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To cite this article: A. L. Mordenti, F. Merendi, M. Fustini & A. Formigoni (2007) Effects of different protein plants in cows diet on milk for Parmigiano Reggiano production, Italian Journal of Animal Science, 6:sup1, 463-465, DOI: [10.4081/ijas.2007.1s.463](https://doi.org/10.4081/ijas.2007.1s.463)

To link to this article: <https://doi.org/10.4081/ijas.2007.1s.463>



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Published online: 15 Mar 2016.



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Effects of different protein plants in cows diet on milk for Parmigiano Reggiano production

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ABSTRACT: Two homogeneous groups of dairy cows were fed the same base diet added with a concentrate containing 10 % of soybean meal or 10.1 % of faba bean and 10.1 % of pea. The substitution of soybean meal with faba bean + pea reduced dry matter intake (-0.83 kg/head/day equivalent to 3.5%) and milk yield (-1.29 kg/head/day equivalent to 3.9%), but increased fat and casein concentrations in milk and, as a consequence, cheese yield at 32 hours ($P < 0.01$). The present data show that is possible feed a GMO free diet to dairy cows, without using soybean meal.

Key words: GMO free diets, Faba bean, Pea, Cheesemaking properties.

INTRODUCTION – The present study is part of a larger project aimed to investigate the effects of diets low in protein (devoid of soybean) on milk production and cheese-making properties. These objective aims, through an increased utilization of alternative protein plants, to reduce environmental pollution and eliminate soybean, often GM (Mordenti and De Castro, 2005) from the diets of cows. This can be obtained first by using high quality forages (alfalfa hay particularly) in low protein diets with the inclusion of protected amino acids (Mordenti *et al.*, 2005) or using alternative raw materials to soybean, such as faba bean (*Vicia faba minor*) and pea (*Pisum sativum*) which are authorized by Consorzio di Parmigiano Reggiano. The possibility to replace soybean with faba bean and pea has been confirmed for low-middle milk yields (less than 25 kg/d) and in diets added with corn silage (Hoden *et al.*, 1992; Battini *et al.*, 2003; Pasquini *et al.*, 2003). Since very little information is available as to the effects of faba bean and pea on the cheese-making properties of milk, we focused particularly on this aspect.

MATERIAL AND METHODS – The research was carried out in a dairy farm with more than 300 Holstein heads (150 milking cows), with an annexed cheese factory for the production of Parmigiano-Reggiano cheese and a drying system for hay production. After an adaptation period of 2 weeks, 119 milking cows were randomly subdivided into two groups homogeneous for milk yield and quality, age, lactation number (primiparous/multiparous ratio) and BCS (Body Condition Score; Edmonson *et al.*, 1989) and fed for 180 days the following experimental TMR (Total Mixed Ratio) base diet: dehydrated corn (1.6 kg), straw (1.1 kg), mixed hay (4.3 kg), alfalfa hay (9.1 kg), wheat bran (0.9 kg), concentrate (10.4 kg) and water (4.9 kg).

Experimental diets were as follows:

Group A (Soybean meal): TMR base diet + concentrate containing 10 % of soybean meal;

Group B (Faba bean + Pea): TMR base diet + concentrate containing 10.1 % of faba bean and 10.1 % of pea.

Both diets provided the same amount of energy (Net Energy Lactation: 1,55 mCal/kg DM) and protein (Crude Protein: 14 % DM).

Composition of concentrates is reported in Table 1.

During the study, dry cows were removed from each group and replaced with early lactation cows. A Penn State Particle Separator (Lammers *et al.*, 1996) was used to estimate the physical characteristics of the TMR; nutritional conditions of the herd were individually evaluated by the BCS.

Table 1. Composition of the experimental concentrates (%).

Item	Diet	
	Soybean meal	Faba bean + Pea
Corn	% 47.03	40.54
Barley	% 15.68	13.51
Sorghum	% 15.68	13.51
Soybean meal	% 10.00	—
Faba bean	% —	10.14
Pea	% —	10.14
Wheat bran	% 6.62	7.16
Linseed	% 1.62	1.62
Trace elements and vitamins	% 1.01	1.01
Yeasts	% 0.34	0.34
Sodium bicarbonate	% 0.68	0.68
Sodium chloride	% 0.68	0.68
Calcium carbonate	% 0.34	0.34
Magnesium oxide	% 0.34	0.34

Both diets were fed ad libitum and daily consumption was recorded. Every two weeks, samples of bulk milk (soybean meal and faba bean + pea) were collected. For each group we used two vats each one with a capacity of 1100 kg and producing two Parmigiano-Reggiano cheeses every day. Every week, samples of vat milk (2 soybean meal and 2 faba bean + pea) produced in the morning and added to the milk of the evening before (after natural creaming) were collected. The cheesemaking properties were carried out at regular intervals.

Milk analyses were performed according to AOAC (1990) and lactodynamographic analysis (LDG).

The data were subjected to the analysis of variance (ANOVA) and the differences between means were tested with the t test.

RESULTS AND CONCLUSIONS – The effects of the dietary substitution of soybean with faba bean and pea bean on production and quality of milk are briefly summarized.

Production - The faba bean + pea diet significantly decreased dry matter intake (-3.5%) and milk yield (-3.9%; Table 2).

Table 2. BCS, dry matter intake and production during the experimental period (means ± s.d.).

Item		Diet		P value
		Soybean meal	Faba bean + Pea	
BCS	n.	2.72 ± 0.34	2.74 ± 0.32	n.s.
Dry matter intake	kg D.M./cow/day	24.05 ± 1.05	23.22 ± 1.36	P<0.01
Milk production	kg/cow/day	33.13 ± 6.91	31.84 ± 6.62	P<0.01

Milk quality – Bulk milk quality (fat, casein, lactose, urea, somatic cells, titratable acidity and curdling time) was not influenced by diet. The faba bean + pea diet significantly increased vat milk fat ($P<0.01$) and casein ($P<0.05$) concentrations (Table 3).

Cheese-making properties of milk – Milk LDG analysis does not show any significant differences between treatments (Table 3).

Cheesemaking production – The quantity of cheese (at 32 hours) produced from 100 kg of vat milk was significantly greater in the faba bean + pea group, likely due to the higher milk fat and casein content; after 1 year of seasoning this trend was still observable but differences were not significant (Table 4).

Table 3. Vat milk composition and cheese-making properties (means \pm sd).

Item		Diet		P value
		Soybean meal	Faba bean + Pea	
Observations	n	30	30	—
Fat	%	2.58 \pm 0.10	2.66 \pm 0.11	$P < 0.01$
Casein	%	2.49 \pm 0.05	2.52 \pm 0.07	$P < 0.05$
Fat/casein	n.	1.04 \pm 0.04	1.05 \pm 0.05	ns
Lactose	%	5.03 \pm 0.09	5.01 \pm 0.10	ns
Somatic cells	n x 1000/dl	3.09 \pm 0.30	3.11 \pm 0.50	ns
Titratable acidity	$^{\circ}$ SH/50 ml	3.52 \pm 0.13	3.53 \pm 0.15	ns
pH	n	6.65 \pm 0.03	6.65 \pm 0.03	ns
Curdling time (rLDG)	min	16.77 \pm 2.40	16.43 \pm 2.43	ns

Table 4. Cheese yield of vat milk at 32 hours and after 1 year of seasoning (means \pm s.d.).

Item		Diet		P value
		Soybean meal	Faba bean + Pea	
<i>Yield at 32 hours</i>				
Observations	n	30	30	—
kg cheese / 100 kg of vat milk		8.44 \pm 0.19	8.61 \pm 0.21	$P < 0.01$
Weight losses	%	11.58 \pm 1.37	11.39 \pm 1.00	ns
<i>Yield at 1 year</i>				
Observations	n	15	13	—
kg cheese / 100 kg of vat milk		7.49 \pm 0.18	7.62 \pm 0.22	ns

The present results show that substitution of soybean meal with faba bean and pea bean in the diet of dairy cows is possible; the reduction of feed intake and milk production is partially compensated by the increased fat and casein content of milk and cheese yield at 32 hours after cheesemaking was improved by the faba bean + pea diet. The results obtained suggest the opportunity of a better characterization of these feed in order to optimize dairy cows diets.

We wish to thank the "Azienda Caretti" in S. Giovanni in Persiceto (BO) and Drs. Mauro Cazzoli and Franco Ghelfi for their collaboration.

This research was carried out in collaboration with CRPA of Reggio Emilia and with funds from Regione Emilia-Romagna.

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