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Lupin seed as a substitute to soybean meal in broiler chicken feeding: incorporation level and enzyme preparation effects on performance, digestibility and meat composition

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During 22 days, 324 chicks (56.3 ± 4.8 g of live weight) received 3 iso-energy and iso-first limiting amino acids (Met, Lys, Thr and Trp) diets (table 1), with or without an enzyme preparation [Ronozyme VP (Roche Vitamins) containing pectinase (3000 IU/g), fungal β-glucanase (50 U/g) and hemicellulase (15000 IU/g) according to Kocher et al. (2000)] in a randomised blocks design (6 treatments). The experiment was composed by a 20-d growing period followed by a 3-d period for digestibility measurement. Finally, 2 days were devoted to dissection (12 chicks/treatment).

Table 1. Composition and nutritional value of diets

	Soybean meal diet	Lupin 30 diet	Lupin 58 diet
Wheat	53.27	40.00	29.19
Lupin	-	30.00	57.98
Soybean meal	35.00	17.70	-
Soybean fat	7.50	7.90	8.15
Mineral and vitamin mixture[1]	1.50	1.50	1.50
$CaHPO_4.2H_2O$	1.79	1.95	2.10
Limestone	0.45	0.37	0.30
NaCl	0.10	0.09	0.10
Methionine	0.26	0.31	0.36
Lysine	0.10	0.15	0.25
Tryptophane	-	0.04	0.07
Threonine	0.03	-	-
Ronozyme VP	+/-	+/-	+/-
Crude protein	23.04	24.04	24.48
ME (kcal/kg)	2879	2874	2877
Fat	8.93	11.70	14.17
Crude fibre	3.03	5.10	6.99

[1]Pluimvee CAZO 15 (Roche Vitamins), supplying 100 ppm of Roxazyme G2G in diets

All diets contained β-glucanase (1800 IU/kg), cellulase (800 IU/kg) and xylanase (2600 IU/kg) activities (Roche Vitamins, Roxazyme G2G). Average daily gain, food conversion ratio, N retention, apparent metabolisable energy (table 2) and apparent nutrient digestibility (table 3) were significantly depressed with 'Lupin 58' diet while nutrient ingestion, except fat, did not decrease significantly amongst treatments. The low N digestibility was due to the fact that urinary N was not separate from undigested N in excreta.

Table 2. Treatment effect on average daily gain (ADG, g/d), food conversion ration (FCR), N retention (g/d) and apparent metabolizable energy (AME, kcal/d)

	Soybean meal diet		Lupin 30 diet		Lupin 58 diet		*P*	*P*
Enzyme	-	+	-	+	-	+	Régime	Enzyme
ADG	31.0[a]	30.5[a]	28.6[a]	28.7[a]	24.7[b]	23.4[b]	0.001	0.425
FCR	1.32[a]	1.34[a]	1.38[a]	1.40[ab]	1.50[bc]	1.55[c]	0.001	0.163
N retained	1.41[a]	1.45[a]	1.34[a]	1.20[a]	0.82[b]	0.76[b]	0.001	0.467
AME	3058[a]	3148[a]	2980[a]	2845[a]	2354[b]	2404[b]	0.001	0.980

[a,b,c]Within a row, means lacking a common superscript letter differ ($P < 0.05$)

Table 3. Ingestion and apparent digestibility of nutrients for all treatments

	Soybean meal diet		Lupin 30 diet		Lupin 58 diet		*P*	*P*
Enzyme	-	+	-	+	-	+	Diet	Enzyme
Ingestion								
DM	70.4	65.7	68.8	63.0	59.1	63.3	0.112	0.431
OM	66.1	61.7	64.5	59.3	55.5	59.4	0.107	0.445
N	2.78	2.55	2.65	2.41	2.28	2.41	0.211	0.452
Fat	5.75[a]	5.73[a]	7.47[b]	7.16[ab]	7.99[b]	8.00[b]	0.001	0.722
Energy (kcal/J)	333	350	341	335	305	280	0.013	0.737
Digestibility								
DM	64.4[a]	63.7[a]	59.4[b]	57.1[b]	50.2[c]	51.3[c]	0.001	0.306
OM	67.1[a]	66.2[a]	61.9[b]	59.4[b]	52.0[c]	53.6[c]	0.001	0.267
N	51.2[a]	51.6[a]	49.5[a]	45.9[a]	36.3[b]	37.3[b]	0.001	0.542
Fat	88.7[a]	87.1[a]	86.8[a]	84.4[ab]	82.1[b]	84.2[ab]	0.001	0.451
Energy	66.2[a]	66.0[a]	61.8[ab]	59.2[b]	49.9[b]	51.5[b]	0.001	0.647

[a,b,c]Within a row, means lacking a common superscript letter differ ($P < 0.05$)

Proportionally to live weight, gizzard weight and ileum length were increased with 'Lupin 58' diet compared to 'Soybean meal' and 'Lupin 30' diets (3.208 *vs* 2.478% - $P < 0.001$ and 0.075 *vs* 0.069% - $P < 0.05$, respectively), and probably reflected the high fibre content of lupin seeds. Chyme viscosity in the small intestine increased with 'Lupin 58' diet compared to 'Soybean meal' diet (duodenum: 3.7 *vs* 3.1 cp – $P < 0.001$; jejunum/ileum: 5.4 *vs* 3.9 cp – $P < 0.05$), probably due to the high soluble fibre (mainly pectines) content of lupin seeds. No effect of enzyme preparation was observed on performances, nutrient digestibility or chyme viscosity and could reflect the presence of other antinutritional factors in lupin for broilers (such as galactanase, Steenfeldt et al. 2003) or the inefficiency of the enzyme supplementation, which could be due to the high polymerisation level of lupin non starch polysaccharides (Annison et al., 1996). Fat and protein contents in chicken legs did not differ amongst treatments but $C_{16:0}$ and $C_{16:1}$ contents were lower for lupin based diets (table 4), which reflects the fatty acid pattern of lupin seeds compared to soya. Differences in meat composition were small but chicken were killed to a low live weight (760 to 870 g) and had not yet deposit a lot of fat.

Table 4. Water, crude protein and fat contents and fatty acid pattern (% total fatty acids) of leg meat according to treatments

	Soybean meal diet		Lupin 30 diet		Lupin 58 diet		*P*	*P*
Enzyme	-	+	-	+	-	+	Diet	Enzyme
Water	69.20	69.16	69.85	69.03	68.88	69.05	0.720	0.630
Crude protein	16.53	16.43	16.31	16.27	15.68	16.22	0.370	0.676
Fat	13.18	13.07	12.77	13.63	14.09	13.73	0.554	0.837
C12:0	0.74	0.57	0.66	0.65	1.17	0.98	0.451	0.435
C14:0	0.21	0.26	0.60	0.29	0.26	0.29	0.348	0.567
C16:0	18.58^{a}	18.70^{a}	15.57^{b}	15.81^{b}	14.96^{b}	14.52^{b}	0.001	0.726
C16:1 cis	2.17^{ab}	2.94^{a}	1.41^{b}	1.65^{b}	1.53^{b}	1.18^{b}	0.001	0.023
C18:0	7.74	6.26	8.85	7.20	8.03	9.14	0.256	0.325
C18:1 t9	0.03	0.05	0.03	0.02	0.02	1.50	0.157	0.165
C18:1 cis9	28.28	30.40	31.07	30.29	30.68	32.18	0.219	0.770
C18:2 c9c12	38.48	37.14	37.31	39.15	38.23	35.77	0.244	0.694
C18:2 c9t11	0.05	0.03	0.01	0.05	0.03	0.14	0.529	0.314
C18:3 c9c12c15	3.71	3.64	4.48	4.89	4.68	4.31	0.108	0.991

^{a,b}Within a row, means lacking a common superscript letter differ ($P < 0.05$)

It was concluded that the enzyme preparation was not efficient to improve lupin valorization by broiler chicken and that lupin seeds could not replace all soybean meal in their feeding. Results suggested that an incorporation level of 30% of lupin seeds in diets is maximal to maintain growth performances of broiler chicken. Other enzymes or enzymes more specific to lupin fibres should be investigated in the future.

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References

Annison G., Hughes R.J., Choct M. (1996). Effects of enzyme supplementation on the nutritive value of dehulled lupins. Br. Poult. Sci. 37: 157-172.

Kocher A., Choct M., Hughes R.J., Broz J. (2000). Effect of food enzymes on utilization of lupin carbohydrates by broilers. British Poultry Science 41: 75-82.

Steenfeldt S., González E., Bach Knudsen K.E. (2003). Effects of inclusion with blue lupins (Lupinus angustifolius) in broiler diets and enzyme supplementation on performance, digestibility and dietary AME content. Anim. Feed Sci. Tech. 110: 185-200.