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SUPPLEMENTATION OF SORGHUM SILAGE FOR GROWING HEIFERS AND MILKING COWS

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Three experiments were carried out to evaluate sorghum silage as a cattle feed. In Experiment 1, 18 Holstein and Brown Swiss heifers were fed sorghum silage *ad libitum* and supplemented with 1, 2 or 3 kg/head/day of ground sorghum, using a completely randomised experimental design. In Experiment 2 the same number of heifers were supplemented with 2, 3 or 4 kg/head/day of a concentrate composed chiefly of maize and cotton seed meals. The liveweight gains were 0.09, 0.26 and 0.42 kg/day ($P < .01$) in Experiment 1 and 0.67, 0.87 and 0.94 kg/day ($P < .01$) in Experiment 2. The results show that heifers receiving sorghum silage require supplementation with a balanced concentrate which should constitute about half of the total ration. In Experiment 3, 24 Holstein and Brown Swiss cows were used to determine the milk yield obtained from sorghum silage supplemented with 5 and 9 kg/day of concentrates, compared with *Pennisetum purpureum* forage supplemented with 9 kg/day of concentrates. The yields produced were 10.9, 13.6 and 12.2 kg milk/cow/day. Cows of this level of production receiving sorghum silage should be supplemented with high levels of concentrates.

Key words: Sorghum silage, supplementation, cattle, milk yield, liveweight gain.

In Venezuela, dairy farms tend to be situated in areas where rainfall is well distributed throughout the year and the cattle are maintained almost exclusively on grazing. Silage is one of alternatives used to cover the forage deficit which occurs during the brief periods of scarcity. However, little information is available in the tropics concerning the levels of growth rate and milk production which may be sustained with silage, or the amount of supplementation required to satisfy the nutrient requirements of heifers and cows.

Three experiments were carried out to evaluate sorghum silage as a feed for cattle. In the first two, the effect of supplementing silage with ground sorghum and concentrates on feed consumption and growth rate of heifers was studied, while in the thifd, sorghum silage was compared with elephant grass (*Pennisetum purpureum*) as a basis for feed for milking cows.

Materials and Methods

One bunker silo of 100 tons was filled for each experiment with sorghum (*Sorghum bicolor*), variety Dekalb D^{+}59, harvested at the milky grain stage, and approximately 40 kg of ground maize were added to each three tons of fresh sorghum. The silos were opened between three and five months after preparation.

Experiments 1 and 2: In the first two experiments, a completely randomised design was used with 3 treatments and 6 repetitions per treatment. Experiment 1 lasted 83 days and Experiment 2, 70 days. In Experiment 1, 3 levels of supplementation were used (1, 2 or 3 kg/head/day of ground sorghum with 2% minerals and 1% salt), while in Experiment 2, 3 levels (2, 3 or 4 kg/head/day) of a concentrate consisting of 86% ground maize, 10% ground cotton seed, 2% minerals, 1% urea and 1% salt were fed. The silage was offered *ad libitum* at between 0700 and 0800 hours, allowing a 10% refusal, and the concentrate was fed in a single ration at the same time. All the animals had been consuming silage in the 4 weeks previous to the start of the trials.

Eighteen heifers, 9 Holstein and 9 Brown Swiss, were used in each experiment. Their mean initial weights were 214 and 216 kg, respectively, in Experiments 1 and 2 and they were randomly distributed with 6 heifers (3 Holstein and 3 Brown Swiss) to a corral. All cattle were treated for internal parasites with Panacur 10% (Hoechst Laboratories) at the start of the trials.

Silage consumption was determined daily by difference between the quantity offered and refused. Dry matter intake was estimated after adjusting the material offered and refused for dry matter content. Samples were dried in an oven at 80°C and no correction was made for the loss of volatile substances. Animals were weighed weekly before feeding and weight gains calculated by a simple regression analysis of weight on time. The mean weight gains for each treatment were compared using least significant difference tests.

Experiment 3: A completely randomised design was used to compare three treatments with eight repetitions per treatment. The treatments consisted of: 1) sorghum silage *ad libitum* with 9 kg/head/day of concentrate, 2) sorghum silage *ad libitum* with 5 kg/head/day of concentrate and 3) elephant grass forage of approximately 65 days' growth with 9 kg/head/day of concentrate. The concentrate included 68% ground maize, 29% cotton seed cake, 2% minerals and 1% salt.

A total of 24 cows were used with a mean liveweight of 411 ± 42 kg. Five Holstein and 3 Brown Swiss were assigned to each treatment and kept together in corrals for the 70 days' duration of the trial. At the start of the experiment, the cows had been in milk 98 ± 53 days and were in their 1st to 5th lactation. As far as possible, treatments were balanced according to calving number and date and to milk yield of the cows at the start of the experiment. Cows were milked twice daily and yield measured on a fixed day weekly. Mean milk yield during the trial was corrected by covariance for production during the first 42 days of lactation and treatment means compared using least significant difference tests. Cows were weighed twice and weight changes estimated by a simple regression analysis of weight on time.

The silage was fed once a day between 0700 and 0800 hours, allowing approximately 10% refusals. Consumption was estimated in the same way as in Experiments 1 and 2. The concentrates were offered in equal portions at 0800 and 1700 hours.

Chemical analysis and digestibility: Weekly samples of the silage offered and refused and monthly samples of the ground sorghum and concentrate were taken for the determination of dry matter, ash and crude protein according to the AOAC (1965) methods, and of acid detergent fibre (ADF) and cell wall content according to Goering and Van Soest (1968). In Experiment 3, an additional sample of silage was taken for the determination of the concentration and proportions of volatile fatty acids (VFA) in the rumen liquid using gas liquid chromatography (Series 200, Varian, California, USA) with isovaleric acid as the internal standard. The digestibility *in vitro* of the ground sorghum and concentrate was determined by the procedure of Tilley and Terry modified by Alexander and McGowan (1966). In Experiments 1 and 3, *in vivo* digestibility of the silage and forage was estimated by difference, assuming that the *in vitro* and *in vivo* digestibilities of the ground sorghum and concentrate were the same and that there was no associative effect between them and the roughage component of the ration. For this purpose, 3 and 4 animals per treatment were placed in individual stalls at the end of Experiments 1 and 3, respectively, and individual feed consumption was measured. Faeces excretion was estimated by the method of Hodgson and Rodriguez (1971)

Results and Discussion

The chemical composition and digestibility of the sorghum silage are shown in Table 1. The protein content of the three silages was about 8%,

Table 1:
Chemical composition and digestibility of the diets (%)

	Crude protein	Acid detergent fibre	Cellulose	Lignin	Ash	Digestibility
Experiment 1:						
Sorghum silage	7.8	48.3	32.2	9.9	11.1	57.6*
Ground sorghum	7.8	7.1	4.3	2.6	4.6	86.9**
Experiment 2:						
Sorghum silage	8.6	44.1	29.3	9.7	11.1	-
Concentrate	15.7	7.8	6.7	1.2	5.1	-
Experiment 3:						
Sorghum silage	8.1	44.7	26.2	8.5	15.3	58.8*
Elephant grass	5.7	50.7	36.2	9.9	8.8	52.2*
Concentrate	22.8	7.7	5.6	2.2	6.0	82.4**

* *In vivo* digestibility. ** *In vitro* digestibility.

which is low compared with the values given by the NRC (1978). The digestibility of the organic matter was about 58% in the experiments in which it was measured, a value comparable with that of tropical forage of medium quality (Minson, 1981). Higher values were to have been expected in view of the high grain content of the silage, and the difference may be explained by the low quality of the vegetative parts (leaf and stem) of the plant once the grain was formed, as well as by the high proportion of grain which passed through the tract without being digested, as was observed in all three trials. The volatile fatty acid content of the silage in Experiment 3 was 45 g/kg DM, made up of 90.3% acetic acid, 8.2% propionic acid and 1.5% butyric acid. Flynn (1981) gave butyric acid contents of 0.3% and 2.3% in silages of good and poor quality and the result obtained here was intermediate between these values. The dry matter content of the silage used in Experiment 3 was 27.2% when dried in an oven, which is equivalent to a 28.9% DM content when corrected for the loss of volatile materials, according to the procedure described by Dulphy and Demarquilly (1981). In view of the similarity of the results, no correction was made for loss of volatile substances in the results presented.

Experiments 1 and 2: The liveweight gains of the heifers in these two experiments are shown in Table 2. In the first trial, liveweight gain increased linearly with supplementation. However, in the second

Table 2:
Consumption of silage or forage, weight gain and milk production.

Experiment 1. Treatments:	**Silage + 1 kg/d**	**Silage + 2 kg/d**	**Silage + 3 kg/d**
Feed consumption(kg MS/100 kg LW)	1.65	1.46	1.38
Weight gain (kg/day)	.09[a]	.26[b]	.42[c]
Experiment 2. Treatments:	**Silage + 2 kg/d**	**Silage + 3 kg/d**	**Silage + 4 kg/d**
Feed consumption(kg MS/100 kg LW)	1.37	1.36	1,01
Weight gain (kg/day)	.67[a]	.87[b]	.94[b]
Experiment 3. Treatments:	**Silage + 9 kg/d**	**Silage + 5 kg/d**	**Forage + 9 kg/d**
Feed consumption(kg MS/100 kg LW)	.80	1.37	.75
Weight gain (kg/day)	.33[a]	.30[a]	.32[a]
Milk yield (kg/d)	13.6[a]	10.9[b]	12.2[ab]

a, b, c Means accompanied by different letters are significantly different ($P < 0.01$).

trial, no difference was found between the levels of 3 and 4 kg/head/day of supplement. If the second and third levels of supplementation are compared between the two experiments, it is clear that weight gains were greatly superior in Experiment 2. This may be explained, in the first

place, by the low availability of energy in diets including ground sorghum. In fact, in a study of the ruminal digestibility of various raw materials carried out at this Institute, Parra et al (1983) observed that both sorghum grain and ground sorghum were materials with a very low rate of degradation in the rumen. In addition, the diets supplemented with ground sorghum may have been deficient in rumen degradable nitrogen, due to the low content of this nutrient in the ground sorghum as well as in the sorghum silage. In Experiment 2, higher levels of degradable nitrogen were included by the inclusion in the ration of urea and cotton seed meal. The weight gains in the latter trial were similar to those obtained by other authors' using moderate levels of supplementation (Vivela *et al.*, 1973; Gatica *et al.*, 1981). However, in other studies where sorghum silage has been fed without any supplementation, lower weight gains have been recorded (Table 3).

The consumption of silage fell by 0.43 and 0.44 kg MD for every kg of concentrate fed as supplement in Experiments 1 and 2, respectively, as was to be expected given a base ration of medium quality (Blaxter *et al.*, 1961; Holmes, 1975). Similar levels of consumption have been reported in the literature, with variations according to the supplementation used (Table 3).

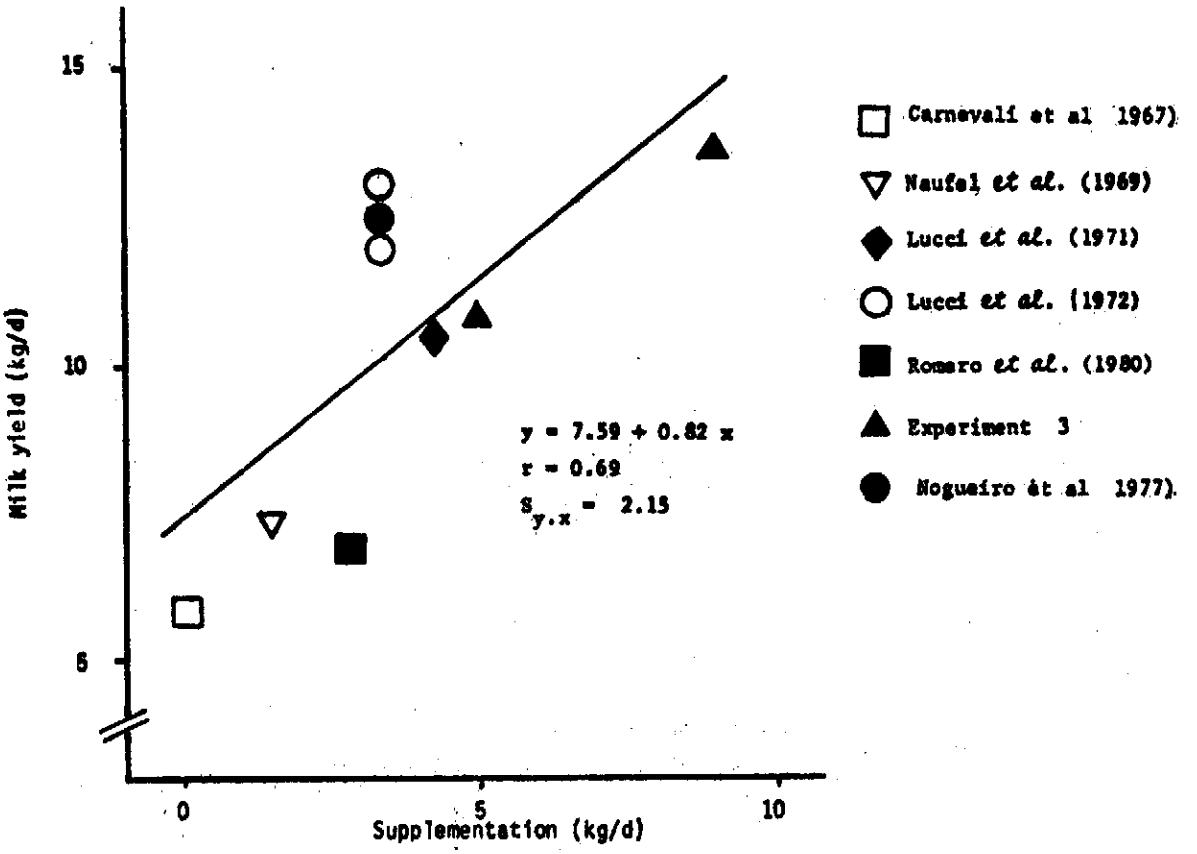
The results of these trials show that heifers fed similar quality silage should receive a balanced concentrate supplement as approximately half of their ration.

Table 3:
Consumption and weight gains of growing cattle fed sorghum silage in the tropics.

Source	Breed	Sex	Silage consumption (kg DM/100 kg LW)	Concentrate consumption (kg/day)	Weight gain (kg/day)
Mattos *et al.* (1969)	Guzerat	M	0.02	4.0	0.66
Vivela *et al.* (1973)	Holstein x Gir	M	1.73	1.5	0.84
	Gir	M	1.23	1.5	0.65
Rosas *et al.* (1976)	Zebú x Criollo	M		0	0.17
Talapatra *et al.* (1978)	Haryana	M	2.00	1.0	0.41
Singh *et al.* (1980)	Haryana	H	1.87	0	0.20
Gatica *et al.* (1981)	Holstein	H	1.79	1.5	0.72

Experiment 3: The milk yield of the cows used in this trial increased considerably when the level of concentrates rose from 5 to 9 kg/head/day (Table 2), although weight gains were similar in both treatments. At the same level of supplementation, milk yield was higher among cows fed sorghum silage than among those fed elephant grass, due possibly to the better quality of the silage (Table 1). However, the consumption of roughage was low on all treatments because of the high

Figure 1:
Relationship between milk yield and supplementation in some published experiments carried out with dairy cows receiving sorghum silage in the tropics



levels of concentrates fed and, as was pointed out above, because of the poor quality of the fibre used. The consumption of silage observed in this study was lower than that reported in the literature (Carnevali et al 1967), probably because the higher levels of concentrates used in the present case reduced silage intake. For each additional kg of concentrate between the levels of 5 and 9 kg/head/day, the consumption of silage was reduced by 0.62 kg.

The milk yields produced by cows fed sorghum silage are comparable with those reported by Lucci et al (1971) who obtained 10.5 kg in cows fed sorghum silage and 4.2 kg of concentrates. However, in other studies, better yields have been reported even with low levels of supplementation (Lucci et al 1972; Nogueiro et al 1977). In the various studies revised concerning milk production from sorghum silage in tropical conditions, different levels of concentrate supplementation have been used. An attempt to integrate the available information is shown in Figure 1, in which the level of milk production in various publications,

including Experiment 3, has been related to the amount of supplement fed. From this it is clear that the use of sorghum silage as a feed for milking cows requires variable levels of supplementation, according to cows' production levels, in order that their genetic potential may be expressed. Only very low-yielding cows would be able to satisfy their requirements on a diet of sorghum silage with no supplementation at all.

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