Possibilities of Using Bananas for the Feeding of Ruminants in Humid Tropical Regions[1]

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ABSTRACT

The possibility of using green or ensiled bananas was studied with goats green-fed a tropical grass (*Digitaria decumbens*). Bananas increased both dry matter intake and digestible organic matter intake. Offered *ad libitum* bananas represented 50 to 70% of the diet of lactating or young growing goats without reducing milk production or growth rate. Provided the nitrogen level of the diet was balanced it was possible to reduce concentrate by 300 to 450 g/day/animal. It was also possible to fatten young goats with a complete diet composed of banana, cereal, bagasse, and urea simultaneously ensiled. Further study is needed to determine whether these types of diets are effective for cattle.

INTRODUCTION

According to many studies, tropical grasses, in spite of their high production potential and easy utilization, have a lower feeding value than grasses from temperate zones. Nevertheless, in humid tropical regions these grasses constitute the basic feeds for ruminants, as the more nutritious legume plants are difficult to produce, and make low yields. Thus, utilization of grasses for the feeding of animals with high production potentials must be accompanied by large supplies of concentrates. Importation of these concentrates in the Antilles is expensive.

Many studies have been made on the utilization of sugarcane or its by-products (Puerto Rico, Cuba, Barbados, Mexico) but few data are available on the utilization of banana waste in animal feeding although non exportable bananas, representing 30 to 40 thousand tons in the French Antilles (10 to 15% of the production) are usually lost. This is often the case in Latin America, where the total production in 1970 (5) was 17.8 million tons and where the waste (spoiled bunches, harvest

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exceeding the shipping capacity, elimination of substandard or defective bunches) widely exceeded the amounts exported (4). There is need to search for techniques for transforming banana waste into animal products so as to solve this problem. Le Dividich et al. (6) succeeded in fattening pigs with banana wastes, and the authors thought that it would be possible to use them in the feeding of ruminants.

The aim of the study was to find out which ones among the less fully utilized local products may partially or totally replace concentrates. This paper presents the results obtained with goats, chosen as experimental animals for practical reasons. The main topics studied were: 1) Substitution of the greatest possible concentrate fraction by addition of fresh or ensiled banana and urea to the diet, and 2) preparation of a silage mainly composed of banana to be used as a complete fattening diet.

REVIEW OF THE LITERATURE

The possibilities of using bananas in animal feeding have been the subject of very few studies, especially in the feeding of ruminants. Chenost et al. (1) have indicated its potential advantage for polygastric animals and the published data (2) are reconsidered and completed in this paper. The interest in banana waste was also emphasized by the FAO in 1969 (4). The possibility of substituting cereals for dehydrated banana in the concentrates used for rearing and fattening has been stated by Spiro (7). In addition, the utilization of fresh waste as feed supplement for fattening beef cattle on pasture has recently been studied by Cubillos (3).

MATERIALS AND METHODS

Five trials with goats of the Alpine breeds (Chamoisée and Saanen) were carried out during a period of 4 years (1969–73). The first trial was made with male goats, the second with dry goats at maintenance feed level, the third with lactating animals, and the fourth and fifth with growing male kids.

Forage (*Digitaria decumbens*), green-fed *ad libitum* in two meals daily, was either of good quality (regrowths of 30 days receiving 800 kg N/ha/year) in the case of young growing animals, or poor quality (50-day old regrowths receiving 350 kg N/ha/year) in the case of adult animals. The digestibility and chemical composition of the forage are reported in table 1.

The grass forages were supplemented in each trial; the supplementation was always isonitrogenous. Various feed concentrates were prepared. Their composition is given in table 2.

DIGESTIBILITY TRIALS 1 AND 2

In the first trial two groups of six male goats were placed in digestibility cages. During three consecutive periods of 20 days (10 days of adaptation, 10 days of measurements) either green or ensiled bananas were offered *ad libitum* together with a common diet of pangola of variable digestibility according to the period.

In the second trial twenty dry 2- to 4-year old goats were divided into 4 groups, equilibrated according to weight and appetite and placed in digestibility cages. During the experimental period of 5 weeks (4 weeks of adaptation, 1 week of measurements), each group received at random one of the four following diets (treatments): 50-day old pangola regrowth

TABLE 1.—*Mean and extreme values of the chemical composition of forages and bananas, and of the digestibility of forages used*

Nature of the trials	Chemical composition			Digestibility of organic matter
	Ash (Dry matter)	Crude fiber (Dry matter)	Total crude protein (Dry matter)	
	%	%	%	%
Trial 1				
Banana				
green	5.2	2.8	6.0	—
ensiled	3.7	5.1	6.9	—
Forage				
Female goats	9.9	31.5	10.6	cf. fig. 1
Male goats	(5.8-8.4) 6.8	(33.1-34.7) 34.2	(5.6-9.0) 7.0	cf. fig. 1
Trial 2				
Forage	(5.5-5.7) 5.6	(32.0-36.0) 34.7	(9.0-14.0) 11.6	(56.1-59.2) 57.1
Trial 3				
Forage	(7.5-10.3) 8.5	(32.2-34.2) 33.2	(11.8-17.1) 14.9	(60.7-72.2) 67.7
Complete silage				
0 urea	4.9	6.3	21.7	72.2
1% urea	4.6	5.0	21.2	73.4

(*Digitaria decumbens*) together with 0, 1, 2, or 3 kg fresh green bananas during the first period, and ensiled bananas during the second one. Thirty grams of concentrate 1 were offered to all animals in order to satisfy their maintenance requirements for crude protein.

Dry matter intake, total digestibility of the diets, and nitrogen balances were determined (Kjeldahl method).

LACTATING GOATS (TRIAL 3)

Thirty lactating goats were kept under tying stall conditions and fed *ad libitum* 50-day old pangola regrowths. They received, for a period of 20 weeks, beginning the second month of lactation, the following six feed

supplements according to a 3 × 2 factorial scheme: cereals, fresh banana, or ensiled banana plus either oil meal or oil meal and urea.

The supplementation of pangola was isonitrogenous. Green and ensiled bananas replaced the cereals (barley, corn) in the proportion of 1.3 kg banana dry matter for each kilogram of cereal dry matter. This supplementation, determined on the basis of previous trials and adjusted from one week to another, supplied an amount equivalent to 450 g usual feed concentrate per kg milk produced (90 g crude protein per kg milk produced).

Milk yield was measured 5 days per week, butterfat content 2 days per week, and the digestibility of total rations, as well as the nitrogen

TABLE 2.—*Composition of the concentrates used in the different trials*

Component	Concentrate number			
	1	2	3	4
	%	%	%	%
Corn	—	20	20	38
Barley	—	40	30	30
Wheat	—	—	10	10
Soybean oil meal	79	—	15	—
Peanut oil meal	—	18	6	—
Linseed oil meal	—	6	—	—
Dehydrated alfalfa	—	10	—	—
Wheat straw	—	—	14	14.5
Molasses	9	—	—	—
Urea	12	—	0	2.5
Minerals and vitamins	6	6	5	5
Total	100	100	100	100
Total N (% dry matter)	11.35	2.9	2.54	2.46
N supplied with urea (% of total N)	51.0	0	0	47.0

balances, during one period in the middle and another at the end of the trial.

YOUNG GROWING GOATS (TRIALS 4 AND 5)

Twenty male goats 6 months old and with a mean weight of 27 kg were divided into four groups, equilibrated according to previous weight and weight gains, and fed 30-day old pangola regrowth. The groups were allotted at random the following diet treatments: 1) Classical feed concentrate (concentrate 3), 650 g/day/animal; 2) feed concentrate including urea (concentrate 4), 650 g/day/animal; 3) concentrate 4, 325 g/day plus fresh green bananas; and 4) same as treatment 3, but with ensiled bananas; the latter two to appetite.

Fresh bananas were cut by hand in small pieces before feeding. Ensiled bananas were obtained one and one-half month after having been chopped and put in a trench silo without additive.

In the last two treatments the bananas were fed together with 5 g urea to readjust the amounts of total crude protein offered as compared with the first two treatments. The urea was thoroughly mixed by hand with the bananas before feeding.

In another trial, 24 3-month old male goats with a mean weight of 15 kg were divided into two groups immediately after weaning. Each group received one of the two following diet treatments until slaughter at 36 kg: 1) Complete silage composed of 80% banana, 3% bagasse, 5% cereals, and 12% oil meal; 2) complete silage composed of 82% banana, 3% bagasse, 5% cereals, 9% oil meal, and 1% urea.

The animals were weighed on 3 consecutive days at the beginning and at the end of the experimental period, and on 2 consecutive days every 15 days during the experimental period.

RESULTS AND DISCUSSION

DIGESTIBILITY AND FEED INTAKE

Total digestibility of the whole ration composed of forage and fresh or ensiled bananas increased with the proportion of bananas. This increase was more marked with green than with ensiled bananas (fig. 1). These findings confirm those of Cubillos (3) who observed that the performance and weight gains of steers per hectare were higher when increasing proportions of bananas were offered animals on pangola pastures.

In the trial with lactating goats (trial 3), the digestibility (y) of the total ration could be related to the proportion (x) of forage in this ration by means of the equation

$$y = 81.59 - 0.3x \qquad (r = -0.89^{**\,3};\ n = 29)$$

This equation was obtained from all digestibility data measured in the different experimental groups: cereals, green bananas, and ensiled bananas.

Digestibility of the crude fiber and crude protein decreased when the proportion of bananas was increased. The nitrogen retention coefficients did not depend on the physical form and proportion of bananas fed (table 3).

Total dry matter intake was higher for ensiled than for green bananas. It reached its maximum when bananas constituted 20% of the diet, amounting to 1.80 and 2.20 kg/100 kg liveweight with green bananas and ensiled bananas, respectively. The forage dry matter intake increased when the proportion of bananas in the diet rose from 0 to 20%. Thereafter

[3] Significant at the 1-percent level.

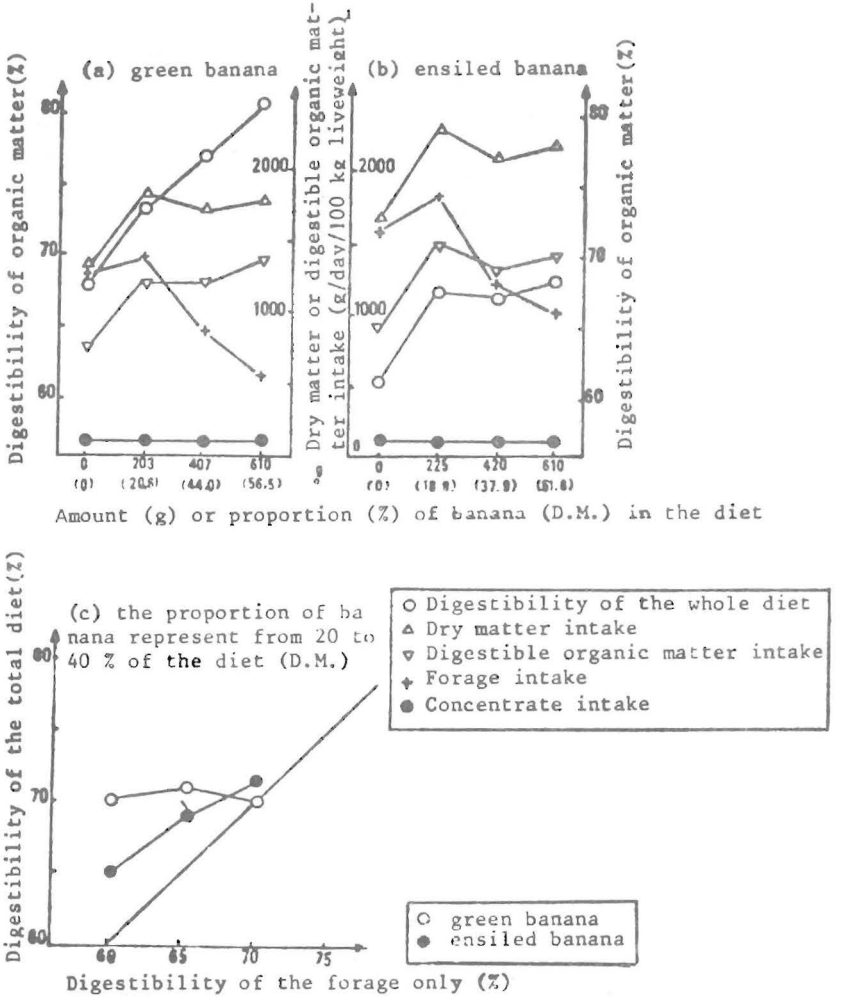

FIG. 1.—Influence of a supply of green or ensiled bananas on the dry matter intake (DM) or digestible organic matter (DOM) intake and on the apparent digestibility coefficient (ADC) of diets based on pangola according to the amount of green banana (a) or ensiled banana (b) offered, and according to the digestibility of the forage (c).

it regularly decreased, the substitution of forage by bananas being realized kilogram per kilogram dry weight (fig. 1).

The digestible organic matter intake, which characterizes very well the feeding value of the diet, increased with the proportion of bananas (fig. 1). The maximum value was reached (1.45 kg/100 kg liveweight) when the banana silage represented 20% of the ration. It was higher with fresh than with ensiled bananas.

MILK PRODUCTION

Total substitution for cereals in the concentrates of fresh or ensiled bananas led to a tendency for increase in total dry matter intake, especially in the case of the silage where the amounts of dry matter ingested in the form of bananas represented 72% of the total ration (table 4). This increase was not statistically significant.

Milk production of the goats fed bananas was not significantly different (P = 0.05) from that of the control group. The butterfat levels were low regardless of diet and were similar to those generally observed for the preceding 4 years in the herd.

Urea did not reduce significantly either milk production or butterfat level.

TABLE 3—*Effect of increasing supplies of green or ensiled bananas on N digestibility and retention and on digestibility of crude fiber in diets composed mainly of pangola* (Digitaria decumbens)

Item	Physical form of bananas							
	Green banana				Ensiled banana			
Proportion of bananas in the diet, %	0	20	40	60	0	20	40	60
Digestibility of the organic matter, %	68.4	73.5	77.0	81.4	61.4	67.6	67.3	68.6
Digestibility of crude fiber, %	71.7	70.3	67.9	67.7	70.4	68.3	62.7	63.0
Digestibility of crude protein, %	68.6	60.4	57.6	57.9	54.4	56.5	46.7	45.7
Nitrogen balance, g/day	5.5	5.7	5.0	5.7	4.2	8.8	6.5	6.6
Nitrogen retention coefficient, %	37.0	35.6	34.7	38.9	28.9	41.2	34.6	35.0

GROWTH

The results from trial 4 with growing young goats (table 5) show that it is possible to replace half of the usual concentrate by green or ensiled bananas if the diets are isonitrogenous. The total dry matter intake was higher with bananas than without. Green bananas, with or without urea, led to higher weight gains and feed conversion ratios than the concentrate feed or ensiled bananas.

In trial 5 all dietary components were introduced at the beginning of the ensiling process in order to simplify handling, and bagasse was used to permit the animals to ruminate in spite of the absence of forage. The results show that it is possible to fatten young goats with this diet only. Performance was not improved when the entire amount of protein was introduced into the silo in form of oil meal. This is quite normal since part of the protein nitrogen of the oil meal is converted into non protein nitrogen through the action of micro-organisms during the fermentation process.

TABLE 4.—*Effect of the nature of energy and protein supplementation on feed intake and milk production by dairy goats*

Group number	I	II	III	IV	V	VI
Energy source	Cereals		Green bananas		Ensiled bananas	
Protein source	Soybean meal	Soybean meal + urea	Soybean meal	Soybean meal + urea	Soybean meal	Soybean meal + urea
Initial mean weight, kg	48.2	43.2	45.1	53.7	47.9	44.2
Final mean weight, kg	48.1	42.7	48.9	54.1	51.2	44.1
Weight variation, kg	−0.1	−0.5	+3.8	+0.4	+3.3	−0.1
Milk production, kg/day/animal	1.312 a[1]	1.213 ab	1.693 a	1.309 b	1.620 a	1.182 b
Mean persistance coefficient	77.5	78.6	83.8	79.9	84.6	78.1
Butterfat content, g/1000g	26.4	26.7	25.1	29.5	26.7	27.1
Crude protein, g/1000g	28.2	24.0	32.5	32.5	27.7	29.4
Dry matter intake, g/day/animal						
50-day pangola regrowth	695.0	734.0	216.0	366.0	304.0	405.0
Green banana	—	—	1143.0	974.0	—	—
Ensiled banana	—	—	—	—	1011.0	785.0
Concentrate	662.0	599.0	379.0	160.0	361.0	139.0
Total	1357.0	1333.0	1738.0	1500.0	1676.0	1329.0
Dry matter intake per 100 kg live-weight, kg	2.82 a	3.10 a	3.70 a	2.78 a	3.39 a	3.01 a
Urea N, % of total N ingested	0	32.2	0	28.9	0	28.5
Dry matter intake per kg milk produced, g						
50-day pangola regrowth	530 a	604 b	184 c	317 d	190 c	345 d
Green banana	—	—	675	744	—	—
Ensiled banana	—	—	—	—	624	664
Concentrate	504 a	494 a	224 b	122 c	223 b	117 c
Total	1034 a	1098 a	1083 a	1183 a	1037 a	1126 a

[1] The figures which are not followed by the same letter are significantly different at $P < 0.05$.

In addition, unpublished data from complementary trials showed that it is possible to simplify even more these complete silages by ensiling at the same time a mixture composed of 74% bananas, 3% bagasse, 22% brans, and 1% urea.

CONCLUSION

These are preliminary results that should be checked in other trials conducted over longer periods and with a greater number of animals, specially beef cattle. However, they seem to show that non exportable bananas, instead of being thrown away, might constitute valuable energy supplements to tropical forages, since they can replace at least 50% of the concentrate feed used in the diets of lactating goats and of growing young goats.

TABLE 5.—*Feed intake and performance of young goats receiving either pangola supplemented with cereals or bananas, or a complete silage*

Nature of the diets	1969				1973	
	Cereals		Bananas		Complete silage	
	(0 urea) Diet 3	(urea) Diet 4	Green (urea) ½ diet 4	Ensiled (urea) ½ diet 4	0 urea	Urea
Initial weight, kg	27.3	27.5	27.6	27.8	13.0	13.0
Final weight, kg	33.8	34.8	33.6	34.7	33.2	35.1
Duration, days	56	56	56	70	160	156
Daily mean gain, g	116 a	130 a	155 b	123 a	126 a	142 b
Dry matter intake, g/day						
Forage	156	198	139	171	—	—
Concentrate	616	616	308	308	—	—
Banana	0	0	462	510	—	—
Total	772	814	909	989	856	776
Feed conversion ratio	6.7 a	6.2 a	5.9 b	8.0 a	6.8	5.3
Carcass yield	—	—	—	—	58	58

[1] Figures not followed by the same letter are significantly different at $P < 0.05$.

It is even possible to simplify the feeding operations to eliminate the whole forage fraction of the ration by adding to the bananas at the moment of ensiling the necessary fraction of energy, protein and fiber in the form of by-products such as a silage with a bran and urea, and bagasse. At the same time bran and bagasse can lead to a higher dry matter content, and consequently can reduce losses and increase dry matter intake.

Bananas constitute an efficient source of carbohydrates for the utilization of urea, but the studies have to be pursued in order to specify the optimum levels of bananas and urea that can be introduced into the

diets to obtain best utilization of the digestible organic matter and production of milk and meat.

RESUMEN

Un estudio sobre las posibilidades de utilización de guineo (plátano, banano) verde o ensilado por los rumiantes fue comenzado hace varios años con cabras lecheras y cabritos en crecimiento que recibían adicionalmente una gramínea tropical (*Digitaria decumbens*) suministrada en verde.

Hasta 20% de la dieta, el guineo no disminuye la ingestión de forraje y el nivel de materia orgánica digerible sigue aumentando más allá de esta proporción, gracias al aumento en la digestibilidad global de la dieta.

El guineo ofrecido *ad líbitum* pudo representar de 50 a 70% de la dieta de las cabras en lactación y de los cabritos en crecimiento y permitió, sin disminuir la producción lechera o el aumento medio diario, ahorrar 300 a 450 g. de alimento concentrado al día y por cabeza cuando el contenido en materia nitrogenada de esta dieta está balanceado mediante la incorporación de cantidad de urea hasta 50% del nitrógeno total. Incluso es posible cebar cabritos con una dieta a base de ensilaje solo, consistente de guineo, cereales, bagazo y urea.

La eficiencia de tales dietas (digestión, balance nitrogenado) para la producción de carne y leche deberá estudiarse más a fondo. El guineo parece permitir una mayor utilización del nitrógeno no proteico con respecto a la de los cereales en el caso de cabritos en crecimiento y de igual eficiencia en el caso de la cabra lechera.

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