Utilization of lupin seed as the main protein source in broiler chicken feeding: influence of the variety and interest of a protease addition

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Introduction

The results of a previous study (Froidmont et al., 2004) suggested that an incorporation level of lupin seed (*Lupinus albus*) exceeding 30% of DM in broiler chicken feeding risks to affect growth performances. It also showed that the addition of an enzyme preparation with cellulase, glucanase, hemicellulase and pectinase activities to diets had no effect on lupin seed valorisation by chicken. In the literature, most of the enzyme preparations having a positive effect contained a protease activity (Brenes et al., 1993; Marquadt et al., 1996, Brenes et al., 2002) but no explanation in relation with this enzyme is given. Another parameter that could influence the results is the composition of lupin seed, directly dependent on the variety of lupin used. The aim of this trial was to investigate the effects of 3 lupin varieties as the major source of protein in broiler chicken feeding, with or without a supplement of protease, on growth performances, nutrient digestibility and fatty acid composition of the leg meat.

Material and methods

During 25 days, 360 4-d chicks received 3 iso-energy and iso-first limiting amino acids (Met, Lys, Thr, Trp) diets (table 1) differing by the variety of lupin used (*Lupinus albus*, var. Amiga & Lublanc and *Lupinus angustifolius*, var. Boltensia) and containing xylanase (2600 IU/kg), cellulase (800 IU/kg), ß-glucanase (2600 IU/kg), pectinase (300 IU/kg) and hemicellulase (1500 IU/kg) activities in a randomised blocks design (6 treatments). These diets were investigated with or without a supplement of protease (Bio-Feed Pro CT, Novozymes, Bagsvaerd, Denmark) supplied at an incorporation rate of 1 g/kg. The experiment was composed by a 20-d growing period, followed by a 3-d period for nutrient digestibility measurement and 2 days for dissection (12 chicks/treatment).

Table 1. Composition (% DM) and nutritional value of diets

	Lublanc	Amiga	Boltensia
Composition			
Wheat	34.6	34.7	34.4
Lupin	51.1	51.1	51.1
Soja fat	8.5	8.6	8.6
Mineral, vitamin & AA mixture	5.8	5.7	5.9
Bio Feed Pro CT	+/-	+/-	+/-
Nutritional value			
Crude protein, %	21.80	22.70	22.41
ME, kcal/kg	3248	3285	3261
Fat, %	13.86	14.10	11.58
Cellulose, %	9.65	7.84	9.71

Results and discussion

The average daily gain (ADG) observed with *Lupinus albus* diets was similar to control diets containing soybean meal in similar experiments (Froidmont et al., 2004; Rubio et al., 2003). This suggested that lupin could be incorporated to a higher rate than 50% DM and be used as the major source of protein for broiler chicken.

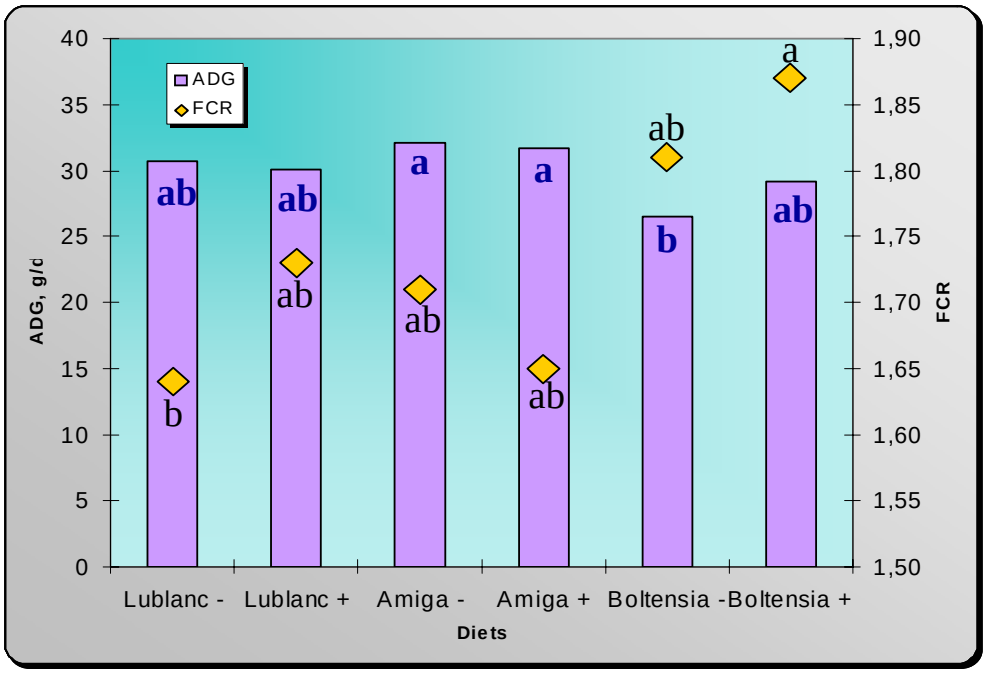

Figure 1. Average daily gain (ADG) and food conversion ratio (FCR) according to the variety of lupin incorporated into diets, with (+) or without (-) protease addition
[a,b]for a same factor, means with a similar letter did not differ, P > 0.05)

During the growing period, the protease addition tended to improve DM intake (48.4 *vs* 54.4 g/d/chick, P = 0.121) for Boltensia diets and had no effect on the appetence of *Lupinus albus* diets. The enzyme did not improve significantly growth performances in term of ADG and FCR amongst diets (figure 1). For Boltensia diets, the ADG variation was related to the difference of ingestion but FCR was similar, suggesting that the protease did not improve the protein valorisation by chicken. Without protease, ADG data suggested that Boltensia is a less appropriated variety for chicken feeding than Amiga.

During the digestibility period, the intake of main nutrients did not differ significantly with treatments (table 2). Apparent digestibility of DM, OM and energy differed amongst diets with, in general, a higher digestibility of these nutrients with Amiga, intermediate values with Lublanc and a low digestibility with Boltensia. Contrary to other nutrients, fat was better digested with Boltensia diet. This could be explained by differences in total fat content of the diet and, maybe, in the variation of the fatty acid composition amongst both lupin species. N digestibility was not influenced by treatments, probably due to the mix of urinary and undigested N in excreta.

Table 2. Individual ingestion, apparent digestibility of nutrients and metabolizable energy supply of the diets

	Lublanc -	Lublanc +	Amiga -	Amiga +	Boltensia -	Boltensia +	P
Ingestion							
DM, g/d	84.4	79.5	90.5	85.9	78.7	82.6	0.362
OM, g/d	79.1	74.6	84.8	80.9	73.4	77.3	0.368
N, g/d	3.1	2.8	3.4	3.2	3.1	3.3	0.110
Energy, kcal/d	433.3	405.2	466.8	432.7	404.0	422.5	0.322
Fat, g/d	10.5	9.9	11.2	10.7	9.8	10.3	0.377
Digestibility							
DM, %	60.0acd	57.5bcd	62.8a	62.0ac	54.9b	55.5bd	0.001
OM, %	61.7acd	59.5bcd	64.3a	63.9ac	56.7b	57.1bd	0.001
N, %	55.8	52.3	56.8	56.2	54.7	55.4	0.345
Energy, %	66.3acd	64.6bcd	69.3a	67.1ac	62.1bd	62.7bcd	0.001
Fat, %	82.4ac	80.5c	84.5a	84.4a	88.6b	88.3b	0.001
AMEn, kcal/kg	3239a	3143ab	3400a	3206ab	3014b	3028b	0.001

[a,b,c,d]Means with a common letter are not significantly different (P > 0.05)

AMEn of the diet (apparent metabolisable energy corrected for N retained as proposed by Bourdillon et al., 1990) was higher with Amiga – compared to Boltensia diets and reflected differences in diet digestibility.

Table 3. Organ size related to body weight (BW) and physico-chemical characteristics of digesta according to the diets

	Lublanc -	Lublanc +	Amiga -	Amiga +	Boltensia -	Boltensia +	P
Gizzard weight, %BW	2.55	2.46	2.42	2.57	2.42	2.40	0.727
$L_{duo\&jej}$, cm/g BW	0.087a	0.087a	0.087a	0.087a	0.098b	0.096b	0.004
L_{ileum}, cm/g BW	0.061	0.062	0.063	0.063	0.071	0.066	0.080
$pH_{duo\&jej}$	5.90	5.86	5.98	5.91	5.81	5.78	0.347
pH_{ileum}	6.85	6.73	7.05	7.01	6.78	6.67	0.598
$Osmolarity_{duo\&jej}$, mM	312	349	338	403	340	331	0.516
$Osmolarity_{ileum}$, mM	301ab	319ab	379a	359ab	273b	313ab	0.020
$Viscosity_{duo\&jej}$,cP	3.19a	3.12a	2.83a	2.99	6.28b	6.01b	0.001
$Viscosity_{ileum}$, cP	4.77a	4.49a	4.20a	4.47a	13.19b	14.16b	0.001

[a,b]Means with a common letter are not significantly different (P > 0.05)

The diets did not influence the part of the gizzard in the body weight while the proportional length of the duodenum/jejunum section was significantly higher with Boltensia diets. The pH and the osmolarity of duodenum and jejunum content were not influenced by the diets but their viscosity increased sharply with Boltensia diets, due probably to the higher soluble fibres content of this lupin variety (Bach Knudsen and Gonzalez, 2004). According to Brenes et al. (2002), the increase of the intestinal length could result from the higher viscosity of intestinal contents.

	Lublanc -	Lublanc +	Amiga -	Amiga +	Boltensia -	Boltensia +	P
C12:0	0.48	0.46	0.38	0.62	0.41	0.49	0.507
C14:0	0.22	0.24	0.32	0.20	0.28	0.29	0.143
C16:0	12.47	13.03	13.16	12.80	13.50	13.49	0.455
C16:1 cis	0.63	0.81	0.77	0.61	0.76	0.65	0.781
C18:0	5.80	6.56	5.77	6.89	7.28	7.78	0.227
C18:1 cis9	33.36a	32.88a	33.37a	32.76a	27.82b	26.34b	0.001
C18 :1 cis11	2.28a	2.42a	2.32a	2.24ac	1.89bc	1.80b	0.001
C18 :2 c9c12	38.94a	38.44a	38.43a	38.10a	43.40b	44.39b	0.001
C18 :3 c9c12c15	5.80a	5.17ab	5.48ab	5.76a	4.66b	4.73b	0.001

[a,b]Means with a common letter are not significantly different (P > 0.05)

The fatty acid profile of leg meat did not differ amongst *Lupinus albus* diets, and was independent of the protease addition. The parts of C18:1 and C18:3 in total fatty acids were decreased by Boltensia diets to the profit of C18:2. These modifications reflected the variation in fatty acid profiles of both lupin species (Sauvant et al., 2002).

Conclusions

An incorporation rate of 51% DM of lupin seed from *Lupinus albus* varieties in broiler chicken feeding enabled better growth performances compared to the *Lupinus angustiofolius* variety. The high soluble fibres content of this variety induced a higher viscosity of the digesta, reducing the digestibility of most of nutrients. The protease addition had no effect on the protein valorisation by chicken. The fatty acid profile of the meat was influenced by treatments and reflected the composition of lupin oil.

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