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Influence of bitter lupin on consumption and digestibility in organic dairy cattle soya bean free diets

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ABSTRACT: One of the main principles of organic husbandry is that animal feed must be GMO free, and soya bean is well-known as a high risk GMO alimentary source. About 25 dry dairy cattle of the Italian Holstein breed, from the Cooperativa Emilio Sereni of Borgo S. Lorenzo (FI), were fed in two successive diets: the first with extruded soya bean (A), and the second in which bitter lupin, faba bean and proteinic pea substituted the soya bean (B). We evaluated both the consumption and the apparent digestibility (using acid insoluble ash as internal marker) of the two diets, repeating the trial twice. The presence of bitter lupin did not influence either the consumption of other feed, or the faecal water content. The apparent digestibility of the organic matter resulted satisfactory in both the diets, but was significantly higher in diet (A) than in diet (B) (71,6% vs 67,3%). In conclusion, even though we wish the cultivation of sweet lupin would be increase in Italy, we retain that also bitter lupin (mixed with other feed to increase the palatability) could be used as alternative protein source in dairy cattle diets.

Key words: Bitter lupin, Organic dairy cattle, Apparent digestibility, GMO.

INTRODUCTION – One of the main principles of organic animal production is that the feedstuffs of animals are GMO free (European Commission, 1999). The GMO contamination risk is particularly present in dairy cattle nutrition, where soya bean is used to attain the high protein values required by the animals. The solution could represented by others legumes such as lupin that has a DM yield in grain of 1300 kg/ha and a crude protein (CP) content of 30 - 35 % (on DM) whereas soya bean, a high risk GMO supplement, has a DM yield in grain of 2784 kg/ha and 40 - 41% of CP (on DM). In fact, lupin is one proteinaceous species that appears more interesting and promising for its high content in proteins. Although sweet lupin is widely used in Northern Europe and other large areas of the world, in Italy it is not widely cultivated and it is difficult to obtain. For this reason in this work we were limited to the use of bitter lupin from the province of Viterbo. However, it is well-known that bitter lupin contains alkaloids and anti-nutritional factors (Singh *et al.*, 1994; El-Adawy *et al.*, 2001). Since the cattle refused the addition of pure bitter lupin to the rations, and it was not possible to soak the bitter lupin the day before, in order to eliminate the alkaloids accountable of the bitter flavour (as it is usually performed by shepherds before giving it to sheep), it was necessary to crush and mix the lupin with faba bean and proteinic pea, to make it more appealing to the animals. The aim of this work was to evaluate whether there were changes in feed consumption, in the consistency of faeces and in digestibility, by replacing soya bean in the ration of organic dairy cattle with different legumes: bitter lupin mixed with faba bean and proteinic pea. Such test was useful as a "forerunner" for a successive trial on the utilization of bitter lupin on lactating dairy cattle.

MATERIAL AND METHODS – In spring 2006, a trial was carried out on dry dairy cattle using rations with bitter lupin. For this trial the entire group of dry dairy cattle (about 25 animals) of the Italian Holstein breed from the Cooperativa Agricola Emilio Sereni of Borgo S. Lorenzo (FI) were used. The cattle were fed for 15 days diets with extruded soya bean (1 kg TM) (A) or bitter lupin (0,3 kg TM) mixed with faba bean and proteinic pea (0,7 kg

TM) (B). The diets have the same nutritional value (0,69 UFL/kg DM), but the diet A, by comparison with the B, where we substituted the same quantity of soya bean with others Legumes, has a slighter higher CP content (9,16% vs. 8,24%) (table 1). The farm adopts an intentionally low protein level in the diet of dry cattle, because, in this way, it has verified a reduction of sanitary problems during the drying period and at the calving.

The trial, A versus B, was repeated twice, using all available dry dairy cattle. Every day both the administered diets and the residues were weighed to evaluate the consumption. The first 10 days were considered adaptation time and hence only the last 5 days were considered to calculate the intake. During the last day of the cycle, individual samples of faeces were collected to evaluate the dry matter (DM) of the faeces, and the apparent digestibility of both dry matter (DMd) and organic matter (OMd), using acid insoluble ash (AIA) as internal marker (Antongiovanni and Gualtieri, 2002). All the aliments of the diet were analyzed in order to determine the bromathological composition: DM, organic matter (OM), crude fibre (CF), CP, ether extract (EE) and the content in AIA with the method described by Martillotti *et al* (1987) (table 1).

For the faecal samples only the DM, the OM and the AIA were determined. The data on the consumption of the last five days of the trial were analyzed with ANOVA, using as a fixed factor the type of diet, in order to determine possible differences in consumption between the treatments. ANOVA, fixed factor type of diet, was used to evaluate, for each repetition of A vs. B and in total, also the faecal DM and the apparent digestibility of both the DM and OM (SAS, 2002).

RESULTS AND CONCLUSIONS – In table 1 we reported the bromathological composition of two diets.

Table 1. Diets composition.

	Total Matter (TM) kg		DM kg		CF % DM		CP % DM		EE % DM		Ash % DM	
Diets	A	B	A	B	A	B	A	B	A	B	A	B
May hay	11.0	11.0	9.4	9.4	31.6	31.6	7.2	7.2	1.5	1.5	6.9	6.9
Straw	2.0	2.0	1.8	1.8	45.0	45.0	3.7	3.7	1.3	1.3	6.3	6.3
Bitter lupin	-	0.3	-	0.3	-	15.0	-	34.0	-	8.7	-	3.7
Faba bean + Proteinic pea	-	0.7	-	0.6	-	5.1	-	26.4	-	1.4	-	3.6
Extruded soya bean	1.0	-	0.9	-	6.8	-	39.6	-	6.1	-	12.3	-
Total	14.0	14.0	12.1	12.0	31.6	31.8	9.2	8.2	1.8	1.6	7.2	6.5

As far as the consumption of the alimentary sources was concerned, significant differences between the two diets were not found, for the intake of the different feedstuffs (table 2). From this result, it seems possible to speculate that addition of bitter lupin to diets of dry cattle, did not affect the DM intake. We observed that animals fed with extruded soya bean (A) consumed the feedstuff quickly, whereas more time was required for the animals fed with bitter lupin, proteinic pea and faba bean (B).

Table 2. Consumption of alimentary sources (results of ANOVA).

	DF = 18														
	May hay			Straw			Bitter lupin		F.bean + Proteinic pea		Extruded S. bean		Total		
Diets	A	B	sign	A	B	sign	A	B	A	B	A	B	A	B	sign
TMkg	11.3	10.9	ns	2.1	2.0	ns	-	0.3	-	0.7	1.1	-	14.4	13.9	ns
DMkg	9.6	9.3	ns	1.8	1.8	ns	-	0.3	-	0.6	1.0	-	12.4	11.9	ns
DM%	77.2	77.8	ns	14.6	14.7	ns	-	2.3	-	5.3	8.2	-	100.0	100.0	-

ns = not significative.

As shown in table 3, the water content in the faeces was not significantly influenced by the diet. Concerning the apparent digestibility of the two rations, calculated by using the AIA as an internal marker, there were no significant differences during the first trial, even if the apparent digestibility seemed to be slightly higher in diet B. Significant differences were shown during the second trial and considering both trials together: results showed that diet A was more digestible (4%) than diet B. An explanation for this result could be due to the presence of alkaloids and antinutritional factors in bitter lupin, even though the levels of apparent digestibility of the diet B resulted good. To have an idea, even if approximative, of the synergistic effect of the various aliments of the rations on apparent digestibility, we also tried to calculate the weighted average of the theoretic digestibility of organic matter of the two diets using the data evaluated by INRA for each aliment (Sauvant *et al.*, 2002). The values shown are very similar for both the diets (A = 55.2% vs. B = 55.3%) even if clearly lower to the apparent digestibility found in the present work, and this would demonstrate the positive effect of the presence of proteinaceous feed, particularly soya bean.

The OMd could be influenced also by the low protein level adopted in this trial, but, as reported above, we followed the choices of the organic farm were the trial was carried out.

Table 3. Faecal DM and digestibility (results of ANOVA).

	1st Trial - DF = 41			2nd Trial - DF = 55			Total - DF = 98		
Diets	A	B	sign	A	B	sign	A	B	sign
Faeces DM%	12.9	13.2	ns	13.4	13.9	ns	13.2	13.5	ns
DMd %	62.5	65.8	ns	73.1	65.1	***	69.4	65.5	**
OMd %	64.8	67.8	ns	75.1	66.7	***	71.6	67.3	**

*ns = not significative; ** P<0,01; *** P<0,001.*

In conclusion, bitter lupin, when mixed to make it more palatable (even when not soaked to remove the alkaloids), could be an interesting legume for the formulation of diet in organic dairy cattle nutrition both to avoid the GMO contamination risk and as a good alternative to soya bean. The result of this trial, could also been used to convince the breeder that soya bean is not better than lupin or faba bean only because the animals eat these Legumes with avidity.

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