Livestock Research for Rural Development 15 (7) 2003

Citation of this paper

Some chemical and biological measurements of two contrasting cultivars of *Gliricidia sepium* (Jacq) Kunth ex Walp

R. Alonso, R M Pedraza*, S O Apori and E R Ørskov*****

ETSIA Universidad Pública de Navarra. C/ Arrosadia s/n 31006 Pamplona (Navarra), Spain.
ruben@upna.es

* Study Centre for the Development of Animal Production (CEDEPA), Universidad de Camagüey. Camagüey 74650, Cuba.
redi@reduc.cmw.edu.cu

** University of Cape Coast. Cape Coast, Ghana.
*** The Macaulay Land Use Research Institute. Craigiebuckler, Aberdeen AB15 8QH, Scotland, UK.

Abstract

Some chemical and biological measurements of two contrasting cultivars of *Gliricidia sepium*, one grown in Cuba (22°, 55' N and 82°, 01' W) and one in Ghana (5°, 05' N and 1°, 13' W), were determined.

Leaves of the Cuban cultivar had higher crude protein content; both browses showed similar essential amino acid content. The Ghana cultivar contained more polyphenols than cv. Cuba. The contents of phytates and haemagglutinating activity were higher in the Cuba cultivar. Levels of protease inhibitors were low and no µ-amylase inhibitory activity was detected. Rumen degradation of dry matter and crude protein was high and similar in both browses. In general, the cumulative gas production in both cultivars was high (more than 30 ml at 48 h incubation) and was not affected by action of polyphenols.

More research work is needed to establish how environment and plant interactions can influence the nutritive value of Gliricidia sepium foliage.

Keywords: Gliricidia sepium, chemical composition, antinutritional factors, rumen degradation, in vitro gas production

Algunas mediciones químicas y biológicas en dos cultivares contrastantes de *Gliricidia sepium* (Jacq) Kunth ex Walp.

Resumen

Se realizaron algunas mediciones químicas y biológicas al follaje de dos cultivares contrastantes de *Gliricidia sepium*, uno procedente de Cuba (22°, 55' N and 82°, 01' O) y el otro de Ghana (5°, 05' N and 1°, 13' O).

Las hojas del cultivar de Cuba tuvieron un mayor contenido de proteína, mientras que ambos mostraron similar concentración de aminoácidos esenciales. El cultivar de Ghana tuvo mayor concentración de polifenoles; sin embargo, el follaje del cultivar de Cuba mostró mayor concentración de fitatos y actividad hemoaglutinante. En ambos cultivares el nivel de inhibidores de proteasa fue muy bajo y no se detectaron inhibidores de µ-amilasa. Ambos cultivares tuvieron una alta degradabilidad ruminal de la materia seca y del nitrógeno; la producción de gas *in vitro* en los dos cultivares fue también alta (más de 30 ml a las 48 h de incubación) y no se afectó por la acción de los polifenoles.

Se necesitan continuar estudios para precisar como las interacciones planta – ambiente pueden influir en el valor nutritivo del follaje de Gliricidia sepium.

Palabras claves: Gliricidia sepium, composición química, factores antinutritivos, degradabilidad ruminal, producción de gas in vitro.

Introduction

Gliricidia sepium (Jacq) Kunth ex Walp. is a shrub legume widely cultivated and used in the tropics.It is a classical example of a multi-purpose tree. The potential of *G. sepium* has been recognised, due to the relatively high crude protein content in the leaves, and the ability to tolerate and thrive in adverse climatic and soil conditions (Nochebuena and O´Donovan 1986; Smith and Van Houtert 1987). In some regions this tree seems to be a substitute for *Leucaena leucocephala.* Many compounds from browse species of tropical legumes have been shown to have anti-nutritional effects in livestock nutrition (Skerman et al 1988). However, considerable variation exists between and within the same species.

The aim of this research was to determine some chemical and biological characteristics of the foliage of two contrasting cultivars of *Gliricidia sepium* grown in Cuba and Ghana.

Materials and methods

Samples

Bulked samples including leaves and petioles from more than 10 trees of each cultivar of *Gliricidia sepium* were used in all studies. The cultivar from the Republic of Ghana was obtained from Cape Coast (5°, 05' N and 1°, 13' W, about 50m over sea level) and the cultivar from the Republic of Cuba in Havana province (22°, 55' N and 82°, 01' W, about

90m over sea level). Both foliage samples, about 80 days of regrowth, were taken in July 1997; no fertilisers or irrigation were applied before sampling. Samples were dried in an air forced circulation oven at 55 ºC for 48 h and stored at 4 °C until analysis.

Chemical analyses

Proximate analysis were determined according to AOAC (1992) methods. Insoluble dietary fibre components were analysed by the procedure of Robertson and Van Soest (1981). Amino acid composition was analysed according to Llames and Fontaine (1994) using the Pico-Tag® method. Carbohydrate analyses were conducted by the procedures of Englyst and Cummings (1984). Phytic acid was determined after reaction with the modified Wade reagent (Frühbeck et al 1995). Condensed tannins were determined according the vanillin assay (Broadhurst and Jones, 1978). Total polyphenols were determined using the Folin-Denis reagent, according Christensen (1974). Trypsin inhibitors were determined by the procedure of Armour et al (1998). Chymotrypsin inhibitors were analysed by the method of Sathe and Salunkhe (1981) and µ-amylase inhibitor activity by the method of Grant et al (1994). Haemagglutinating activity was measured by a serial dilution procedure using rabbit blood cells as described by Grant et al (1983). One unit of haemagglutinating activity (HU) was defined as that being present in the last dilution giving 50% agglutination of the blood cells.

Rumen degradation analysis

Dry matter (DM) and crude protein degradation analysis were carried out according to the nylon bag procedure described by Mehrez and Ørskov (1977); three rumen fistulated sheep were used. They were fed twice daily on a diet of 67% grass hayv and 33% alfalfa cubes. The rumen degradation data were fitted to the exponential equation

$$p = a + b\ (1 - e\text{-}ct)$$ (Ørskov and McDonald 1979).

In vitro gas production analysis

The procedure was that described by Menke et al (1979) and Menke and Steingass (1988); the use of polyethylene glycol 4000 was done according to Khazaal et al (1996).

Statistical analysis

The t-student test was used to determine the differences between cultivars in some indicators. Differences were considered significant with a P value at the 5 % level.

Results

Leaves of cv. Cuba had a higher crude protein content than those of cv. Ghana (Table 1). Cultivar Ghana contained significantly more crude fibre and neutral detergent fibre than cv. Cuba. Total sugar content was higher ($P<0.05$) in cv. Cuba than in cv. Ghana (Table 2).

Table 1. Chemical composition (% DM) of *Gliricidia sepium* cv. Ghana and cv. Cuba foliage.

	cv. Ghana	cv. Cuba	Pooled SD
Crude protein (N x 6.25)	22.2	24.3	0.6*
Crude fibre	41.9	32.8	0.17*

Neutral detergent fibre	40.8	32.8	1.54*
Acid detergent fibre	28.9	26.2	2.17
Ash	7.6	5.6	0.2
Ether extract	2.7	2.2	0.2

** Significant differences according to t-test (P< 0.05).*

Table 2. Carbohydrate content of *Gliricidia sepium* foliage

	cv. Ghana	**cv. Cuba**	**Pooled SD**
Rhamnose	1.65	2.15	0.07
Fructose	0.20	0.25	0.01
Arabinose	1.75	2.45	0.05
Xylose	1.85	2.75	0.05
Manose	0.85	1.05	0.03
Galactose	2.40	2.60	0.05
Glucose	11.7	12.2	0.43
Uronic acid	5.10	7.20	0.08
Total sugars	**25.5**	**30.7**	**0.75**

There were no major differences between the two cultivars in the pattern of amino acids (Table 3). No major differences were found in the anti-nutritional factors in both cultivars (Table 4). The cultivar Ghana had higher polyphenol contents than cv. Cuba, but the degree of condensation was higher in cv. Cuba. Phytates and haemagglutinating activity were significantly higher in cv. Cuba. Moderate haemagglutinating activity was found in cv. Cuba, whereas negligible activity was detected in cv. Ghana; no µ-amylase inhibitors were detected in either cultivar.

Table 3. Amino acid (AA) composition of *Gliricidia sepium* foliage (g/16g N)

	cv. Ghana	**cv. Cuba**	**Pooled SD**
Asp	7.34	8.77	0.85
Thr	4.74	4.20	0.35
Ser	3.98	3.74	0.31
Glu	9.70	8.89	0.58
Gly	4.53	3.92	0.20
Ala	4.40	3.90	0.19
Val	5.11	4.85	0.67
Cys	1.36	0.98	0.10
Met	0.61	0.52	0.11
Ile	4.01	3.80	0.62
Leu	7.20	6.05	0.38
Tyr	3.81	3.17	0.42
Phe	4.99	4.40	0.33
Lys	4.86	4.05	0.21
His	1.87	1.85	0.10
Arg	4.88	4.71	0.21
Pro	3.62	3.56	0.19

Table 4. Anti-nutritional factors in *Gliricidia sepium* foliage (DM basis)

	cv. Ghana	cv. Cuba	Pooled SD
Phytic acid (g/kg)	0.2	0.5	0.04*
Condensed tannins (g equiv. Catechin/kg)	4.2	5.1	0.3*
Total phenols (g equiv. tannic acid/kg)	29.5	26.3	2.6*
Trypsin inhibitors (g equiv./kg)	0.3	0.4	0.03
Chymotrypsin inhibitors (g equiv./kg)	0.3	0.3	0.1
α-amylase inhibitors (g equiv./kg)	ND †	ND	–
Haemagglutinating activity (HU/100 mg)	4	128	–

*† ND, not detected; lower limit of detection was 0.5 g equivalent/kg. HU, unit of haemagglutinating activity. * Significant differences according to t-test (P<0.05).*

The water soluble dry matter and protein, and the potential degradability of these components were much higher in cv. Cuba than in cv. Ghana (Table 5). However, gas production rates in the *in vitro* test showed an opposite trend (Figure 1). Adding PEG 4000 slightly increased the extent of gas production in cv. Cuba but had no effect in cv. Ghana.

Table 5. Rumen degradation characteristics of dry matter and protein in the foliage of *G. sepium*

	cv. Ghana	cv. Cuba	Pooled SD
Dry matter degradation characteristics			
a (%)	9.0	21.9	1.8
b (%)	64.3	60.1	3.4
a + b (%)	73.4	81.9	2.7
c (% h^{-1})	0.098	0.070	0.004
Protein degradation characteristics			
a (%)	0.5	17.1	1.5
b (%)	81.2	75.0	3.1
a + b (%)	81.9	92.1	2.7
c (% h^{-1})	0.068	0.074	0.002

***a** is the degradable fraction at zero time; **b** is the insoluble but fermentable fraction; **c** is the degradation rate of fraction **b; a+b** is the potential of degradation*.

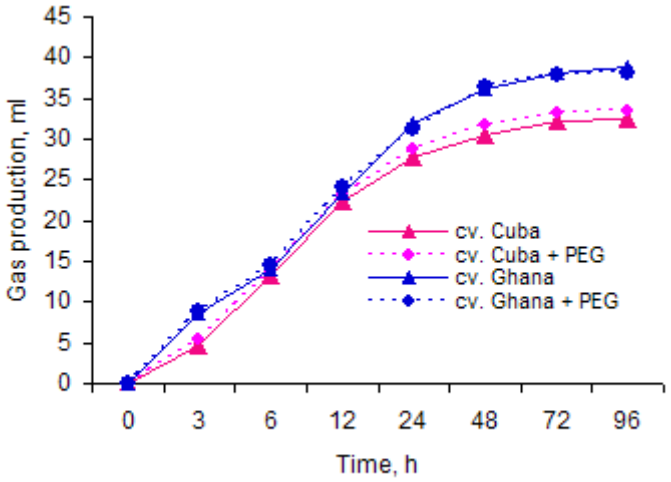

Figure 1. In vitro gas production and effect of PEG 4000 on gas production

Discussion

The crude protein levels in the foliage of both cultivars were in the range reported in the literature (Topps 1992; Pedraza 1995). The amino acid pattern indicated a major deficiency in the sulphur amino acids, as the combined proportions of methionine and cystine were only 40% of the concentration of lysine, whereas in an ideal protein these amino acids should be 65% of the level of the lysine (Wang and Fuller 1989). The concentration of condensed tannins in the leaves of both cultivars was close to the level (4 to 6% in DM) considered to be advantageous in terms of protecting the protein from rumen degradation (Barry and McNabb 1999). Addition of PEG in the *in vitro* system had minimal effects on gas production, which indicates that the tannins in Gliricidia leaves are not likely to be a constraint to their use as a protein supplement for ruminants. In fact, there are several reports showing major benefits in performance traits of ruminants from adding Gliricidia foliage to basal diets of low quality forages (Preston and Leng 1987; Pathirana and Ørskov 1995; Abdulrazak et al 1996; Nguyen van Hao and Nguyen van Hiep 2003) .

Acknowledgements

The authors wish to thank the Chemical Services Group of the Rowett Research Institute (RRI), Aberdeen, UK, for carbohydrate analysis. The Senior Author gratefully acknowledges the European Community for funding this work. Pedraza is grateful to the Chevining Scholarship Award Program and British Council for financing his stay at RRI. Apori is grateful to the Royal Society for funding his work at RRI.

References

Abdulrazak S A, Muninga R W, Thorpe W and Ørskov E R 1996 The effects of supplementation with Gliricidia sepium or Leucaena leucocephala forage on intake, digestion and live-weight gains of Bos taurus x Bos indicus steers offered Napier grass. Animal Science. Vol 63 (3) pp. 381-388.

AOAC 1992 Official Methods of Analysis. Association of Official Analytical Chemists, Inc., Washington, USA.

Armour J C, Perera R L C, Buchan W C and Grant G 1998 Protease inhibitors and lectins in soya beans and effects of aqueous heat-treatment. Journal of the Science of Food and Agriculture 78: 225-231.

Barry T N and McNabb WC 1999 The implications of condensed tannins on the nutritive value of temperate forages fed to ruminants. British Journal of Nutrition, Vol. 81 no. 4 pp 263-272(10)

Broadhurst R B and Jones W J 1978 Analysis of condensed tannins using acidified vanillin. Journal of the Science of Food and Agriculture 29: 788-792.

Christensen K D 1974 Improving the Plant Proteins by Nuclear Techniques. International Atomic Energy Agency, Vienna.

Englyst H N and Cummings J H 1984 Simplified method for the measurement of total non-starch polysaccharides by gas-liquid chromatography of constituent sugars and alditol acetates. Analyst 95: 181-193.

Frühbeck G, Alonso R, Marzo F and Santidrián S 1995 A modified method for indirect quantitative analysis of phytate in foodstuffs. Analytical Biochemistry 72: 248-254.

Grant G, Edwards J E and Pusztai A 1994 µ-amylase inhibitor levels in seeds generally available in Europe. Journal of the Science of Food and Agriculture 67: 235-238.

Grant G, More L J, McKenzie N H, Stewart J C and Pusztai A 1983 A survey of the nutritional and haemagglutination properties of legume seeds generally available in the UK. The British Journal of Nutrition 50: 207-214.

Khazaal K, Parissi Z, Tsiouvras C, Nastis A and Ørskov E R 1996 Assessment of phenolic-related antinutritive levels using in vitro gas production technique: a comparison between different types of polyvinylpolypyrrolidone or polyethyleneglycol. Journal of the Science of Food and Agriculture 71: 495-414.

Llames C R and Fontaine J 1994 Determination of amino acids in feeds: Collaborative study. Journal of AOAC International 77: 1362-1402.

Mehrez A Z and Ørskov E R 1977 A study of the artificial fibre bag technique for determining the digestibility of feeds in the rumen. Journal of Agricultural Science 88: 645-650.

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 28: 7-55.

Menke K H, Raab L, Salewski A, Steingass H, Fritz D and Schneider W 1979 Estimation of the digestibility and metabolisable energy content of ruminant feedstuffs from gas production when they are incubated with rumen liquor in vitro. Journal of Agricultural Science, Cambridge 93: 217-222.

Nguyen van Hao and Nguyen van Hiep 2003 Utilisation of Gliricidia leaves (Gliricidia maculata) as a protein source for dairy goats. In: Proceedings of Final National Seminar-Workshop on Sustainable Livestock Production on Local Feed Resources (Editors: Reg Preston and Brian Ogle). HUAF-SAREC, Hue City, 25 – 28 March, 2003. Retrieved July 16, 2003, from http://www.mekarn.org/sarec03/haouaf2.htm

Nochebuena G and O'Donovan N 1986 Valor nutritivo del follaje rico en proteína de Gliricidia sepium. Revista Mundial de Zootecnia 57: 48-49.

Ørskov E R and McDonald I 1979 The estimation of protein degradability in the rumen from incubation measurements weighted according to rate of passage. Journal of Agricultural Science 92: 499-503.

Pathirana K K and Ørskov E R 1995 Effect of supplementing rice straw with urea and gliricidia forage on intake and digestibility by sheep. Livestock Research for Rural Development (7)
2: http://www.cipav.org.co/lrrd/lrrd7/2/7.htm

Pedraza R M 1995 Nutritive value and rumen degradability of Gliricidia sepium. Simulation of performance by dairy cattle supplemented with Gliricidia. In: Proceeding of International Workshop: Dual Purpose Cattle Research (ed. Anderson, S and Wadsworth J), International Foundation for Science/FMVZ-UADY. Mérida, México. pp. 264-272.

Preston T R and Leng R A 1987 Matching ruminant production systems with available resources in the tropics and sub-tropics. Penambul Books, Australia

Robertson J B and Van Soest P J 1981 The detergent system of analysis and its application to human foods. In: The Analysis of Dietary Fiber in Foods (ed. James W P T and Theander O). Marcel Dekker, New York. pp. 123

Sathe S K and Salunkhe D K 1981 Studies on trypsin and chymotrypsin inhibitory activities, haemagglutinating activity, and sugars in the Great Northern beans (Phaseolus vulgaris L.). Journal of Food Science 46: 626-629.

Skerman P J, Cameron D G and Riveros F 1988 Tropical Forage Legumes. Food and Agriculture Organisation of the United Nations, Rome. 707p

Smith O B and Van Houtert M F J 1987 The feeding value of Gliricidia sepium. A review. World Animal Review 62: 57-68.

Topps J H 1992 Potential, composition and use of legume shrubs and trees as fodder for livestock in the tropics. Journal of Agricultural Science, Cambridge 118: 1-8.

Wang T C and Fuller M F 1989 The optimum dietary amino acid pattern for growing pigs. 1. Experiments by amino acid deletion. British Journal of Nutrition 62:77-89.

Received 26 June 2003; Accepted 16 July 2003

Go to top