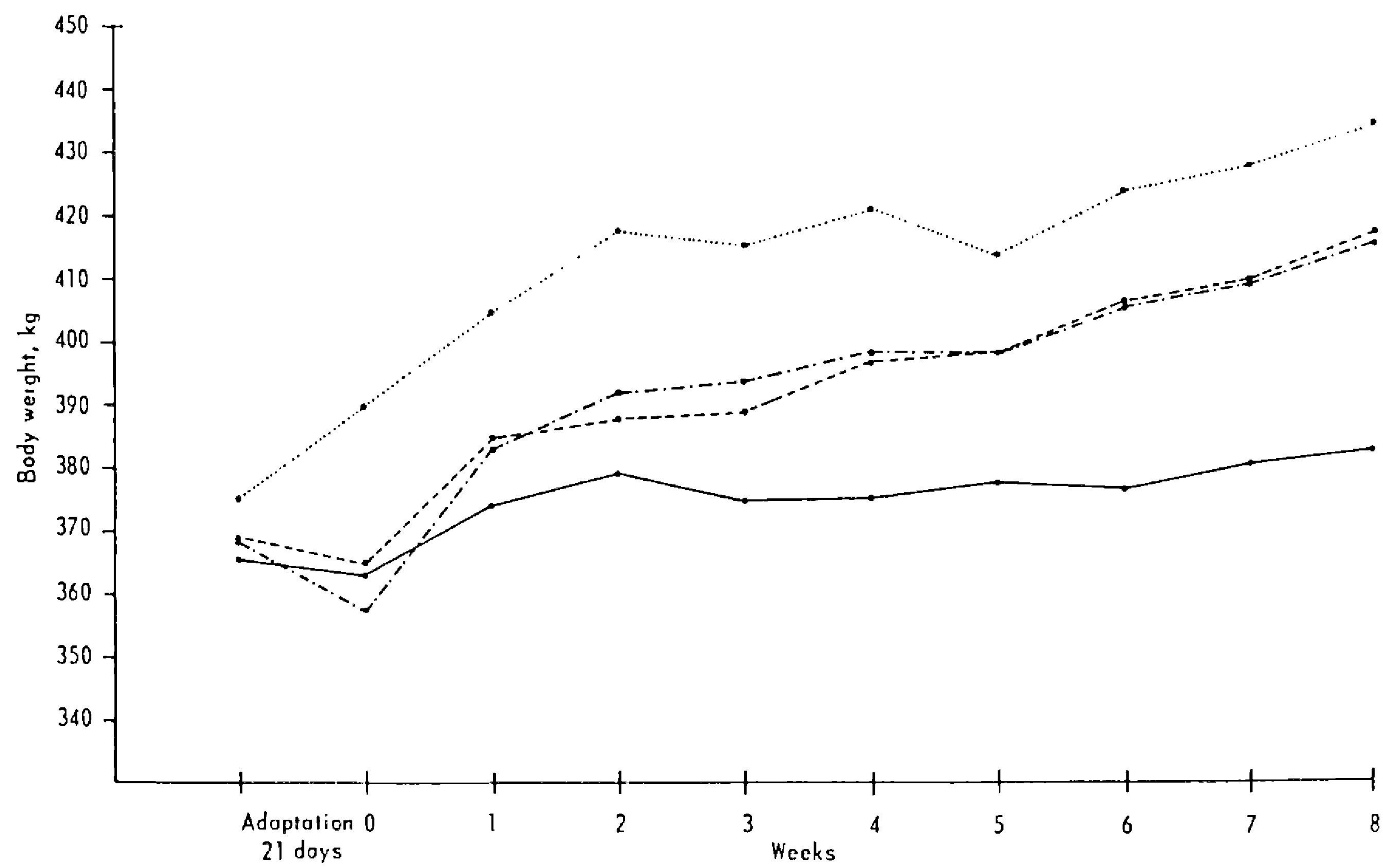

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FIGURE 1 Body weight increments in bovine adult males consuming lemon grass bagasse.

Table 6 shows feed intake, weight gain and the efficiency of feed utilization of the four diets studied. Although ration (A) gave inferior results when compared with the other three rations studied, it is important to note that this ration (A) was able to maintain body weight and even to promote a slight weight increment in spite of its inferior nutritive value as compared to the rations evaluated. Animals in group A refused about 12% of the amounts of feed offered, in contrast to a 5% refusal in the other groups. This was probably due to the low level of protein supplementation received by this group. In all cases dry matter consumption averaged 2.4% of body weight, which is good for this type of rations.

TABLE 6 Consumption, Body Weight Increments and Efficiency of Feed Utilization in Cattle Consuming Diets Containing Lemon Grass Bagasse

Item	Intake[a] (kg)	Dry matter consumption (% body weight)	Body weight increment (kg)	Efficiency of feed utilization[b] (kg)
Experimental group				
A	786.9	2.3	19.4	25.2[a,c]
B	903.9	2.5	52.7	10.4[b,d]
C	888.7	2.4	58.3	9.1[e]
D	878.0	2.3	45.3	11.5[d]

[a]Values expressed on as-fed basis.
[b]Expressed in terms of dry matter consumption.
[c,d,e]Different letters indicate values are significantly different.

The results obtained with the cattle in spite of using material of such poor quality can be explained first of all, because of the additive effect of urea, minerals, natural proteins and molasses. This improving effect on the digestibility has been observed both by Johnson et al. (1966) and in other experiments where corn stover silage was supplemented with urea and ammonium polyphosphate by Lonsdale (1970) and by Collebrander et al. (1971). It has also been demonstrated that the addition of natural protein sources such as soybean meal or cottonseed meal as well as sources of nonprotein nitrogen (NPN) have a beneficial effect not only on digestibility of poor-quality roughages, but also on the daily ingestion and the rate of passage of the feed through the gastrointestinal tract (Ammerman et al. 1962, 1972; Coombe and Tribe 1963; Minson 1967; Henley 1968). The addition of molasses and cottonseed meal is considered to be one of the important factors in promoting better utilization of cellulose, crude protein and N-free extract as reported by Dysli and Bressani (1969).

Briefly, field trials showed that is is possible to obtain good increments in body weight with rations where lemon grass bagasse constitutes the source of forage. Its utilization would, therefore, contribute to a more efficient animal production system in areas with extended dry seasons.

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