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Nutritional characteristics of forages from Niger

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ABSTRACT: Twelve forages from the arid zone of Niger were evaluated with the IVGPT, that appears to be the most suitable technique for use in developing countries where resources may be limited. Differences emerged between Gramineae and Leguminosae for *in vitro* fermentation (ie, degradability, gas and volatile fatty acids production, kinetics). Strong relationships were evidenced between *in vitro* characteristics and chemical composition parameters for all the forages.

Key words: Forages, Niger, *In vitro* gas production technique (IVGPT), Fermentation kinetics.

INTRODUCTION – In the production systems of the semi-arid areas low quality forages are commonly used as the basal diet (Wilkins, 2000) and, as a consequence, the nutritional status of ruminants depends mainly on the ability of rumen fermentation to yield nutrients such as the short chain fatty acids and microbial biomass (Preston and Leng, 1987). The forages browsed by the livestock can be classified into two main groups: ephemeral annual plants, which germinate and remain green for only a few weeks after rain, perennial shrubs and tree fodders. Despite their potential as feeds, little research has determined their nutritive value. *In vivo* evaluation is the best estimation method of feed's nutritional value, however it is very laborious and difficult to standardize with browsing animals. O the contrary, *in vitro* methods are less expensive, less time consuming and allow a better control of experimental conditions than *in vivo* experiments. The *in vitro* gas production technique (IVGPT) appears to be the most suitable method for use in developing countries where resources may be limited (Makkar, 2004). Increased interest in use of non-conventional feed resources has led to an increase in use of this technique, since IVGPT can provide useful data on digestion kinetics of both the soluble and insoluble fractions of feedstuffs. The aim of the present research was to evaluate twelve forages from the arid zone of Niger using the IVGPT.

MATERIAL AND METHODS – The forages were: 8 plants (4 Gramineae: *Eragrostis tremula*, *Cenchrus biflorus, Aristida longiflora, Pennicetum pedicellatum* and 4 Leguminosae: *Zornia glochidiata*, *Tephrosia bracteolata*, *Tephrosia purpurea*, *Alysicarpus ovalifolius*), leaves of 3 woody species (*Maerua crassifolia*, *Gliricidia sepium, Combretum aculeatum*) and 1 perennial shrub*: Pergularia tomentosa*. They were harvested in Autumn 2005 in the Tillabery district, dried at 70°C for 5 h at the Faculté d'Agronomie de l'Université Abdou Moumouni (Niamey, Niger), and sent to DISCIZIA (Napoli, Italy). The samples, ground to pass a 1 mm screen, were analysed for chemical composition (AOAC, 1999) and structural carbohydrates fractions (Van Soest *et al.*, 1991). Rumen liquor for the inoculum was collected at the slaughtering from 2 buffalos (*B. bubalis*) fed diet with NDF 43 and CP 12 % DM, and immediately transported to the laboratory. The gas measurements was as per Theodorou (1993) and the gas profiles were fitted to the Groot *et al.* (1996) model which allows to estimate the asymptotic value (A, ml/g), the time after incubation at which A/2 has been formed (B, h), the time to reach the maximum rate (t_{max}, h) and the maximum rate (R_{max}, ml/h). At the end of the incubation (120 h), the final gas production was related to incubated OM (OMCV, ml/g); the OM degraded (dOM, %) was determined by filtration and ashing. VFA were measured by gas chromatography (Calabrò *et al.*, 2006). The t-test was used to assesses statistically the *in vitro* characteristics differences of Leguminosae and Gramineae. Correlation between chemical composition and *in vitro* parameters were studied by Proc Corr (SAS, 2000).

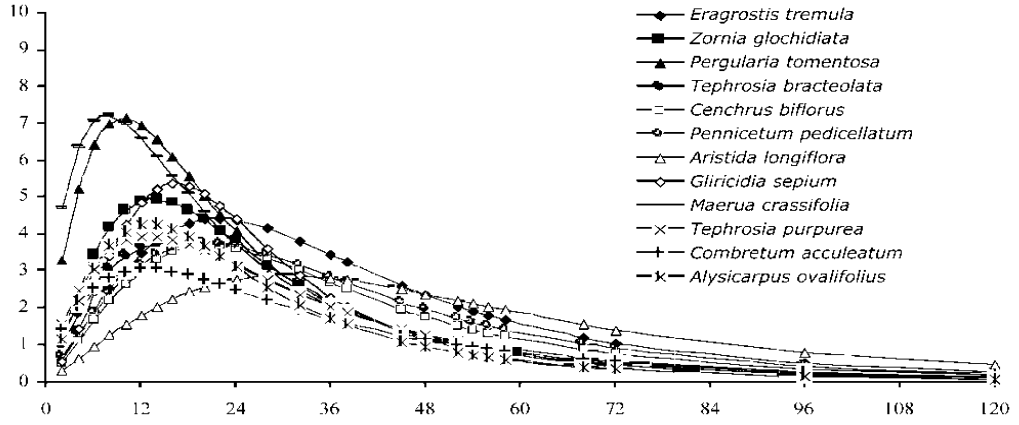
RESULTS AND CONCLUSIONS – The plants presented high structural carbohydrates (NDF: 71.1 ± 8.56 % DM) and low crude protein content (CP: 5.49 ± 4.18 % DM), due to the advanced vegetative stage at harvesting (table 1). As expected, the Gramineae resulted richer in NDF (77.4 ± 3.98 % DM) and showed extremely low CP content (2.76 ± 1.07 % DM) compared to the Leguminosae (64.8 ± 6.91 and 8.24 ± 4.44 % DM for NDF and CP, respectively); on the other hand, the latter showed higher ADL content (13.4 ± 2.03 vs. 8.10 ± 1.33 % DM).

Table 1. Chemical composition of the forages and in vitro fermentation characteristics.

	CP	NDF	ADF	ADL	Ash	dOM	OMCV	A	B	VFA
			% DM			%	ml/g	ml/g	h	mM/g
Eragrostis tremula	2.70	76.9	47.3	7.30	3.66	54.8	228	239	35.7	70.2
Zornia glochidiata	6.78	67.4	56.0	15.6	4.65	42.9	178	185	24.1	49.1
Pergularia tomentosa	9.86	41.8	37.1	7.31	9.53	67.5	212	226	19.7	62.8
Tephrosia bracteolata	3.65	73.3	57.9	14.5	4.01	34.2	155	164	27.7	56.3
Cenchrus biflorus	4.00	75.6	49.8	9.70	7.60	47.8	178	186	33.5	79.7
Pennicetum pedicellatum	2.92	74.1	47.0	6.75	10.2	52.7	202	207	35.6	90.5
Aristida longiflora	1.40	83.2	53.8	8.64	3.98	55.6	193	227	51.2	70.9
Gliricidia sepium	15.0	42.6	33.4	17.1	9.56	56.6	176	176	23.6	87.6
Maerua crassifolia	19.3	23.1	17.0	3.50	22.0	82.8	222	233	19.7	72.7
Tephrosia purpurea	14.2	58.3	40.4	12.4	5.96	46.0	169	178	27.7	53.4
Combretum aculeatum	9.52	33.3	27.4	6.02	8.13	63.4	140	152	30.5	51.1
Alysicarpus ovalifolius	8.29	60.1	44.8	11.1	21.3	49.7	147	152	23.0	50.1

Leaves of woody plants and shrubs showed a more favourable chemical composition, either for CP (13.4 ± 4.65 % DM) and NDF (35.2 ± 9.10 % DM). Only *Gliricidia* showed very high ADL content (17.1 % DM), probably due to the lignified stems. Generally, the final gas production (OMCV) resulted similar to the potential value estimated by the fitting model (A) indicating that the incubation time was sufficient to complete the fermentative process (table 1). Excluding *Pergularia, Maerua* and *Combretum*, dOM resulted quite low for all the samples in agreement to their chemical composition. Comparing Gramineae and Leguminosae, the former showed higher dOM (51.8 ± 3.58 vs 43.2 ± 6.64 %), total gas and VFA production significantly higher and fermentation rate significantly lower; this result, surely due to the high ADL content in the Leguminosae, confirm that also in region with complete different climate condition, the diversity behaviour between the two families is maintained unchanged.

Figure 1. Fermentation rate (ml/g) over time.



The fermentation rate profiles (Figure 1) appeared similar for all the forages: the most part of the process occurred in the first 60 h of incubation to complete slowly within the 96 h. The fermentation rate of *Pergularia* and *Maerua*, in the first 12 h of incubation was particularly high due to their elevate content in non-structural carbohydrates (NSC: 33.84 and 30.73 % DM). While, *Gliricidia* NSC (41.60 % DM) fermentation was probably inhibited by its high ADL content. The behaviour of *Combretum* is not easy to explain: in contrast with its favourable chemical composition, this woody specie presented a slow fermentation kinetics, maybe due to the anti-nutritive factors content as found by Sangaré *et al.* (2003). The correlation study between the IVGPT parameters and the chemical composition of the forages confirm the influence of some chemical characteristics of the substrates on the fermentation process. dOM resulted negatively ($P<0.01$) correlated with all the cell wall fractions (NDF: $r = -0.737$; ADF: $r = -0.856$; ADL: $r = -0.716$). Also the kinetics parameters were affected by the NDF content (B/NDF: $r = 0.686$, $P<0.05$; t_{max}/NDF: $r = 0.775$, $P<0.01$; R_{max}/NDF: $r = -0.619$, $P<0.05$), while for B and t_{max} the best correlation ($P<0.0001$) emerges with the ADF/CP ratio (B: $r = 0.906$; t_{max}: $r = 0.902$). OMCV resulted correlated with total VFA ($r = 0.5187$; $P<0.05$). The latter, even if not very strong, is very important because testify the regular trend of the fermentation in the closed system used. Indeed, it must be underlined that the partitioning factor (mg OM degraded/ml gas produced) ranged between 1.46 and 4.77, thus comprised in the interval suggested by Getachew *et al.* (1998) for conventional feeds (roughages). In conclusion, the IVGPT allowed to better characterize some Nigerin forages for some parameters (i.e. degradability and fermentation kinetics) little known.

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