Livestock Research for Rural Development 18 (9) 2006 | Guidelines to authors | LRRD News | Citation of this paper

The influence of *Moringa oleifera* leaves as substitute to conventional concentrate on the *in vitro* gas production and digestibility of groundnut hay

F S Nouala, O O Akinbamijo*, A Adewumi*, E Hoffman, S Muetzel** and K Becker****

Délégation Provinciale MINADER Littoral BP 257 Douala-Cameroun
** International Trypanotolerance Centre PMB 14 Banjul, The Gambia*
***Department of Aquaculture Systems and Animal Nutrition, Institute 480, University of Hohenheim, Stuttgart, Germany*
nouala@hotmail.com

Abstract

In view of generating a database of feed resources available in West Africa, a study was carried out to investigate the effect of various levels of *Moringa oleifera* supplementation, sole or combined with conventional concentrate, on 24 hours gas production and *in vitro* digestibility of groundnut hay. Four supplements were used for the study: concentrate (Co), *Moringa oleifera* leaf meal (Mo), concentrate and *Moringa oleifera* mixture (75/25: C75 and 50/50: C50).

Gas production (GP) after 24 hours fermentation and *in vitro* digestibility (IVTD) were significantly higher with *Moringa oleifera* compared to concentrate whatever the level of supplementation when they were used as sole supplements. When *Moringa oleifera* replaced concentrate in the supplement by 25 % (C75) or by 50% (C50), there was no significant difference in GP and IVTD between these supplements and *Moringa oleifera* alone at 10% and 20% level of supplementation.

The results of the present study suggest that *Moringa oleifera* leaves when mixed with conventional concentrate could improved its utilization.

Key words: Concentrate, *in vitro* gas production, *Moringa oleifera*

Introduction

Nutritional constraints of most crop residues are low content of nitrogen (N), poor digestion and low intake, such that productive performance of tropical animals is often low. It has been recognised that intake and utilisation efficiency of crop residues are influenced by the rate of rumen fermentation (Van Soest 1982) and the balance of nutrients absorbed in the intestines. Improvement in the nutritive value, removal of nutritional limitations to rumen fermentation, and a balanced supply of nutrients to host animals would result in an improvement in animal productivity.

Supplementation with concentrate mixtures including cereal grains, cereal bran, or oilseed meals has resulted in increased intakes in intensive production systems and has been the subject of several excellent reviews including that of Bangani et al (2000). However these supplements are often not fed due their unavailability and their high cost.

Therefore, other sources of supplementation need to be investigated. The use of forages legumes as supplement has been suggested as an alternative to use of concentrate (Jones 1979; Ndemanisho 1996; Roothaert and Paterson 1997). However, many tropical fodder legumes contain secondary plant compounds such as tannins, saponins, cyanogens, mimosine and coumarins, which limit nutrient utilisation (Leng 1997; Makkar 1993)

Moringa oleifera Lam a non-leguminous multipurpose tree with a high crude protein in the leavaes (251g/kg DM) and negligible content of tannins and other anti-nutritive compounds (Makkar and Becker 1996) and offers therefore an alternative source of protein to ruminants wherever they prosper.

In The Gambia, *Moringa oleifera* in grown in the backyards and the leaves are mainly used as food. Because of the potential of *Moringa oleifera* as feed resource for ruminants, the present study investigated the effect of various levels of *Moringa oleifera* supplementation, alone or combined with conventional concentrate, on 24 hours gas production and *in vitro* digestibility of groundnut hay. The study was carried out in the context of generating a database of feed resources available in the West Africa region.

Materials and methods

The green leaves of *Moringa oleifera* were air-dried, ground through a 2-mm mesh hammer mill and stored in plastic airtight bottles. The conventional concentrate consisted of a mixture of groundnut cake and rice bran (1:1 w/w).

The basal diet was groundnut hay. All feed components were ground through a 2mm mesh. Their nutrient composition is given in table 1

Table 1. Nutrients composition (as % dry matter) of feed components used in the study

Feed	Organic Matter	Crude Protein	Neutral Detergent Fibre	Acid Detergent Fibre
Groundnut hay	90.72	12.79	51.20	43.06
Moringa oliefera meal	89.29	23.27	18.74	16.07
Concentrate mixture*	83.97	29.84	41.44	34.44
C75	85.30	28.19	35.76	29.85
C50	86.63	26.55	30.09	25.26

** concentrate mixture= groundnut cake and rice bran (50/50;w/w)*

Treatments

Four different supplements were tested. They consisted of concentrate mixture (Co) alone, *Moringa oleifera* alone (Mo), and two combinations of concentrate and *Moringa oleifera* w/w i.e. 75:25 (*C75*)and 50:50 (C50). The supplements were tested at four levels of inclusion (0, 10, 20, 30 and 40%).

24 hours gas production

A 24 hours *in vitro* incubation was carried out to determine the gas production and *in vitro* true digestibility.

Three N'Dama x Jersey crossbred bulls aged 6 years and fitted with permanent rumen canulae provided rumen liquor for the gas production technique. The bulls were penned individually and fed with baby corn stover supplemented with 20% concentrate mixture. The concentrate mixture was offered in two equal portions in the morning and in the afternoon. Mineral licks and water were available *ad libitum*. Rumen liquor and digesta were collected from the three bulls in the morning before the bulls were offered the concentrate and mixed in a pre-warmed thermos flask. The rumen liquor and digesta were strained though a nylon bag with 100 micro pore size and squeezed into a pre-warmed flask. All laboratory handling of rumen liquor was done under continuous flushing with CO_2 to maintain anaerobic conditions.

Each test diet (400 mg) was weighed into three 100ml calibrated glass syringes, each syringe was fitted with a plunger as described by Menke and Steingass (1979). The syringes were pre-warmed (39^0C) overnight prior to injection of 30ml of incubation media prepared as described by Menke and Steingass (1988) in each syringe. The syringes were incubated in an upright position in a water bath at 39^0C as described by Blümmel and Ørskov (1993). Three syringes without substrate were incubated at the same time as blank. The syringes were shaken by hand twice in the first hour of incubation and regularly during the incubation period to prevent the plunger from picking up substrate as it rose. The gas volume was recorded after 24 hours. The syringes were then transferred into a cold-water bath to prevent further microbial activity. The residues were filtered in nitrogen free polyester bags (40µm pore size). The syringes were then rinsed with 100-ml tap water into the bags until the entire residue was collected. The bags were air-dried and heat-sealed for determination of the true digestibility in Akom fiber analyzer following the NDF procedure.

Statistical analysis

The experimental design was a 5x 4 factorial. Gas values presented in the results section are the average of three gas values, and the individual values did not deviate from the mean by more than 5%. The different supplements were compared using Duncan's multiple range test after GLM classified data with the aid of the SAS/STAT program version 8.

Results and discussion

When averaged for all supplementation levels, 24-hour gas production and *in vitro* true digestibility (IVTD) increased as the proportion of *Moringa oleifera* in the supplement increased (Figures 1 and 2).

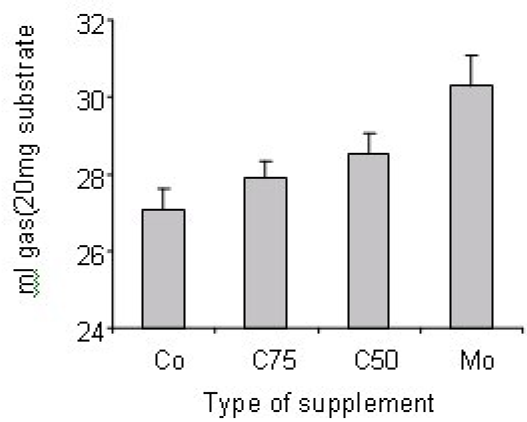

Figure 1. Average 24 hour gas production of groundnut hay supplemented with 4 different supplements

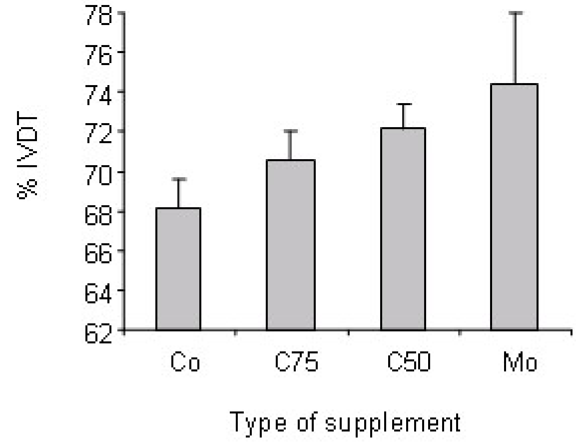

Figure 2. Average % IVTD of groundnut hay supplemented with 4 different supplements

Effects of increasing levels of supplementation on gas production (GP) and *in vitro* digestibility (IVTD) are shown n Figures 3 and 4.

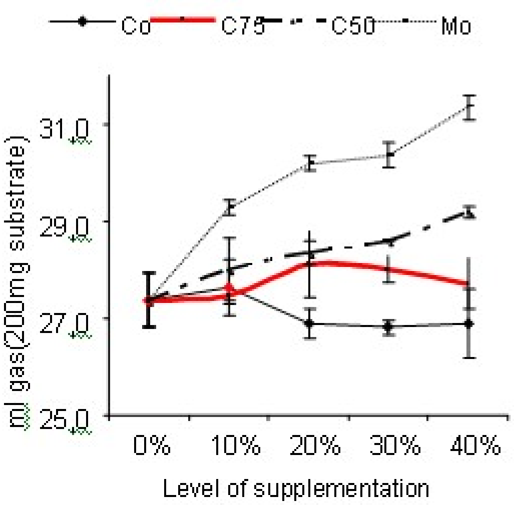

Figure 3. 24 hours gas production

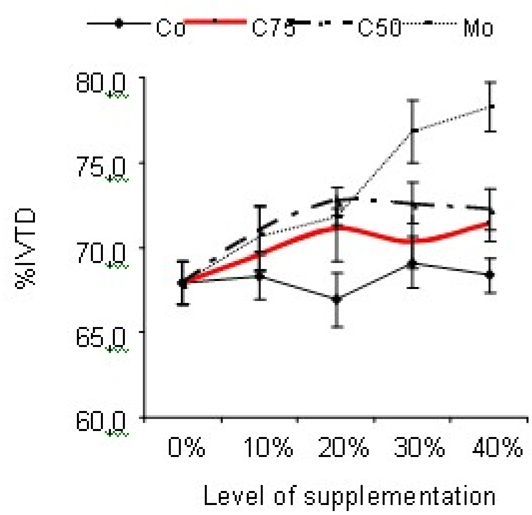

Figure 4. *In vitro* true digestibility

There was a significant effect of type supplement and its level of inclusion in the diet on 24-hour gas production and *in vitro* digestibility. The GP and IVTD were significantly ($p<0.0001$) higher with *Moringa oleifera* (Mo) as sole supplement compared to concentrate (Co) as sole supplement whatever the level of supplementation. The difference between the two supplements increased as the level of supplementation increased. Barrios et al (2000); Fondevila et al (2002) reported negative effects of concentrate high in carbohydrates due to a modification of the environmental conditions of the rumen towards an unfavourable condition for the fibrolytic microorganisms. Whereas supplementation with tree leaves invariably alleviate N deficiency and other mineral deficiencies, thus increasing the intensity of rumen microbial activity (Bonsi et al 1994; Merkel et al 1999; Hove et al 2001).

When *Moringa oleifera* partially replaced concentrate in the supplement, the difference between the supplements depended on the level of supplementation. At 10% and 20% level of supplementation, there was no significant difference in IVTD between Mo, C75 and C50 although at these levels it tended to be higher with C75. After 20%, IVTD was higher (p<0,001) with Mo and no significant difference was observed between C75 and C50. Gas production remained significantly higher (p<0, 0001) with Mo, and the difference between C75 and C50 was only significant above 20% level of supplementation.

As the level of supplementation increased, GP with Co and C75 as supplements tended to reach a peak at 10% and 20% respectively, whereas with Mo and C50 it increased linearly.

A linear trend was also observed for IVTD with Mo as supplement as the level of supplementation increased, whereas with C75 and C50, a plateau was obtained at 20% level of supplementation. Nouala (2004) estimated the optimum level of supplementation when N'Dama x Jersey crossbred bulls were fed groundnut hay supplemented with concentrate, at 20%. Blümmel and Ørskov (1993) reported a strong correlation between IVTD and *in vivo* dry matter digestibility on the one hand, and on the other hand between the gas production at 24 hours and the digestible dry matter intake. Theses reports suggest from our results that if *Moringa oleifera* replaces concentrate in a supplement by only 25%, the utilisation of concentrate is highly improved..

Sarwatt et al (2002) reported that decreasing the level of sunflower seed cake and replacing it with *Moringa oliefera* leaf meal, increased the voluntary dry matter intake with goats particularly between 25 - 50% *Moringa oliefera*, and concluded that the optimum economic level of substitution was 50%. This positive effect was also observed on milk production when dairy cows were supplemented with Moringa (Sarwatt et al 2004). Working with *Calliandra calothyrsus* and coconut oil meal in Sri Lanka, Perera and Perera (1996) found that up to 30% of the concentrate could be replaced with *Calliandra calothyrsus* without affecting feed intake. In the present work, *Moringa oleifera* could replace concentrate by 50% without affecting IVTD and gas production, in other words without affecting the activity in the rumen. It should be noted that in the report by Nouala (2004), animals were fed up 40% *Moringa oleifera* in the diet with no negative effects being observed.

The ratio of "substrate truly degraded (mg): gas produced (ml)", termed the partitioning factor (PF) (Blümmel et al 1997), was calculated as an indication of efficiency of microbial production (Table 2).

Table 2. Partitioning factor (PF) observed with the fermentation of 4 diets (groundnut hay and supplement) at 5 levels of supplementation (±sd)

Supplements	Level of supplementation				
	0%	**10%**	**20%**	**30%**	**40%**
Co	2.48 ±0.08	2.47±0.04	2.49 ±0.03	2.58 ± 0.07	2.54 ± 0.05
C75	2.48 ±0.08	2.53 ± 0.05	2.53 ±0.10	2.51 ±0.04	2.58 ± 0.09
C50	2.48 ±0.08	2.54 ±0.1	2.57 ±0.04	2.54 ±0.04	2.48 ± 0.05
Mo	2.48 ±0.08	2.41 ±0.08	2.38 ±0.01	2.53 ±0.08	2.5 ± 0.03

The PF was affected neither by the type of supplement nor by the level of supplementation. The interaction supplement x level was also non significant.

Conclusions

- *Moringa oliefera* leaves appear to be an alternative source of protein for ruminant production in West African settings and can be used as supplement to diets based on crop residues / poor roughage. In combination with concentrate, they may further improve the efficiency of concentrate utilization.

- This study was only conducted *in vitro* and *in vivo* studies are essential to confirm the positive effects of using leaves of *Moringa oliefera* in ruminant diets.

Acknowledgements

This study was made possible with the financial support of the EU- funded project Programme Concerté de Recherche-Developpement sur l'Elevage en Afrique de l'Ouest (PROCORDEL) based at the International Trypanotolerance Centre (ITC).

References

Bangani N M, Botha J A, Muller C J C and Cruywagen C W 2000 The production performance of lactating Jersey cows receiving varying levels of Lucerne hay and oat silage as roughage sources. South African Journal of Animal Science: 30 (Supplement 1).

Barrios Urdaneta A, Fondevila M, Balcells J, Dapoza C and Castrillo C 2000 *In vitro* microbial digestion of straw cell wall polysaccharides in response to supplementation with different sources of carbohydrates. Australian Journal of Agricultural Research: 51, 393-399.

Blümmel M, Makkar H P S, Chisanga G, Mtimuni J and Becker K 1997 The prediction of dry matter intake of temperate and tropical roughages from in vitro digestibility/gas-production data, and the dry matter intake and in vivo digestibility of African roughages in relation to ruminant live weight gain. Animal Feed Science and Technology: 69 131-141.

Blümmel M and Ørskov E R 1993 Comparison of in vitro gas production and nylon bag degradability of roughages in predicting feed intake in cattle. Animal Feed Science and Technology: 40: 109-119.

Bonsi M L K, Osuji P O, Nsahlai I V and Tuah A K 1994 Graded levels of Sesbania sesban and Leucaena leucocephala as supplements to Teff straw given to Ethiopian Menze sheep. Animal Production: 59: 235-244.

Fondevila M, Barrios Urdaneta A, Balcells J and Castrillo C 2002 Gas production from straw incubated *in vitro* with different levels of purified carbohydrates. Animal Feed Science and Technology: 101, 1-15.

Hove L, Topps J H, Sibanda S and Ndlovu L 2001 Nutrient intake and utilization by goats fed dried leaves of shrub *legumes Acacia angustissima, Calliandra calothyrsus* and *Leucaena leucocephala* as supplement to native pasture hay. Animal Feed Science and Technology: 91: 95-106.

Jones R J 1979 The value of Leucaena leucocephala as a feed in the tropics. World Review of Animal Production

Leng R A 1997 Tree foliage in ruminant nutrition. FAO Animal Production and Health Paper: No. 139, Rome, Italy. http://www.fao.org/docrep/003/w7448e/W7448E00.htm#TOC

Makkar H P S 1993 Antinutritional factors in foods for livestock. In: MGill, E Owen, G E Pollott and T L J Lawrence (editors), Animal Production in Developing Countries. Occasional Publication No 16 British Society of Animal Production: pp 69-85.

Makkar H P S and Becker K 1996 Nutritional value and antinutritional components of whole and ethanol extracted *Moringa oliefera* leaves. Animal feed science technology: 63 211-228.

MenkeK, Raab L, Salewski A, Steingass H, Fritz D and Schneider W 1979 The estimation of the digestibility and metabolizable energy content of ruminant feeding stuffs from the gas production when they are incubated with rumen liquor in vitro. Journal of Agricultural Science Cambridge: 93, 217-222.

Menke K H and Steingass H 1988 Estimation of the energetic feed value obtained from chemical analysis and *in vitro* gas production using rumen fluid. Animal Research and Development: Volume 28. pp. 7-55.

Merkel R, Pond K, Burns J and Fisher D 1999 Intake, digestibility and nitrogen utilization of three tropical tree legumes II. As protein supplements. Animal Feed Science and Technology: 82:107-120.

Ndemanisho E E 1996 The use of *Leucaenaleucocephala* (LAM) de wit forage as a protein supplement for dairy goats. PhD Thesis, SUA, Morogoro.

Nouala F S 2004 The comparison of plant cell wall degrading community in the rumen of N'Dama and N'Dama x Jersey crossbred cattle in relation to *in vivo* and *in vitro* cell wall degradation. PhD Thesis University of Hohenheim, Institute 480.

Perera A N F and Perera E R K 1996 Use of *Calliandra calothyrsus* leaf meal as a substitute for coconut oil meal for ruminants. In: D O Evans (editor). Proceedings of the International Workshop on the Genus Calliandra. Forest, Farm and Community Tree Research Reports (Special Issue). Winrock International, Morrilton, Arkansas, USA. Pp. 245-250

Roothaert R L and Paterson R T 1997 Recent work on the production and utilization of tree fodder in East Africa. Animal Feed Science and Technology: 69, 39-51.

Sarwatt S V, Kapange S S and Kakengi A M V 2002 Substituting sunflower seed-cake with *Moringa oleifera* leaves as supplemental goat feed in Tanzania. Agroforestry Systems: 56:241-247

Sarwatt S V, Milang'ha M S, Lekule F P and Madalla N 2004 *Moringa oleifera* and cottonseed cake as supplements for smallholder dairy cows fed Napier grass Livestock Research for Rural Development. Volume 16 Article # 38. Retrieved June 2006 from http://www.cipav.org.co/lrrd/lrrd16/6/sarw16038.htm

Van Soest P J 1982 Nutritional Ecology of the Ruminant. O & B Books, Inc. Corvallis, Oregon. USA. pp. 76-78.

Received 2 June 2006; Accepted 20 August 2006; Published 11 September 2006

Go to top