Preliminary Evaluation of Ramie (*Boehmeria nivea* (L.) Gaudich) as a Forage Source for Livestock Feeding[1]

O. D. Ramírez-Torres, J. A. Arroyo-Aguilú, and N. Semidey-Laracuente[2]

ABSTRACT

Ramie (*Boehmeria nivea* (L.) Gaudich) was evaluated at 20-, 40-, and 60-day growth stages in three trials for chemical composition, yield, and intake with Holstein steers, respectively.

Crude protein and ash contents decreased while crude fiber and nitrogen free extract contents increased as ramie advanced in maturity from 20 to 60 days of age. The ether extract content remained about the same between 20- and 40-day stages but decreased at the 60 day stage. Significant differences ($P < .01$) were obtained in green forage yields between 20- and 40- or 60-day ramie, and in dry forage and crude protein yields between 20- and 40-day, 20- and 60-day, and 40- and 60-day ramie. Significant differences ($P < .01$) were also obtained in green forage intakes between 20- and 40-day, 20- and 60-day, and 40- and 60-day ramie, and in dry forage intakes between 20- or 40- and 60-day ramie.

Although ramie has a high crude protein content, its yields and intakes are very low in comparison to those of tropical grasses and alfalfa. It may be utilized as a feed or feed ingredient for livestock, principally monogastrics or small ruminants.

INTRODUCTION

Ramie (*Boehmeria nivea* (L.) Gaudich) is a fiber crop (12) that has been reported to be high in crude protein (CP) content (4, 6, 7, 9, 11, 15). It was introduced to the University of Puerto Rico, Agricultural Experiment Station at Río Piedras from Guayaquil, Ecuador, February 28, 1974.

Cattle feeding in Puerto Rico depends entirely on tropical grasses and on imported concentrate feeds (17). McDowell et al. (10) concluded that high levels of concentrate feeding are not to be recommended when cows have good quality pastures available at the rate of 2.5 cows per ha. Ramie could be of importance as a protein source in the reduction of feed costs for livestock feeding in Puerto Rico. Machin (9) reported ramie to be an excellent forage for all types of livestock, since it is a good source of CP, lysine, methionine, carotenoids, riboflavin, and calcium and has a low crude fiber (CF) level. These results have prompted this study to evaluate ramie as a forage source for livestock in Puerto Rico.

MATERIALS AND METHODS

In 1976 ramie material was planted on flats at the Río Piedras quarantine greenhouse facilities of the Agricultural Experiment Station. The

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[2] Plant breeder, Horticulture Department; Nutritionist, Animal Industry Department; and Research Assistant, Agronomy Department, Agricultural Experiment Station, Mayagüez Campus, University of Puerto Rico, Río Piedras and Lajas, P. R., respectively.

FIG. 1.—Ramie plant.

plants (fig. 1) were propagated for further agronomic and nutritional evaluations. Three concrete beds, 5.94 m long × 0.91 m wide, were used for propagation. At 20, 40 and 60 days of age, plants were harvested and sampled. At 30 days of age, leaves (fig. 2) and stems were also harvested and sampled. The material was dried at 60°C, and analyzed for CP, CF, ether extract (EE), and ash (A) contents (3). Total green forage yield (GFY), dry forage yield (DFY), and crude protein yield (CPY) per ha per year were calculated and statistically analyzed.

In 1976, an experiment was conducted at the Gurabo Substation, to

evaluate ramie at growth stages of 20, 40 and 60 days. A complete block design was used. The experimental plots were 8.36 m^2, with 20 plants per plot. Plants were 0.46 m apart within rows and 0.91 m apart between rows. All plots were fertilized every 4 mo with a 15-5-10 analysis, equivalent to 4480 kg/ha/year. At each growth stage, all material was harvested, weighed and sampled. Samples were dried at 60°C and ground in a Wiley mill to pass through a 1-mm screen. Dry matter (DM) and CP determinations (3) were conducted on all samples. Statistical analyses

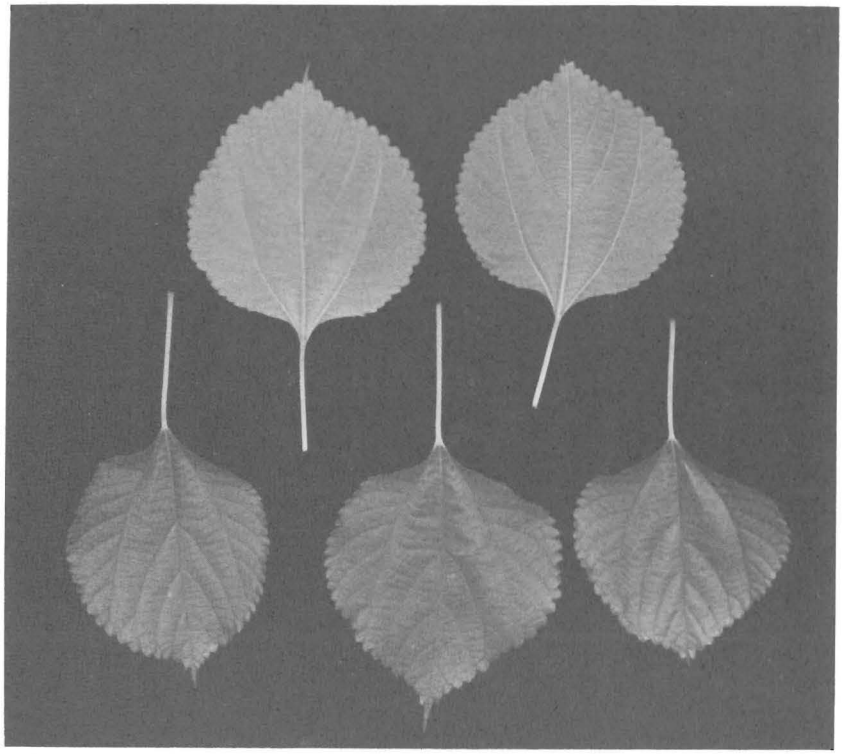

FIG. 2.—Ramie leaves.

were conducted according to Snedecor and Cochran.

Palatability trials, with ramie at growth stages of 20, 40, and 60 days, were conducted in 1978 at the Gurabo Substation with 2 male Holstein steers per growth stage. The ramie forage was fertilized and managed as indicated above. The green forage, cut into 3- to 6-cm pieces, was offered at a level of 10% of animal weight. Each experimental period lasted 8 days for 20-day ramie and 10 days for 40- and 60-day ramie, respectively. For the 20- and 40-day ramie trials, a 20% CP commercial concentrate

was offered daily at the rate of .91 kg per steer. For the 60-day ramie trial, the same amount of 20% CP concentrates was offered daily during the last 5 days only. Daily forage samples were collected and composited. These were dried at 60°C, and analyzed for DM and CP contents (3). Green forage intake (GFI), dry forage intake (DFI), crude protein intake (CPI) per animal per day were calculated and statistically analyzed (13).

RESULTS AND DISCUSSIONS

Mean CP, CF, NFE, EE and A contents of ramie at 20-, 40-, and 60-day growth stages are presented in table 1. CP and A contents decreased while CF and NFE contents increased as ramie advanced in maturity from 20 to 60 days of age. EE content remained about the same between 20- and 40-day stages but decreased at the 60-day stage. Similar results in EE and A content were obtained by Squibb et al. (11). Arroyo-Aguilú et al. (2) and Coward-Lord et al. (5) observed a decrease in CP content

TABLE 1.—*Mean crude protein, crude fiber, nitrogen-free extract, ether extract, and ash contents of 20-, 40-, and 60-day ramie plants, and mean crude protein, crude fiber, and ash of 30-day ramie leaves and stems*

Harvest interval	Crude protein	Crude fiber	Nitrogen-free extract	Ether extract	Ash
Days			%		
20[1]	23.02	12.01	35.42	5.87	23.68
40	17.73	15.08	41.52	5.94	19.73
60	13.71	21.03	42.30	4.95	18.01
30[2]	23.44	10.02	—	—	20.90
30[3]	8.36	43.29	—	—	7.63

[1] Ramie plants.
[2] Ramie leaves.
[3] Ramie stems.

and an increase in fibrous contents as tropical grasses advanced in maturity from 7 to 63 and from 30 to 180 days of age, respectively.

Ramie is higher than tropical grasses (2) and similar to alfalfa (*Medicago sativa*) (15) in CP content. CP reductions in ramie (9.31 percentage units) are also larger than in tropical grasses (6.5 or 8.0 percentage units) (2, 4) as these advance in maturity from 20 or 30 to 60 days of age.

Ramie CF content followed the same trend of tropical grasses, with a larger increase for the ramie (9.02 percentage units) than for the tropical grasses (4.7 percentage units) (5) as plants advanced in maturity from 20 or 30 to 60 days of age. Similar results were obtained by Squibb et al. (15), as ramie increased in height from 13 to 89 cm. Also the younger ramie plant has half as much of the CF content as alfalfa.

As expected, ramie leaves are much higher in CP and A but much lower in CF than ramie stems. Differencies of +15.08, +13.27, −33.27 percentage units were obtained between 30-day ramie leaves and stems

in CP, CF, and A contents, respectively. In Sudan, Cleasby and Sideek (6) obtained similar CP and CF contents in ramie leaves.

Table 2 presents yield (GFY, DFY, and CPY) data of ramie at 20, 40, and 60 days of age. GFY was significantly higher at 40 and 60 days than at 20. The 60-day GFY was less than half of the lowest GFY (96,182 kg per ha per year) (table 3) for Star (*Cynodon nlemfuensis*) grass harvested at 30 days (14). Forty five- and 60-day Star grass and 30-, 45-, and 60-day

TABLE 2.—*Mean green forage, dry forage, and crude protein yields and dry matter and crude protein contents of 20-, 40-, and 60-day ramie*

Growth stage	Green forage yield	Dry matter content	Dry forage yield	Crude protein content	Crude protein yield
Days	*Kg/ha/year*	%	*Kg/ha/year*	%	*Kg/ha/year*
20	12992[a1]	9.4	1221[a]	19.6	239[a]
40	42291[b]	12.1	5117[b]	16.2	829[b]
60	45539[b]	19.7	8971[c]	14.2	1274

[1] Means in the same column followed by the same letter do not differ significantly at the 5-% level.

TABLE 3.—*Green forage, dry forage, and crude protein yields and dry matter and crude protein contents of three forage grasses at various cutting intervals*

Variety	Green forage yield	Dry matter content	Dry forage yield	Crude protein content	Crude protein yield
	Kg/ha/year	%	*Kg/ha/year*	%	*Kg/ha/year*
		Pangolagrass (Digitaria decumbens)			
30 days	127,910	20.53	26,296	12.51	3,288
45	132,117	18.84	24,805	10.91	2,713
60	141,361	25.30	35,726	7.76	2,772
		Stargrass (Cynodon nlemfuensis)			
30 days	96,182	25.77	24,810	13.76	3,433
45	109,873	26.34	28,754	10.18	2,956
60	128,737	32.68	42,004	9.09	3,834
		Congograss (Brachiaria ruziziensis)			
30 days	118,198	20.57	24,405	11.53	2,816
45	136,680	18.62	25,435	9.79	2,486
60	162,960	24.82	40,508	7.16	2,903

Pangola (*Digitaria decumbens*) grass produced still higher GFY, ranging from 109, 873 to 141, 361 kg per ha per year (table 3) (14). Vélez Santiago et al. (15) obtained highest GFY in alfalfa cultivars Florida 66 (62,382 kg per ha per year) and Venezuela (69,925 kg per ha per year).

Significant differences ($P < .01$) in DFY were obtained between 20- and 40-days, 20- and 60-day, and 40- and 60-day ramie. Ramie DFY were much lower than those of grasses (21,326 to 42,004 kg per ha per year)

(14) or high-yielding alfalfas (15,947 to 18,116 kg per ha per year) (12) and only compared to those of low-yielding alfalfas (7,251 to 9,634 kg per ha per year) (16).

Similar trends were evident for CPY in ramie. Twenty-day ramie CPY yield was significantly less ($P < .01$) than yields in 40- and 60-day ramie. In comparison to grasses (2,415 to 3,834 kg per ha per year) (10) and to high-yielding (3,508 to 4,008 kg per ha per year) and low-yielding alfalfas (1,595 to 2,215 kg per ha per year) (16), ramie CPY was much lower. It is worth mentioning that fertilizer applications for ramie were the same as for grasses. Machin (9) indicated that, unlike alfalfa, ramie would require heavy fertilizer applications. Being a legume, alfalfa can provide a considerable amount of its protein from nitrogen fixed from the atmosphere.

Ramie intakes (GFI, DFI, and CPI) are presented in table 4. Significant differences ($P < .01$) in GFI were obtained between 20- and 40-day, 20- and 60-day, and 40- and 60-day ramie, and in DFI between 20- and 60 day, and 40- and 60-day ramie. As the ramie advanced in age, CFI

TABLE 4.—*Mean daily green forage, dry forage, and crude protein intakes and dry matter and crude protein contents of 20-, 40-, and 60-day ramie, consumed by steers*

Growth stage	Green forage intake	Dry matter content	Dry forage intake	Crude protein content	Crude protein intake
Days	*Kg/day*	%	*Kg/day*	%	*Kg/day*
20	16.35[a1]	9.4	1.54[a]	19.6	.30[a]
40	14.13[b]	12.1	1.71[a]	16.2	.28[a]
60	10.64[c]	19.7	2.10[b]	14.2	.30[a]

[1] Means in the same column followed by the same letter do not differ significantly at the 5-% level.

declined, DFI increased, and CPI remained the same. As a result, mean daily intake levels were 9.1, 8.2, and 7.6 kg per 100 kg body weight for GFI, and .9, 1.0, and 1.5 kg per 100 kg body weight for DFI in 20-, 40-, and 60-day ramie, respectively. Overall GFI and DFI levels were 8.3 and 1.3 kg per 100 kg body weight, respectively. Arroyo-Aguilú et al. (1) reported mean daily GFI and DFI levels in dry Holstein cows of 8.4 and 1.9 kg per 100 kg body weight, respectively, for Pangola, Congo (*Brachiaria ruziziensis*), and Star grasses at 40–46, 54–60, and 68–74 days of age. For Pangola and Star hays (8), mean daily DFI of native goats and Holstein steers was 2.0, 1.8 and 1.7, 1.5 kg per 100 kg body weight, respectively. Ramie palatability and coarseness were probably responsible for the decrease in GFI with advancing plant age. However, DFI increased with advancing plant age, due to the higher DM content. With decreasing CP content and advancing DFI, CPI remained about the same.

Gains in steer weights were evident with 20- and 40-day ramie intakes at .6 and .4 kg per day, respectively. However, weight losses of 1.7 kg per

day occurred with 60-day ramie intake, accompanied with loose stools. This was probably due to the lower quality and less palatability of the 60-day ramie.

Although ramie has a high CP and a low CF content, the yields and intakes, by Holstein steers, are low as compared to those of grasses and alfalfa. There exists the possibility of utilizing ramie as a feed or feed ingredient for livestock, principally for monogastrics or small ruminants.

RESUMEN

El ramio (*Boehmeria nivea* (L.) Gaudich) es una planta textil de excelente calidad, rica en proteina y con un potencial como alimento para animales domésticos. Se evaluó en 3 pruebas a etapas de crecimiento de 20, 40 y 60 dias de edad en la Subestación Experimental de Gurabo, con respecto a composición química, producción y consumo por novillos Holstein castrados.

Los contenidos en proteína bruta y ceniza disminuyeron mientras los de fibra bruta y extracto libre de nitrógeno aumentaron de los 20 a los 60 días de edad. El contenido en extracto etéreo permaneció igual en nuestras cosechadas a los 20 y 40 días pero disminuyó en la de 60 días. Se obtuvieron diferencias significativas ($P < .01$) en producción de forraje verde entre ramio de 20 y de 40 ó 60 días de edad, y en producción de forraje seco y de proteína bruta entre ramio de 20 y 40 días, 20 y 60 días y 40 y 60 días de edad. Los consumos de forraje verde entre las edades de 20 y 40 días, 20 y 60 días y 40 y 60 días y de forraje seco entre las edades de 20 ó 40 y 60 días fueron significativos ($P < .01$).

Se puede concluir que, aunque el ramio es rico en proteína bruta, su producción y consumo son bajos, al compararse con gramíneas tropicales y alfalfa. Sin embargo, su utilización como alimento o como ingrediente en raciones de alimentos para animales, principalmente monogástricos o rumiantes pequeños, es una posibilidad.

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