

Effect of field bean vicine /convicine content on production performances of laying hens and the quality of the egg

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The incorporation of field bean into feeds for the laying hen may cause a reduction in laying performance and impair the internal quality of the egg, mainly the number of blood spots. According to some authors, these negative results may be attributed to the anti-nutritional factors present in field bean and the nutritional imbalance that it brings about at a high dietary incorporation level.

This trial aimed to study the impact of field-bean anti-nutritional factors, vicine and convicine (V+C), on the production performances and egg quality of the laying hen. To this end, two spring field beans, dehulled and with the same protein content (33.7% dry weight), were used: one had a high V+C content (Marcel), the other had a low V+C content (Divine). In fact, Marcel contained 7 times as much Vicine (3428 vs 489 µg/g) and 12 times as much Convicine (2428 vs 209 µg/g) as Divine. They were incorporated as 20% into balanced diets, either alone or in combination (14/6 and 6/14%) in order to cover a sufficiently wide range of V+C. These 4 diets were compared with a soybean-based control diet presenting the same nutritional characteristics (Table 1). In order to reach this objective, field-beans were analysed and their metabolisable energy value was estimated to 3370Kcal/kg DM. Each diet was fed to 48 laying hens (6 replications of 8 hens) at the beginning of the laying period for 5 28-day periods. Conventional production parameters were measured: egg number and weight, laying percentage, feed conversion ratio, as well as the egg quality (resistance to shell breakage, presence of blood spots, Haugh units, yolk diameter, color and height).

The results are presented in Table 2. Considering the overall trial period, the laying percentage recorded ranged between 96.9 and 97.7% and did not depend on the dietary treatment. The same went for the feed conversion ratio, even though the soybean control feed showed slightly higher efficacy ($p=0.10$). This last result may be explained by an over estimate of the ME value of field beans. This hypothesis was confirmed by ME results observed on cockerels fed on the basal (3081kcal/kg DM), 20% Marcel (3019 kcal/kg DM) and 20% Divine (2952 kcal/kg DM) diets. The numbers of eggs per hen were also the same. On the contrary, the mean egg weight was significantly reduced by the diet with the highest V+C content and improved by that with the lowest V+C content. The other feed batches and the control batch were intermediate. Egg weight (EW) was linearly decreased by increasing levels of V+C ($EW(g)=58.2-0.03V+C(\mu g)$). The quantity of eggs exported per hen during the whole trial period was also increased by Divine.

Regarding egg quality, shell breakage occurred under very close loads and only batch C (14% Marcel + 6% Divine) presented slightly more resistant eggs ($p=0.06$); however, shell indices were identical in all batches. On average, Haugh units in "field-bean" hens' eggs were 2 to 6 points higher than those in "soybean" hens' eggs; among the field-bean batches, those with a high vicine/convicine content yielded better quality eggs. The yolk color was not modified by the dietary treatment, the number of blood spots was significantly reduced by the presence of Marcel, but Divine was not different from the soybean diet ($p=0.01$). Finally, the diameter/height ratio of the egg yolk was significantly increased by the presence of field bean in the feed.

In conclusion, the incorporation of 20% of dehulled spring field bean with high Vicine and Convicine content reduced laying hen performances. On the contrary performances of birds fed low V+C diets were at least identical to those observed on birds fed the control diet. As a consequence, the dietary use of large amounts of field beans with low Vicine and Convicine content made it possible, under our feed formulation conditions, to reach the same production performances and egg quality as a regular soybean meal diet.

Table 1 Composition and calculated nutritional value of experimental diets.

Composition (g/kg)	BASAL	MARCEL	DIVINE
Field bean		200	200
Corn	619	543.6	523.2
DL Méthionine	1.36	1.8	1.8
Lysine HCl	0.62	0.5	0.6
Corn gluten meal	42.42	47.2	48.4
Soybean meal	196.6	74.3	72
Rapeseed oil	16.7	8.3	8.6
Wheat			21.2
Alfalfa	15	15	15
Tryptophane	0.2	0.5	0.5
Threonine		0.4	0.4
Mineral and Vitamin mix	108.1	108.4	108.3
Calculated composition			
Metabolisable energy value (kcal/kg)	2750	2750	2750
Crude protein (g/kg)	170	170	170
Lysine (g/kg)	8.00	8.02	8.05
Méthionine (g/kg)	4.32	4.33	4.33
Vicine (g/g)		686	98
Convicine (g/g)		486	42

Table 2 Laying performances and egg quality.

Experimental diet	Basal	Marcel	2/3 Marcel+ 1/3 Divine	1/3 Marcel+ 2/3 Divine	Divine
Laying rate (%)	96,92	97,16	96,25	97,74	96,89
Egg number	135,7	136,0	134,7	136,6	135,6
Mean egg weight (g)	56.62 b*	54.34 c	56.34 b	56.30 b	57.95 a
Egg-mass (g)	8183 b	7868 c	8148 b	8197 b	8382 a
Feed conversion ratio	1,873	1,927	1,911	1,930	1,920
Haught units	80,6c	86,3ab	86,6a	83,9b	82,1bc
Blood spot number**	1,979ab	1,894b	1,917b	1,936b	2,063a
Egg shell (N)	37,14b	38,45ab	39,53a	37,74b	37,87b

*: Values with the same letter are not significantly different ($p < 0.05$)

** : 1= no blood spot, 2= 1, 2 or 3 spots, 3=more than 3 spots.