

DRY MATTER DEGRADATION OF LEGUME STRAWS IN THE RUMEN.1- *Vicia sativa*, *Vicia villosa* & *Vicia faba*

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SUMMARY

Three ruminally cannulated adult rams were used to study of the rumen degradation of three legume straws using nylon bags. The tested straws were: 1- common vetch (*Vicia sativa*), 2- hairy vetch (*Vicia villosa*), 3- horse bean (*Vicia faba*). For comparison, wheat (*Triticum durum*) straw was also tested. Chemical composition, degradation characteristics and potential degradability were determined. Values of chemical composition indicated that the common vetch straw attained the lowest values of ADF (40.5%), ADL (8.3%) and NDF (55.6%) with moderate level of CP (9.2%). The potential degradability in the rumen for the common vetch straw, hairy vetch straw, horse bean straw and wheat straw were 68.1, 61.4, 55.1, and 52.5%, respectively.

These legume straws show higher values of potential degradability as well as degradation rate in the rumen indicating better utilization than wheat straws by ruminants.

Keywords: Sheep, rumen, legume straws, chemical composition, DM degradation.

INTRODUCTION

The European community policy is incentivated during years for the production of diverse protein sources, to minimize EC countries dependence on importing animal feeds. This goal was practiced in Portugal as well as other Mediterranean countries to increase in the production of legume grains and hence their respective straws. A systematic study was carried out to characterize cereal straws with respect to their chemical composition and nutritive value (Hadjipanayiotou *et al.*, 1985, Options, 1990). However, few research studies have been done with reference to legume straws produced under the Mediterranean conditions. It is well known that cereal and legume straws are characterized by their high fiber contents and low CP content. The efficiency of their use in ruminant feeding depends on efficient ruminal digestion of the cell walls (Van Soest, 1983).

The aim of the present work was to assess the chemical composition and the kinetics of dry matter degradation in rumen of three legume straws, commonly produced in the Mediterranean regions using the nylon bag technique.

MATERIALS AND METHODS

The tested straws were common vetch (*Vicia sativa* L.), hairy vetch (*Vicia villosa* Roth.) and horse bean (*Vicia faba* L.) wheat (*Triticum durum* Desf) straw was also tested for comparison. The straw samples were ground to pass a 1 mm screen prior to analysis for ash by combustion at 550 °C overnight (18 h), crude protein (CP) using kjeldhal method (N × 6.25), neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) according to Robertson & Van Soest (1981).

The pH and NH₃ - N were assessed (Jouany, 1978) in the rumen liquor collected before the 1st daily meal (0 hours) and 1, 3, and 7 hours afterwards. Three ruminally cannulated adult rams with an average live weight of 58 kg were used. Each animal received 0.7 kg / day of oats vetch hay (chopped in 2-3 cm) and 0.3 kg /day of feed concentrates mixture in two identical meals at 08.30 A.M. and 16.30 P.M.

The dry matter disappearance of the tested straws in the rumen were assessed by the nylon (42 µm pore) bag technique according to Ørskov *et al.* (1980). One nylon bag (size 12 x 7 cm) was used per animal and incubation time, with a sample of about 3 g milled with 2.5 mm mesh. In total, 12 bags per ram were incubated at the same time. There were six replicates for each straw sample (three rams × two times × one bag). Eight incubation times (3, 6, 16, 24, 48, 72, 96, and 120 hours) were used and the washing losses and water - soluble (WS) material were measured according to Hovell *et al.* (1986). The kinetics of DM degradation in the rumen was described by the model $p = a + b(1 - e^{-ct})$ proposed by Ørskov & McDonald (1979), where a, b, and c are constants defining the degradation characteristic of the sample and t is the time of incubation (hr).

The regression parameters were calculated using SAS software. Data of regression parameters were subjected to analysis of variance and differences among means were compared using Duncan's test.

RESULTS AND DISCUSSION

The values of the chemical composition of the legume straws (Table 1) show that the common vetch contained the lowest values of fiber constituents (55.6 % NDF, 40.5 % ADF and 8.3 % ADL) with moderate level of CP (9.2%) compared with the other legume straws. In general, results of chemical composition for the three legume straws are close to those obtained by Radwan and Al Fakhry, 1975 and Maamoun, 1994). However, Hadjipaniotou *et al.* (1985) found some differences particularly for the CP and NDF values of the hairy vetch and horse bean straws (7.0 % ; 56.0 % and 9.8 % , 44.0% , respectively.). Such differences observed among straws species, may be a reflect of different factors, such as stems / leaves ratio (Bhargava *et al.*, 1988), environmental conditions and cultivar used (Dias-Da-Silva and Guedes, 1990). In relation to wheat straw the legume straws (horse bean) studied showed higher CP and ADL contents (CP ≥ 7.11% vs 5.1% ADL ≥ 10.0 % vs 7.4 %) and lower NDF content (≤ 63.8% vs 87.1%) and ADF (51.5% vs 60.4%)

During incubation of straw samples the rumen pH remained always above 6.4 (range 6.4-6.7) and the rumen ammonia nitrogen (NH₃-N) concentration ranged from 25.7 to 37.2 mg/100ml, with a minimum value just prior to feeding and the maximum 1 hour

after feeding. The recorded pH and $\text{NH}_3\text{-N}$ values indicated an optimum rumen environment for degradation of straw samples (Bhargava and Ørskov 1987).

Table 1. Chemical composition of the straws (% DM)

straws	Ash	CP	NDF	ADF	ADL
Common vetch (<i>Vicia sativa</i>)	4.8	9.2	55.6	40.5	8.3
Hairy vetch (<i>Vicia villosa</i>)	9.7	10.1	62.6	44.5	8.9
Horse bean (<i>Vicia faba</i>)	8.2	7.1	63.8	51.5	10.0
Wheat (<i>Triticum durum</i>)	5.9	5.1	87.1	60.4	7.4

The potential DM degradability values of the tested legume straws (Table 2) were higher ($a+b \geq 55.1\%$) than that of wheat straw which agree with the findings of Akin and Robinson (1982). Such results may be explained by the high values of the (a) fraction ($a \geq 1.2\%$) observed in the legume straws. One contribution to this fact is the high values of the washing losses (WL) observed to the legume straws ($\geq 22.6\%$).

Table 2. Degradation parameters (a,b,c), potential degradability (a+b), washing losses (WL) and water - soluble (WS) to dry matter fraction.

Straws	a (%)	b (%)	c (% h^{-1})	a+b (%)	RSD	WL (%)	WS (%)
Common vetch	25.6A	42.5 AB	0.050A	68.1 A	1.18	30.3	18.5
Hairy bean	23.3AB	38.1 BC	0.074 B	61.4 B	0.68	27.9	18.9
Horse bean	19.2 B	35.9 C	0.055 A	55.1 C	0.93	22.6	11.2
Wheat	8.9 C	43.6 A	0.021A	52.5 D	1.91	10.5	1.4

RSD = Residual standard deviation

Values in the same columns bearing different letters are significantly different ($P \leq 0.05$).

The different behaviour in respect to the washing losses of the legume straws in relation to the studied cereal straws (Fig. 1) may be explained by their high values of the water - soluble (WS) fraction which reached more than 50% , (approximately 68,61 and 50% for hairy vetch, common vetch and horse bean straws, respectively) whereas it was only about 13% for wheat straw.

Another characteristic that was found for the studied legume straws , was the high degradation rate in the rumen ($\geq 5.5\% \text{ h}^{-1}$ which is more than double of that observed for wheat straw ($2.2\% \text{ h}^{-1}$). This fact means that the legume straws are fermented faster in the rumen than wheat straws indicating this shorter retention time in the rumen. Thence , the outflow rate of solid digesta will be quicker which would enhance voluntary feed intake (Ørskov and Ryle, 1990).

Among the tested legume straws it is noticeable the similarity of ruminal degradation characteristics of both the hairy vetch and the common vetch (Fig.2) although the common vetch showed larger degradation extent (a+b).

The horse bean straw showed the lowest degradability among the legume straws, which reflects its high contents of NDF and ADF. as it can be confirmed through the coefficients of linear correlation ($r = - .94$ 23; $p \leq 0.05$).

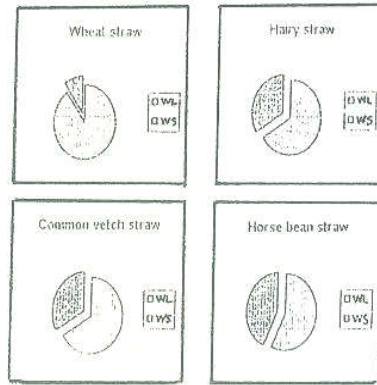


Figure 1. Washing loss (WL) and water soluble losses (WS) of the studied straws (%)

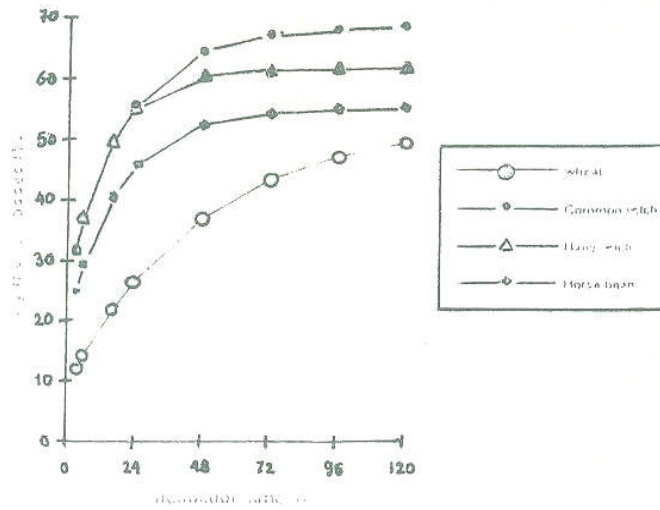


Figure 2 Dry matter degradation curves of the studied straws

In conclusion, the three tested legume straws showed higher values of the extent and the degradation rates of the dry matter in the rumen, than the wheat straw. The values of the *a* fraction ($\geq 19\%$) in the legume straws have contributed to its high relative degradability. The utilization of these straws by ruminants seems to offer some advantages in relation to the wheat straw mainly because of their higher protein contents ($\geq 7.1\%$) and their faster degradation in the rumen, with direct influence on their nutritive values.

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REFERENCES

- Akin, D.E. and E.L. Robinson, 1982. Structure of leaves and stems of arrow leaf and crimson clovers as related to *in vitro* digestibility. *Crop.Sci.*, 22:24-29.
- Bhargava, P.K. and E.R. Ørskov, 1987. Manual for the use of nylon bag technique in the evaluation of feedstuffs. Feedstuff evaluation experimental Development Services (FEEDS), Rowett Research Institute, Bucksburn, Aberdeen, AB2 9SB, Scotland.
- Bhargava, P.K. ; E.R. Ørskov and T.K. Wall, 1988. Rumen Degradation of straw.4. selection and degradation of morphological components of barley straw by sheep. *Anim. Prod.*, 47:105-110.
- Disa-Da-Silva, A.A. and C.V.M. Guedes, 1990. Variability in the nutritive value of straw cultivars of wheat, rye, and triticale and response to urea treatment. *Anim. Feed Sci. Technol.*, 28:79-89.
- Hadjipanayiotou, M;S. Economides, and A. Koumas, 1985. Chemical composition, digestibility and energy content of leguminous straws grown in a Mediterranean region. *Ann. Zootech.*, 34 : 23-30.
- Hovell, F. D. Deb; J. W.W. Ngambi; W. P. Barber and D.J. Kyle, 1986. The voluntary intake of hay by sheep in relation to its degradability in the rumen as measured in nylon bags. *Anim. Prod.* 42:111-118.
- Jouany, J.P., 1978. Contribution a l'etude des protozoaires cilies du rumen, leur dynamique, leur roledans la digestion et leur interet pour le ruminant. Thesis. Univ. Clermont.
- Maamoun, H.A. 1994. Physiological response of certain forage crops to drought. M.Sc. Thesis, Faculty of Agriculture, Ain Sham Universty, Cairo, Egypt.
- Options Mediterraneennes, 1990. Tables of nutritive value for ruminants of Mediterranean forages and by-products. Serie B: Etudes et recherches No 4 CIHEAM, ECC.

- Ørskov, E.R.; and I. McDonald, 1979 . The estimation of protein degradability in the rumen from incubation measurements weighted according to rate of passage. *J. Agric. Sci. Camb.*, 92:499-503 .
- Ørskov, E. R., F.D. Deb Hovell and F. Mould , 1980. The use of nylon bag technique for the evaluation of feedstuffs . *Tropical Anim.Prod.*, 5:195-213.
- Ørskov, E.R. and M. Ryle, 1990. Energy nutrition of microorganisms. In: *Energy nutrition in ruminants*. Elsevier Science Publishers, England.
- Radwan , M.S. and A.K. Al Fakhry, 1975 . The value of vetches for forage production in northern Iraq. *Mesoptamia J.Agric.* 10 : 35-40.
- Robertson, J.B. and P.J. Van Soest, 1981. The detergent system of analysis and its application to human foods. In : *The analysis of dietary fiber in food* , Chapter 8. Ed. W.P.T. James & O. Theander , Merrell Dekker, NY.
- Van Soest, P., 1983 . Chemistry for forages and feeds . In: *Nutritional Ecology of the Ruminant*, Chapter 6, O & B Books, Inc., Oregon, U.SA.

هدم المادة الجافة لأتبان البقوليات في الكرش ١- البقيا *Vicia sativa* ، البقيا المشعرة
Vicia faba ، الفول البلدى *Vicia villousa*

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أستخدمت فى هذه الدراسة عدد ٣ كباش بالغة مزودة بفستيوالات مستديمة فى الكرش لدراسة هدم المادة الجافة لثلاثة أتبان من النباتات البقولية باستخدام اكياس الفايلون . وكانت الأتبان المختبرة هى ١- تبن البقيا (Common vetch) ٢- تبن البقيا المشعرة (Hairy vetch) ٣- تبن الفول البلدى (Horse bean) وأستخدم تبن القمح للمقارنة .

أجريت التحاليل الكيماوية المطلوبة لأتبان وقياسات ومعلمات الهدم المختلفة على فترات مختلفة من التحضين فى كرش الأغنام . وقد اشارت نتائج الدراسة أن تبن البقيا يحتوى على أقل قيمة لمركبات اللجنين (٨,٣ %) ، ADF (٤٠,٥ %) ، NDF (٥٥,٦ %) مع إحتوائه على مستوى معتدل من البروتين الخام (٩,٢ %) . كذلك وجد أن قيمة معدل هدم المادة الجافة فى كرش الأغنام لأتبان البقيا هى ٦٨,١ % ، تبن البقيا المشعرة هى ٦١,٤ % وتبن الفول البلدى هى ٥٥,١ % وتبن القمح هى ٥٢,٥ % . وقد أظهرت نتائج الدراسة أهمية استخدام أتبان البقوليات المختبرة فى تغذية المجترات بالمقارنة بتبن القمح ، حيث أن قيمة هدم المادة الجافة كانت كبيرة كما أن معدلات هدمها تكون عالية فى كرش الأغنام مما يمكن الاستفادة الجيدة منها فى تغذية المجترات .