Nutritive value of different hybrids of sorghum forage determined *in vitro*

D. Colombo, G. M. Crovetto, S. Colombini, G. Galassi, L. Rapetti

Istituto di Zootecnia Generale. Università di Milano, Italy

Corresponding author: Daniele Colombo. Istituto di Zootecnia Generale. Facoltà di Agraria, Università degli Studi di Milano. Via Celoria 2, 20133 Milano, Italy - Tel. +39 02 50316456 - Fax: +39 02 50316434 - Email: daniele.colombo@unimi.it

ABSTRACT: Eight hybrids of sorghum forage were tested in large plots of two farms in two consecutive years to evaluate their chemical characteristics, nutritive value and yield as a possible substitute for maize silage. Two or three cuts were made depending on climatic conditions. On forage samples taken at ensiling chemical analyses and 24 h gas production were performed, to predict the NE_l content. In comparison with maize silage, the sorghum hybrids registered higher protein (13.7% on DM) and NDF (62.6% on DM) contents. Interestingly, the fibre fraction had a low lignin content (3.1% on DM). NE_l content ranged from 4.53 to 5.28 MJ/kg DM, the latter for the hybrid with the lowest NDF content. Hybrid effect was significant for ash, NDF, ADF and NE_l contents, whilst cut effect was significant for EE, CP, NDF and ADF. Yield was strongly influenced by fertilisation; when the latter was applied, it was in the range of 10-18 t DM, 1.7-2.8 t CP and 47-88 thousand MJ NE_l per hectare, as a sum of the 2-3 cuts. Sorghum forage seems to be a possible alternative to the fibrous maize silage fraction in diets of lactating cows, and an excellent forage for the rations of dry cows and heifers.

Key words: Sorghum forage, Nutritive value, Gas production, In vitro.

INTRODUCTION – In the last years maize, the crop which represents the main forage in the diets of dairy and beef cattle in the Padana valley, has shown some weak aspects in terms of quantitative and qualitative production. Among others: a high contamination with mycotoxins (particularly aflatoxins and fumonisins), the corn parasites *Diabrotica virgifera virgifera* and *Ostrinia nubilalis*, the always higher cost of irrigation and of the other technical inputs. Therefore, there is the interest for studying the possibility and convenience to substitute totally or partially maize silage with other forages. Sorghum (*Sorghum vulgare*) has long been used in animal feeding, particularly in dry areas. Forage sorghums are used primarily as silage for livestock and ensiling of forage sorghum proved to be a successful method of preservation (Black *et al.*, 1980; De Brouwer *et al.*, 1991). Recently some research on sorghum has been conducted also in more intensive agricultural lands such as the Padana valley (Tomasoni *et al.*, 2006). In their work the authors, using micro-plots (7,5 m^2), report a good yield of sorghum both as silage (14-17 t DM/ha) and as hay (12 t DM/ha).
Aim of this experiment was to study the yield and the chemical/nutritive characteristics of eight hybrids of sorghum forage.

MATERIAL AND METHODS – The hybrids used were: BMR 333 MH, GRAZER N, GW 5002, KING 61 DR, NICOL, PIPER, SWEET CREEK and TRUE. The hybrids were sown in two farms located in the Padana valley in 2004 and in one of the two in 2005. The hybrid Grazer N was sown only in the first year trial. An average amount of 80 kg seeds/ha was used. The farms spread always manure before seeding while the chemical nitrogen fertilization was not applied by a farm (farm 2) in the first year. The experimental plots measured 20.000-25.000 m^2 and were irrigated once per cut. In the first year the climatic conditions allowed three cuts, while in 2005 the farm could make only two harvests. Seeding happened in the second half of May, after the harvest of Italian ryegrass. All the cuts occurred between the end of the boot stage and the beginning of the early bloom stage. The first cut in 2004 was done after 45-50 days, whilst in 2005 after 59 days. The second cut was done after 32-38 (2004) or 50 (2005) days from the first one. The third cut in 2004 was done after 40-42 days from the second one. The forages were cut with a mower-conditioner, field-wilted with one tedding and harvested with a fodder cutter after two days. At ensiling all the fresh matter was weighted to determine the yield.

In order to correct for soil ashes and to determine the DM content, two samples were collected, one at cutting and one at ensiling. The latter was also chemically analysed to determine: DM, ash, EE, CP, NDF, ADF and ADL. Nutritive value was predicted according to Menke and Steingass (1988) and NE_l was estimated using the 24 h gas production as well as the CP and EE contents of feed as follows:

$$NE_l \text{ (MJ/kg DM)} = 0.54 + 0.0959\ GP + 0.038\ CP + 0.01733\ EE^2$$

where:

GP is expressed as mL/200 mg DM,
CP and EE are expressed as % on DM.

RESULTS AND CONCLUSIONS – Table 1 shows the average chemical composition and feed value of the hybrids. The crude protein and NDF contents are higher than corn silage and the lignin content quite low (on average: 13.7, 62.6 and 3.1% on DM, respectively). Hybrids were not statistically different for crude protein content, ether extract, lignin and non-fibre carbohydrates (NFC). The hybrid BMR 333 MH had the lowest NDF and ADF contents and, consequently, the highest nutritive value (5.28 MJ NE_l/kg DM). On the contrary, PIPER, characterized by the highest fibre content (64.2% NDF on DM), showed the lowest net energy value (4.53 MJ NE_l/kg DM). Comparing our average results with the data (entry no. 102) reported by NRC (2001), it has to be underlined that ash, NDF and NFC contents are similar, while NRC reports a lower content of crude protein (10.8% on DM) and a more than twofold ether extract content (3.6% on DM).

Table 1. Chemical composition (% on DM) and nutritive value of the different sorghum hybrids tested in the experiment (mean values of two or three cuts and two farms, n=8).

Hybrid or variety	DM[1]	Ash	EE	CP	NDF[2]	ADF[2]	ADL[2]	NFC[3]	GP[4]	NE_l
BMR 333 MH	22.6	12.3^{a}	1.67	15.5	59.2^{b}	34.9^{b}	2.36	14.8	42.7^{a}	5.28^{a}
GRAZER N	21.6	11.7^{ab}	1.64	13.7	62.6^{a}	36.2^{ab}	2.70	13.4	40.0^{abc}	4.95^{abc}
GW 5002	23.6	11.4^{ab}	1.54	13.6	63.0^{a}	37.3^{ab}	3.53	13.4	40.1^{abc}	4.95^{abc}
KING 61DR	23.7	11.4^{ab}	1.56	12.7	63.2^{a}	37.7^{ab}	3.08	13.9	41.1^{ab}	5.01^{ab}
NICOL	24.9	11.2^{ab}	1.52	12.3	62.9^{a}	38.0^{a}	3.00	14.8	41.6^{ab}	5.04^{ab}
PIPER	29.1	10.4^{b}	1.51	14.5	64.2^{a}	37.9^{a}	3.50	12.6	35.4^{c}	4.53^{c}
SWEET CREEK	24.9	11.6^{ab}	1.58	13.0	62.8^{a}	37.5^{ab}	3.32	13.9	40.0^{abc}	4.91^{abc}
TRUE	26.8	10.8b	1.60	14.3	62.6^{a}	37.3^{ab}	3.48	13.9	36.5^{bc}	4.63^{bc}
Average	24.7	11.3	1.58	13.7	62.6	37.1	3.12	13.8	39.7	4.91
RMSE[5]	5.25	1.12	0.15	2.54	1.72	1.44	0.97	2.43	4.87	0.40
Hybrid effect	0.309	0.042	0.279	0.238	<0.01	<0.01	0.256	0.673	0.062	0.017
Cut effect	0.212	0.149	<0.01	<0.01	<0.01	<0.01	0.222	0.476	0.599	0.972

[1]= dry matter content at the moment of ensiling.

[2]= the data are expressed as "insoluble ash free".

[3]= NFC=100-(ash+EE+CP+NDF-NDFIP), where NDFIP is equal to 22.2% of CP (NRC, 2001).

[4]= gas production at 24 hours (mL/200 mg DM).

[5]= root mean square error.

[a,b,c]= means in the same column with different letters are significantly different (P<0.05) according to Duncan's multiple range test.

The effect of the cut, significant for EE, CP, NDF and ADF content, was primarily due to the earlier maturity stage of the third cut.

Table 2 reports the yield of DM, CP and net energy per hectare obtained in the two farms. Nitrogen fertilization, not applied in farm 2 during year 2004, had a strong impact on the DM yield that was increased by about 65%. During the second year of the experiment, in farm 2, the yield of maize silage sown in the same date was about 18.1

t DM per hectare; considering an average NE_l concentration of 6.06 MJ/kg DM for maize silage, the total NE_l yield is 109,686 MJ, slightly higher than the best sorghum hybrids. On the other hand, the crude protein yield registered with sorghum when N fertilization was applied, was higher.

In relation to its chemical composition and nutritive value sorghum forage appears an ideal forage for dry cows and heifers. For feeding high yielding cows sorghum forage could successfully substitute the more fibrous parts of maize (stalk and leaves), being associated with maize dry grain or with grain or grain, cob and husks ("ear") high moisture maize in the ration to provide for an adequate starch content of the diet.

Table 2. Dry matter, net energy of lactation and crude protein yield per hectare of the different hybrids obtained in the three trials.

Hybrid	Farm 1 – Year 2004[1]			Farm 2 – Year 2004[1]			Farm 2 – Year 2005[1]		
	DM (t)	NE_l (MJ)	CP (t)	DM (t)	NE_l (MJ)	CP (t)	DM (t)	NE_l (MJ)	CP (t)
BMR 333 MH	12.7	64,990	2.24	7.7	42,456	0.90	9.4	47,606	1.68
GRAZER N	16.0	72,679	2.59	9.6	49,804	1.04	n.d.	n.d.	n.d.
GW 5002	17.1	74,088	2.75	10.8	55,082	1.36	17.8	83,988	2.07
KING 61 DR	18.5	86,643	2.62	10.1	52,258	1.12	15.3	75,275	1.88
NICOL	16.7	77,978	2.43	9.4	51,831	0.98	15.0	72,693	1.74
PIPER	15.9	70,367	2.63	8.1	42,634	0.84	12.0	52,044	1.80
SWEET CREEK	18.7	88,462	2.72	11.1	55,927	1.29	17.9	85,354	2.01
TRUE	16.0	69,876	2.56	8.1	42,976	0.85	13.6	59,342	2.19

[1]= the yields reported represent the sum of three (2004) or two (2005) cuts.

The Authors want to thank ∂Dr. N. Rizzi (ARAL Crema) for the chemical analyses and the owners of the farms, Monti brothers and Dr. Andena.

The research was supported by Regione Lombardia ("Programma regionale di ricerca in campo agricolo 2004-2006").

REFERENCES – **Black**, J.R., Ely, L.O., McCullough, M.E., Sudweeks, E.M., 1980. Effect of stage of maturity and silage additives upon the yield of gross and digestible energy in sorghum silage. J. Anim. Sci. 50: 617-624. **De Brouwer**, C.H.M., Van Der Merwe, H.J., Snyman, L.D., 1991. A laboratory study of the composition and fermentation of various crop silages. S. Afr. J. Anim. Sci. 21: 21-27. **Menke,** K.H., Steingass, H., 1988. Estimation of the energetic feed value obtained from chemical analysis and in vitro gas production using rumen fluid. Anim. Res. & Devel. 28: 7-55. **NRC**, 2001. Nutrient requirements of dairy cattle. National Academy Press, Washington, D.C. **Tomasoni**, C., Borrelli, L., Berardo, N., 2006. Sorgo da foraggio, da trinciato e da granella nella pianura irrigua lombarda. Dal Seme. 1: 57-64.