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López-i-Gelats F., Bartolomé J.

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Exploring the use of alternative forage legume crops to enhance organic livestock farming in a context of climate and socio-economic changes

F. López-i-Gelats[1] and J. Bartolomé[2]

[1]Center for Agro-food Economy and Development CREDA-UPC-IRTA,
Parc Mediterrani de la Tecnologia, ESAB Building, C/ Esteve Terrades 8,
Castelldefels (Barcelona) 08860, Catalonia (Spain)
e-mail: feliu.lopez@upc.edu
[2]Department of Animal and Food Science, Universitat Autònoma de Barcelona,
Campus UAB, Bellaterra (Cerdanyola del Vallès) 08193, Catalonia (Spain)
e-mail: jordi.bartolome@uab.cat

Abstract. Organic livestock farming is going through notable growth in the Mediterranean Europe. This increase is being sponsored by the EU agri-environmental schemes, but also by the rising interest of consumers. However, constraints exist that threaten to curb the present trend. One of them is the lack of good quality forage. There is thus a need to investigate if unusual forage crops could produce good harvests under organic management in Mediterranean conditions. Accordingly, we have conducted an initial exploration on the nutritional value of alternative forage legume crops that organic farmers are growing in Catalonia (Spain), specifically: sainfoin (*Onobrychis sativa*), fenugreek (*Trigonella foenum-graecum*), Narbon vetch (*Vicia narbonensis*) and bitter vetch (*Vicia ervilia*). These forage crops are well adapted to poor soils, harsh weathers, and low water, fertiliser and phytosanitary applications. They have been traditionally cultivated in the Mediterranean region, but they have been gradually dismissed due to the spread of high-yielding forage varieties. The preliminary results indicate that not only these crops are forages of an excellent nutritional value, but they show similar or even superior nutritional values when cultivated organically. However, further research is required in this domain to gather further evidences.

Keywords. *Onobrychis sativa – Trigonella foenum-graecum – Vicia narbonensis – Vicia ervilia.*

Exploration de l'utilisation des cultures alternatives de légumieuses fourragères pour l'amélioration de l'élevage biologique dans le contexte présent de changements climatiques et socio-économiques

Résumé. *L'élevage biologique est en train d'expérimenter une croissance remarquable à l'Europe Méditerranéenne. Cet agrandissement est commandité par les mesures agroalimentaires, mais aussi par l'intérêt en augmentation des consommateurs. Cependant, il y a des limitations qui menacent la tendance actuelle. C'est le cas du manque de fourrages de bonne qualité. Donc on a besoin d'enquêter si cultures fourragères inhabituelles pourriez produire des bonnes récoltes sous une gestion biologique et dans les conditions Méditerranéennes. En conséquence, nous avons effectué une exploration initiale sur la valeur nutritionnelle de cultures alternatives de légumineuses fourragères qui sont encore cultivés à la Catalogne (Espagne), spécialement: sainfoin (*Onobrychis sativa*), fenugrec (*Trigonella foenum-graecum*), vesce de Narbonne (*Vicia narbonensis*) and ers (*Vicia ervilia*). Ces cultures fourragères sont très bien adaptées aux sols pauvres, conditions météorologiques difficiles, et apports faibles d'eau, fertilisant et produits phytosanitaires. Ces fourrages ont été cultivés traditionnellement à la région Méditerranéen, pourtant ils ont été progressivement abandonnés à cause de l'expansion des variétés fourragères à haut rendement. Les résultats préliminaires montrent que pas uniquement ces cultures sont des fourragères avec valeurs nutritionnels excellents; mais ils exhibent souvent meilleurs valeurs nutritionnels sous une gestion biologique. Cependant, on doit poursuivre avec la rechercher pour recueillir plus d'évidences.*

Mots-clés. Onobrychis sativa – Trigonella foenum-graecum – Vicia narbonensis – Vicia ervilia.

I – Introduction

Organic livestock farming is going through notable growth in the last decades in the Mediterranean Europe. This increase is being sponsored by the EU agri-environmental schemes, but also by the rising interest of consumers in organic meat and dairy produce. The market of organic food in Europe was 19.6 billion € in 2010. This supposes an increase of approximately five percent in comparison with 2009 (Willer and Kilcher, 2012) and represents a share of 44% of the turnover of organic products worldwide. However, constraints exist that may curb the present trend (López-i-Gelats and Bartolomé, 2010). One of them is the lack of forage of good quality, particularly for winter feeding (López-i-Gelats *et al.*, 2009). There is thus a need to explore options about alternative forage crops capable of yielding good harvests, both quantitatively and qualitatively, in organic conditions, and which are also well adapted to Mediterranean regions and the typical changes these regions undergo, which are being intensified lately be the effects of climate change, such as irregular rainfall and increasing shortage of irrigation water. In order to fill this void, we have conducted an initial exploration on the nutritional value of alternative forage legume crops that organic farmers are growing in Catalonia (Spain). Particularly, we have focused on the followings: sainfoin (*Onobrychis sativa*), fenugreek (*Trigonella foenum-graecum*), Narbon vetch (*Vicia narbonensis*) and bitter vetch (*Vicia ervilia*). These crops have been traditionally cultivated in the Mediterranean region, but they have been gradually dismissed in the last decades as a consequence of the upcoming of high-yielding forage varieties with the modernisation of agriculture. We have also added alfalfa (*Medicago sativa*) in order to have a reference point of a more conventional fodder crop.

II – Materials and methods

Two methodologies have been applied to assess the nutritional values of these fodder crops. To obtain the nutritional values of the forages under conventional management, literature review has been conducted. In the case of the nutritional values of these forages under organic management, sampling in farms growing organic fodder crops in Catalonia (Spain) was implemented between May and June 2011. The sampling process consisted of mowing 0,25 m² of the fodder crop in the middle of the plot. Two samples were taken in each plot. A total of 24 samples were taken, that is, 12 farms were finally included in the analysis. The samples were distributed as follows: 6 in alfalfa plots, 10 in sainfoin plots, 2 in bitter vetch plots, 4 in Narbon vetch plots, and finally 2 in fenugreek plots. The uneven distribution reflects the uneven cultivation of these crops in Catalonia. It should be stated that we are always referring to non-irrigated plots.

Given the availability of good NIRS calibration curves, to determine the nutritional values of the forages, conventional laboratory analysis were not needed. Thus the NIRS method was implemented to examine the following parameters: Ash, indicating the mineral content; Crude Protein, being the total nitrogenised fraction; Degradable Protein, which means the feed protein that can be broken down by microbial enzymes in the rumen; Neutral Detergent Fibre, which includes cellulose, hemicelluloses and lignin; Acid Detergent Fibre, containing cellulose and lignin; Lignin; Starch, entailing the non-fibrous carbohydrates; Ether Extract, which mainly consists of fats and fatty acids; Net Energy of Lactation, which is an estimation of the quantity of energy available for milk production; and Organic Matter Digestibility, which indicates the fraction of the nutrients that can be used by the animal. These analyses were undertaken between the laboratories of the Food and Animal Science Department in the Universitat Autònoma de Barcelona and the Laboratori Agroalimentari of the Departament d'Agricultura, Ramaderia, Pesca, Alimentació i Medi Natural of the Catalan Government.

III – Results and discussion

Despite the high variance observed in the data available, as may be observed in Table 1, particularly remarkable is the high nutritional values registered in the organic samples of sainfoin, bitter vetch and Narbon vetch. These show similar records to the ones of alfalfa. In general, as also remarked in Table 1, and despite the high dispersion of the data, a general trend is observed that points that the nutritional values of sainfoin, bitter vetch, Narbon vetch, fenugreek, and alfalfa, tend to perform better under organic management. The content in protein in the organic samples tends to be higher than in their conventional counterparts. While in the case of fibre it tends to be the other way around. On the contrary, the digestibility of the organic matter is in general larger in samples in conventional farming. As regards the energy available in the forages, not much difference is appreciated among organic and conventional samples. This results go in line with others in the specialised literature that remark the notable nutritional values of the sainfoin, bitter vetch, Narbon vetch, and fenugreek (Acharya *et al*., 2006; Angeles Garcia *et al*., 1989; Billaud i Adrian, 2001; Mir *et al*., 1997); and the higher nutritional values of organically-produced food in comparison with its conventional counterparts (Davies *et al*., 2004; Worthington 2001). However, further research is required in this domain to provide more evidences, particularly in Mediterranean regions and under changing climatic conditions.

IV – Conclusions

The sainfoin, the fenugreek, the Narbon vetch, and the bitter vetch, are forages that offer excellent nutritional value under Mediterranean conditions. The sainfoin, the fenugreek, the Narbon vetch, and the bitter vetch, show similar and even better nutritional values when cultivate organically in comparison with a conventional management. They are also well-adapted crops to thin soils, harsh weathers, and low water, fertiliser and phytosanitary applications. Consequently they could not only become a sound organic alternative to replace more resource-demanding protein sources for animal feeding, such as soya or maize; but also provide a good alternative to face the upcoming climate change impacts in Mediterranean regions, such as lack of water and irregular rainfall (IPCC, 2007).

The utilisation of these alternative forage legume crops could make an important contribution to deal with one of the main constraints that organic livestock farming encounters nowadays, particularly in the Mediterranean regions, that is, the lack of winter feeding. In addition, this would also support the adoption of livestock fattening among organic livestock keepers, what would enhance the on-farm income generation.

Table 1. Levels of nutritional values of sainfoin (*Onobrychis sativa*), fenugreek (*Trigonella foenum-graecum*), Narbon vetch (*Vicia narbonensis*), bitter vetch (*Vicia ervilia*), and alfalfa (*Medicago sativa*), under organic farming, according to farms sampled in Catalonia (Spain), and under conventional farming, according to references from the specialised literature.

	Organic farming					Conventional farming				
	Alfalfa n=3	Sainfoin n=5	Bitter vetch n=1	Narbon vetch n=2	Fenugreek n=1	Alfalfa n=3*	Sainfoin n=4**	Bitter vetch n=4*****	Narbon vetch n=5****	Fenugreek n=2***
ASH	8.9-12.4	8.0-11.6	7.9-12.8	6.4-12.4	8.2-12.6	10.2-11.1	10.4-11.5			
CP	14.8-26.4	17.8-26.1	15.6-24.7	13.2-23.1	15.2-18.8	16.8-22.4	13.1-17.5	14.0-19.6	14.9-21.8	17.2-17.8
DP	9.0-17.6	10.9-18.9	10.2-17.2	8.0-16.6	9.0-13.3	12.2-18.8	8.1-10.6	12.1-16.9		11.7
NDF	25.0-54.5	30.8-47.7	31.1-47.9	28.9-50.6	30.2-47.9	46.4-52.5	45.1-53.6	25.4-42.8	38.1-42.1	
ADF	16.8-35.4	21.1-35.4	22.7-31.7	20.6-36.0	21.4-35.6	29.4-34.4	27.6-36.3	28.5-31.2	20.6-28.9	
LIGNIN	4.0-6.4	4.3-7.9	4.7-5.6	4.2-7.6	2.7-5.8					
STARCH	1.0-5.6	3.4	1.0-11.0	9.9-14.1	6.5					
EE	1.9-2.0	1.5-2.4	1.8	1.5-2.8	1.8					
NEL	1.3-1.9	1.3-1.7	1.3-1.6	1.2-1.7	1.2-1.7	1.2-1.3	1.3-1.6	1.6-1.7	1.65	1.19
OMD	55.7-80.8	55.0-72.0	60.2-76.1	52.1-75.4	55.8-79.0	60-66	67.0-76.0	77.8-79.2	81.5	66.4-67.4

Where 'n' is the number of sampled sites of organic farming and the number of references from conventional farming found in the specialised literature; 'ASH' is the mineral content; 'CP' is crude protein; 'DP' is degradable protein; 'NDF' is neutral detergent fibre; 'ADF' is acid detergent fibre; 'LIGNIN' is lignin; 'STARCH' is starch; 'EE' is ether extract; 'NEL' is net energy of lactation; and 'OMD' is organic matter digestibility. * INRA (2007, 1990); ** Alibes and Tisserand (1990); INRA (2007, 1990); *** Darby (2004); Alibes and Tisserand (1990); **** Otal *et al.* (2009); Confalone *et al.* (2006); Alibes i Tisserand (1990); ***** Otal *et al.* (2009); Alibes and Tisserand (1990).

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