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in

Porqueddu C. (ed.), Ríos S. (ed.).
The contributions of grasslands to the conservation of Mediterranean biodiversity

Zaragoza : CIHEAM / CIBIO / FAO / SEEP
Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 92

2010
pages 63-66

Natural vetch economic alternative to soybean meal in Tunisia

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Abstract. The price of soybean meal as the main protein source for livestock is prohibitive in Tunisia. The potential to provide a cheap source of protein has long led to interest in vetch (*Vicia* ssp.) seeds for human and animal nutrition. The potential nutritional value of vetch seeds from eleven species and cultivars (*Vicia amphycarpa*, *Vicia sativa*, *Vicia sativa* 'Sanda', *Vicia* 'Y98', *Vicia sativa* 'Mghilla', *Vicia villosa* '2535', *Vicia sativa* 'INRAT303', *Vicia villosa* Sedjnen', *Vicia narbonensis*, *Vicia sativa* 'Languedoc' and *Vicia villosa* '3615') grown in the humid region of northern Tunisia were evaluated by chemical composition, *in vitro* gas production and *in vitro* digestibility techniques. The chemical composition of the cultivars of vetch seeds differed significantly ($p<0.05$). The content of organic matter ranged from 66.7 to 78.3% dry matter (DM). From among studied species and cultivars, *Vicia villosa* '3615' showed the best crude protein content (31.6% of dry matter) while *Vicia sativa* 'Languedoc' had the lowest content (25% DM). The organic matter digestibility ranged from 70.75% (*Vicia sativa* 'Languedoc') to 88.3% (*Vicia sativa*). The gas production after 96 h incubation in glass syringe, Metabolisable energy (ME) and short chain fatty acids (SCFA) were significantly different among the cultivars ($P<0.05$), with the highest value recorded for *Vicia villosa* '2565' and *Vicia sativa* and the lowest for *Vicia villosa* 'Sedjnen' seeds. The ME and SCFA were highest ($P<0.05$) in *Vicia villosa* '2565' and *Vicia sativa.* The result of this study indicates that such cultivars of vetch seeds have the potential to be used as feed supplements for ruminants.

Keywords. Crude protein – Gas production – *In vitro* digestibility – *Vicia* ssp.

La vesce naturelle alternative économique au soja en Tunisie

Résumé. *Le prix du soja, la principale source protéique pour bétail, est élevé en Tunisie. Les graines de vesces peuvent constituer une alternative moins chère pour l'alimentation humaine et du bétail. Les valeurs alimentaires potentielles de 11 variétés de vesce (*Vicia amphycarpa*,* Vicia sativa*,* Vicia Sanda*,* Vicia *'Y98',* Vicia sativa *'Mghilla',* Vicia villosa *'2535',* Vicia *'INRAT303',* Vicia villosa *'Sedjnen',* Vicia narbonensis*,* Vicia *'Languedoc' et* Vicia villosa *'3615') cultivées dans la zone humide du nord de la Tunisie ont été évaluées pour la composition chimique, la production de gaz* in vitro *et des techniques de digestibilité in vitro. La composition chimique a été significativement différente ($p < 0.05$) entre les graines des variétés de vesce. La matière organique a varié de 66,7 à 78,3%MS. Parmi les variétés de vesce étudiées, la vesce villosa 3615 avait le pourcentage de MAT le plus élevé (31,6% MS) alors que la vesce Languedoc avait le pourcentage le plus faible (25% MS). La digestibilité de la matière organique a varié de 70,75% (*Vicia *'Languedoc') à 88,3% (Vicia sativa). La production de gaz après 96 h d'incubation dans des seringues plastiques a aussi varié ($p <0,05$) avec les cultivars, la valeur la plus élevée étant enregistrée pour les variétés* Vicia villosa *'2565' et* Vicia sativa *et la plus faible pour les graines de* Vicia villosa *'Sedjnen'. Les concentrations en énergie métabolisable et acides gras volatils à courtes chaines étaient plus élevées chez* Vicia villosa *'2565' et* Vicia sativa*. Ces résultats montrent que les graines de vesce peuvent être incorporées dans les rations des ruminants.*

Mots-clés. *Matière azotée totale – Production de gaz – Digestibilité* in vitro – Vicia *ssp.*

I – Introduction

In the current global economy where supply of feed resources is limited and feed prices are skyrocketing, the search for feeding alternatives based on local resources is necessary. The diversity of local feed resources especially those rich in proteins is agronomical and economically justifiable (Poncet *et al*., 2003). Nowadays, risks from intensive production systems relying on a few cultivars are growing. Clearly, economic constraints involve durability of production systems and product quality and authenticity. That is, the current conjuncture is favourable for promoting the use of other resources rich in protein such as green peas (Petit *et al*., 1997), lupins (Moss *et al*., 2001), broad beans (Rouissi *et al*., 2008) and vetch (*Vicia*) beans. *Vicia* is naturally found in many regions in Tunisia, which may represent a readily available solution for farmers to use them in formulating ruminant rations. The objective of this study was to select some *Vicia* varieties following their evaluation on chemical composition, *in vitro* gas production and *in vitro* digestibility techniques.

II – Materials and methods

Vetch seeds were collected from eleven species and cultivars (*Vicia amphycarpa, Vicia sativa, Vicia sativa* 'Sanda'*, Vicia* 'Y98'*, Vicia* 'Mghilla'*, Vicia villosa* '2535'*, Vicia* 'INRAT303'*, Vicia villosa* 'Sedjnen'*, Vicia narbonensis, Vicia* 'Languedoc'*,* and *Vicia villosa* '3615') grown in the region of Mateur. Seed samples were ground in a laboratory mill and thereafter analysed for dry matter (DM), organic matter (OM) and crude protein (CP) (AOAC, 1990). All chemical analyses were carried out in duplicate. Organic matter digestibility (OMD) was determined by enzymatic method as described by Aufrère (1982). To study the characteristics of in vitro gas production (Menke *et al.,* 1988), rumen fluid was obtained from four rumen fistulated sheep fed oat hay (70%) and concentrate (30%). The inoculum was mixed with a buffer solution in a ratio of 1:2 (v/v). About 200 mg of dry samples were introduced into calibrated syringes, and 30 ml of the buffered inoculum were sucked through a silicone tube attached to the needle top of each syringe. Then the gas bubbles were removed and the silicone tube was clamped, the position of the lubricated piston was recorded, and the syringes were placed in the oven at 39^{o}C. Gas production was recorded at 3, 6, 12, 24, 36, 48, 60, 72, 84 and 96 hr. The ME of seeds and SCFA produced in syringe were calculated as follows:

ME (MJ / Kg DM) = 2.20 + 0.136 Gp + 0.057 CP (Menke and Steingass, 1988),

SCFA (mmol/syringe) = 0.0239.Gas -0.0601 (Getachew *et al.,* 2000)

Where ME is the metabolisable energy; SCFA: short chain fatty acids; CP, crude protein in % and Gp, the net gas production in ml from 200 mg dry sample after 24 h of incubation.

1. Statistical analysis

A one-way analysis of variance (ANOVA) was carried out to compare gas production, OMD and ME values using the General Linear Model (GLM) of SAS (1989). Significance between individual means was identified using the Tukey's multiple range test.

III – Results and discussion

There were significant differences ($p < 0.05$) in chemical composition among the eleven cultivars (Table 1). Contents in OM ranged from 66.73% DM for *Vicia villosa* to 77.8% DM for *Vicia sativa* 'Mghilla'; *Vicia villosa* '3615' had the highest content (31.61 ± 0.68% DM) while *Vicia sativa* 'Languedoc' had the lowest content (25% DM) in CP. These results are comparable to those reported by Mebarkia (2008). There were also significant ($p < 0.05$) differences in digestibility among the seeds of the eleven cultivars (Table 2). The most digestible seeds were those of

Vicia sativa (OMD = 88.3%) and *Vicia narbonensis* (OMD = 87.78%) in agreement with reports by Hadjipanayiotou (2000). Similarly, the OMD in *Vicia sativa* 'Mghilla' was the highest (70.69%).

Table 1. Chemical composition (in % DM) of *Vicia* ssp. seeds

Cultivar	Crude protein	Organic matter	Ash content
Vicia sativa 'Mghilla'	27.4 ± 0.2 ^{cb}	77.8 ± 0.41 ^{a}	12.5 ± 0.2 ^{b}
Vicia villosa '3615'	31.6 ± 0.68 ^{a}	66.7 ± 5.83 ^{b}	24.4 ± 5.4 ^{a}
Vicia villosa '2565'	28.6 ± 0.41 ^{ab}	76.3 ± 1.51 ^{a}	14.2 ± 1.99 ^{b}
Vicia sativa	28.2 ± 1.37 ^{ab}	77.3 ± 0.11 ^{a}	13.7 ± 0.2 ^{b}
Vicia villosa 'Sedjnen'	26.5 ± 0.024 ^{cb}	77.1 ± 0.95 ^{a}	11.9 ± 1.099 ^{b}
Vicia sativa 'Languedoc'	25.1 ± 0.216 ^{c}	77.5 ± 0.57 ^{a}	12.6 ± 0.312 ^{b}
Vicia narbonensis	29.4 ± 0.423 ^{ab}	77.8 ± 0.1 ^{a}	12.7 ± 0.8 ^{b}
Vicia amphicarpa	28.6 ± 0.01 ^{ab}	76.9 ± 0.07 ^{a}	12.5 ± 0.3 ^{b}
Vicia sativa 'Sanda'	27.3 ± 1.89 ^{cb}	77.6 ± 0.56 ^{a}	12.5 ± 0.31 ^{b}
Vicia 'Y 98'	29.1 ± 0.198 ^{ab}	78.3 ± 0.61 ^{a}	12.6 ± 0.022 ^{b}
Vicia sativa 'INRAT 303'	27.7 ± 0.24 ^{cb}	77.1 ± 1.18 ^{a}	12.6 ± 1.05 ^{b}

$^{a, b, c}$: means in the same column with different superscripts are significantly different at p <0.05.

Table 2. Digestibility of dry and organic matters of seeds of the eleven *Vicia* species and cultivars

Species or Cultivar	Dry matter digestibility	Organic matter digestibility
Vicia sativa 'Mghilla'	87.5 ± 0.05 ^{ab}	87.69 ± 0.08 ^{ab}
Vicia villosa '3615'	83.4 ± 0.16 ^{d}	83.67 ± 0.18 ^{d}
Vicia villosa '2565'	85.9 ± 0.38^{cab}	86.18 ± 0.466^{cab}
Vicia sativa	87.9 ± 0.17 ^{a}	88.3 ± 0.16 ^{a}
Vicia villosa 'Sedjnen'	86.1 ± 0.33^{ab}	86.27 ± 0.19 ^{ab}
Vicia sativa 'Languedoc'	70.6 ± 0.57 ^{c}	70.75 ± 0.38 ^{ab}
Vicia narbonensis	80.9 ± 0.87 ^{e}	87.8 ± 0.8 ^{e}
Vicia amphicarpa	85.9 ± 0.44 ^{cab}	86 ± 0.05 ^{a}
Vicia sativa 'Sanda'	84.1 ± 1.6 ^{cb}	84.8 ± 0.09 ^{cd}
Vicia 'Y 98'	86.9 ± 1.2 ^{cab}	87.4 ± 1.26 ^{cab}
Vicia sativa 'INRAT 303'	85.5 ± 0.6 ^{cbd}	85.6 ± 0.54 ^{cd}

$^{a, b, c, d, e}$: means in the same column with different superscripts are significantly different at p <0.05.

Table 3 shows total gas production after 24 and 96 h, metabolisable energy (ME) and short chain fatty acids (SCFA) produced in syringes. Total gas production was significantly affected (p <0.05) by the type of cultivar examined, with the highest values recorded for *Vicia villosa* '2565' and *Vicia sativa* (196.7ml/g DM) and the lowest gas production was observed for *Vicia villosa* 'Sedjnen' (133 ml/g DM) seeds. The ME and SCFA were the highest (P<0.05) in *Vicia villosa* '2565' and in *Vicia sativa*, the lowest (p <0.05) in *Vicia* 'Languedoc', and intermediate in the remaining cultivars.

IV – Conclusions

Seeds of the eleven vetches had important chemical and digestibility assets. Most of these vetchs are rich in crude protein.

Table 3. *In vitro* gas production and parameters estimated from the gas production

Cultivars	Gas 24 h (ml/gDM)	Gas 96 h (ml/gDM)	ME (Kcal/kgDM)	SCFA (mmol/syr)
Vicia 'Mghilla'	125.6	144.5	1717	0.540
Vicia villosa '3615'	147.6	192.9	1908	0.645
Vicia villosa '2565'	180.2	196.7	2089	0.801
Vicia sativa	180.2	196.7	2097	0.801
Vicia villosa 'Sedjnen'	128.7	133.7	1725	0.555
Vicia 'Languedoc'	113.0	139.1	1604	0.480
Vicia narbonensis	166.7	184.4	2005	0.737
Vicia amphicarpa	157.0	176.3	1938	0.690
Vicia 'Sanda'	157.8	166.7	1925	0.694
Vicia 'Y98'	135.2	147.5	1807	0.586
Vicia 'INRAT 303'	155.9	174.1	1919	0.685

ME: Metabolisable energy**;** SCFA: short chain fatty acids.

Acknowledgements

This research was financially supported by the Laboratory of Economie Agro-alimentaire and AECI (Spanish Agency of International Cooperation for Development).

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