The effect of lectins in combination with sodium butyrate on the performance of broilers

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We tested the effect of 7,5% kidney beans (KB) containing lectins and/or 250g/T sodium butyrate (SB) in broiler diets on average daily growth (ADG) and average daily feed intake (ADFI). The trial consisted of five treatments each with two repetitions of 36 animals (Ross 308 ; male) : a control diet (C), KB in the starter diet (1-10 days) or in the grower diet (11-21 days) with or without SB in starter and grower diet (KBS or KBS-SB and KBG or KBG-SB). ADG and FC were determined at 21 and 42 days of age. All birds received feed (meal) and water ad libitum. Results were analysed by ANOVA (Tukey HSD ; P<0,05). At 21 days of age body weight (BW21) was reduced in the groups containing lectins from 685g (C) to 648g for KBS and 590g for KBG. BW21 was 663g and 637g for groups KBS-SB and KBG-SB respectively. At 42 days of age, the body weight of C was 2544g and 2440g and 2405g for KBS and KBG respectively. BW42 for KBS-SB and KBG-SB was 2513g and 2460g. The ADFI for the whole trial period of 42 days was reduced for the KBG group when compared to the C group (88,2g for C and 83,2g for KBG), while feed conversion did not differ between both groups. The incorporation of KB thus clearly reduced growth of broilers leading to a final body weight that was 4% lower for KBS and 5% for KBG compared to the C group. This negative effect of KB on growth could be reduced when SB was incorporated in the starter and grower diet at 250g/T. Final body weight of KBS-SB was only 1% lower than in C as compared to the growth reduction of 4% in KBS. The growth reduction of 5% in KBG was reduced to only 3% in KBG-SB. Reduced growth in diets with KB is probably due to a damage in the intestinal wall caused by the lectins. This stress effect could be counteracted by the use of sodium butyrate.

Key words : lectin ; butyrate ; broiler ; growth

Introduction

Increased knowledge on nutrient composition of raw materials enables us to better adapt feeds to the animal's requirement. However, the negative effect of anti nutritional factors (ANF) on digestion and animal performance is still more difficult to quantify (CVB rapport). ANF that have been identified are mainly present in cereals (xylans, arabinoxylans, glucans, phytic acid) and protein sources like soya, rapeseed, peas and beans (protease inhibitors, phytic acid, tannins, lectins). Different techniques are available to reduce the effect of these ANF like i) the use of enzymes to destroy the complex carbohydrates in cereals and against phytanic acid (phytase) ii) selection of breeds with low ANF content (e.g. rapeseed) or iii) processing to inactivate the ANF (e.g. heat treatment and enzymatic treatment of soya beans). While the use of carbohydrases and phytase is nowadays widespread, the use of processed protein sources remains limited to starter diets because of the higher price of these ingredients. ANF like protease inhibitors and lectins in soybean and alternatives like peas and beans thus still exert their negative effect on performance. Both protease inhibitors and lectins disturb enzymatic digestion in the gut.

Moreover, lectins bind to surface receptors of the intestinal epithelium leading to disruption of the brush border and interference with the digestion and absorption of nutrients (Huisman and Jansman, 1991).

Butyric acid is an excellent source of energy for the intestinal epithelium and stimulates cell proliferation and growth of the villi (Janssens and Nollet, 2002). It thus helps to maintain the integrity of the intestinal wall at periods of stress like weaning of piglets. The positive effect of butyrate on animal performance has been demonstrated for piglets, layers and broilers (Leeson et al., 2005). Due to its positive effect on cell proliferation and on the growth of the villi, butyrate might reduce the negative effect of lectins on the epithelium and enhance tissue repair.

In this study we included 7,5% raw kidney beans in diets of broilers and evaluated the effect on growth and feed intake. Butyric acid was added to these diets to test if this could reduce the negative effect of the kidney beans on the performance of the broilers.

Materials and methods

A four phase feeding strategy was applied including at starter (S ; 0-10 days of age), grower (G ; 11-21 days of age) and finisher feed (F ; 22-42 days of age). The composition and nutrient values of the different feeds are listed in table 1.

The trial consisted of five treatments each with two repetitions of 36 animals (Ross 308 ; male) : a control diet (C), KB in the starter diet (1-10 days) or in the grower diet (11-21 days) with or without sodium butyrate (SB ; 250ppm Adimix CP 85% sodium butyrate, Nutri Ad Belgium) in starter and grower diet (KBS or KBS-SB and KBG or KBG-SB). The starter diets contained 500ppm Cycostat 6.6% and the grower phase contained 500ppm Sacox 12%. No growth promoter was used. The kidney beans contained 38,2 mg lectin per gram which resulted in 2,87 g lectin/kg feed when 7,5% kidney beans were included in the diet.

The animals were housed on floor pens with an available surface of 2.1 m². The floor was covered with a mixture of straw and peat. Central water heating and infrared bulbs (1 per pen) provided optimal house temperature during the entire period. There was dynamic ventilation with lateral air entrance (at both sides) and air extraction centrally at the top of the building. The ventilation rate depended on the measured temperature and age of the broilers thereby keeping the temperature as close as possible to the optimal temperature schedule and minimizing the moisture, NH3 and CO2-content of the inside air. Mean environmental temperature was 30°C during the first 3 days. From the third day onwards ambient temperature was set at 28 °C to decrease with 1 degree every 3 days until a temperature of 21 °C was reached at day 21. The 21 °C was maintained until the last day of the trial. Daily mortality and culling were recorded for each pen. Feed and water were provided ad libitum by feed mangers, which sizes appropriate to the size of the animals. The lighting program was L/D = 23L:1D during the entire period. The animals were vaccinated against ND at day 1 (Hitchner,spray) and 16 (La Sota Clone 30, drinking water) and against IB at day 1 (H120, spray). Feed intake and body weight were followed per pen at day 10, 21 and 42. At 26 days of age all the birds were weighed individually.

Results were analyzed with Statistica ANOVA with the Tukey HSD test (for unequal sample sizes). Significance is considered when $P < 0.05$ unless otherwise mentioned.
(Statgraphics version 6.1, 1992; Snedecor and Cochran, 1989).

Table 1 : The composition and nutrient values of the different feeds

	CS	KBS	CG	KBG	F
			%		
Wheat	56	50	57	51	62
Full fat soybean HT	11	7	17	18	12
Soja 45	25	25	17	14	18
Fat	5	6	6	6	6
Bicaphosphate 18/25	1,2	1,2	0,7	0,6	0,5
Limestone white	0,8	0,9	0,7	0,7	0,7
Salt fine dry	0,2	0,2	0,2	0,2	0,2
Sodiumbicar sol.	0,2	0,2	0,2	0,2	0,2
L-lysine	0,3	0,3	0,3	0,3	0,3
DL-Methionin	0,3	0,3	0,3	0,3	0,2
L-threonine	0,1	0,2	0,1	0,1	0,1
Kidney beans		7,5		7,5	
Premix	0,5	0,5	0,5	0,5	0,5
			g/kg		
Dry matter	886	892	899	887	886
Crude protein	218	215	207	204	193
Crude ash	58	58	50	50	55
Fat	83	86	103	105	99
Starch	343	343	348	348	391
Crude fibres	36	37	35	36	44
Ca	8,6	8,6	6,7	6,7	6,1
Av. P	4,5	4,5	3,5	3,5	3,2
Ca / Av.P	1,9	1,9	1,9	1,9	1,9
Dig lysine poultry	11,8	11,8	11,0	11,0	10,3
Dig met+cyst/dig lys	0,73	0,73	0,73	0,73	0,73
Dig thr/dig lys	0,65	0,65	0,65	0,65	0,65
Dig try/dig lys	0,2	0,19	0,20	0,19	0,20
OEn broiler (kcal)	2868	2868	3023	3023	3023
OEn broiler (MJ)	12,00	12,00	12,65	12,65	12,65

Results and discussion

The average body weight of the birds at arrival was 38,50 ± 0,51g which illustrates their high quality and uniformity. Body weight and feed intake were registered per pen on day 10, 21 and 42. Since the experiment was designed to study the effect of kidney beans on the health status of the birds with individual registrations (data not shown), we had only 2 pens per treatment. The results are listed in table 2 (no statistical analysis).

The effect of the inclusion of 7,5% KB in the diet becomes clear at 21 days of age when the body weight of the Control group is 685g. Compared to C, growth (average daily gain (ADG) ; Figure 1) was reduced with 7% in KBS and with 16% in KBG. The effect of KB is thus bigger when they are included in the grower phase. The negative effect on growth could be reduced by the inclusion of 250ppm SB in the diet : ADG was reduced with only 2% in KBS-SB and with 13% in KBG-SB. At 26 days of age, body weight of group KBG was significantly ($p<0,05$) lower than of group C. There was however no significant difference between body weight of group C and body weight of group KBG-SB or KBS. For the latter groups body weight was 96% of the body weight of group C (925g vs 963g for group C).

Growth was still reduced in the finisher phase in the groups KBS (3%) and KBG (2%) when compared with group C. ADG of group KBS-SB was equal to ADG of group C in this period while growth in group KBG-SB was even 2% higher.

Table 2 : Growth, feed intake and feed conversion (registration per pen)

		C	KBS	KBG	KBS-SB	KBG-SB
0-10 days of age						
Body weight at day 10	g	197	194	182	183	215
Average daily gain	g/d	15,8	15,5	14,4	14,5	17,6
Average daily intake	g/d	23,6	22,2	22,1	20,1	23,2
Feed conversion		1,49	1,43	1,53	1,39	1,32
11-21 days of age						
Body weight at day 21	g	685	648	590	663	637
Average daily gain	g/d	44,4	41,2	37,1	43,7	38,4
Average daily intake	g/d	67,6	71,8	60,2	64,1	62,7
Feed conversion		1,52	1,74	1,62	1,47	1,63
22-42 days of age						
Body weight at day 42	g	2544	2440	2405	2513	2460
Average daily gain	g/d	88,6	85,3	86,4	88,1	89,9
Average daily intake	g/d	147,3	145,7	141,6	146,9	143,0
Feed conversion		1,66	1,71	1,64	1,67	1,65
0-42 days of age						
Body weight at day 42	g	2544	2440	2405	2513	2460
Average daily gain	g/d	59,7	57,2	56,4	59,0	57,7
Average daily intake	g/d	88,2	94,0	83,2	88,2	86,8
Feed conversion		1,48	1,64	1,48	1,49	1,50

For the whole trial period ADG and feed conversion (FC) of the control group was 59,7g/d and 1,48 respectively which is very good. ADG of KBS was 4% lower than ADG of the group C but this difference almost totally disappeared when also SB was added to the feed during the starter and grower phase (KBS-SB). Feeding KB during the grower phase (KBG) reduced ADG for the 42-day period with 5% (56,4g/d vs 59,7g/d for group C). This growth reduction could only partially be reduced with SB : the ADG of KBG-SB for the entire period was 57,7g/d or 3% lower than in group C. Since there were only two pens per treatment no strong conclusions can be made on FC. The only clear difference with the control group is the higher FC of group KBS from 11 to 42 days of age and for the whole trial period.

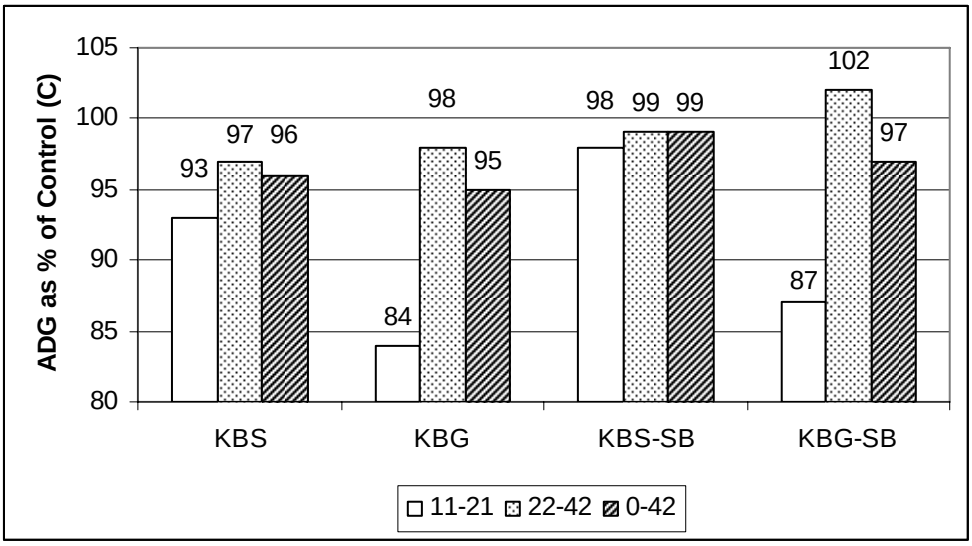

Figure 1 : Average daily gain (ADG) as a percentage of the control group (C) for the grower (11-21 days of age) and finisher (22-42 days of age) and for the whole trial period (0-42 days of age).

These results clearly illustrate the negative effect of the inclusion of kidney beans in broiler diets on growth and feed conversion. Arija et al. (2006) also observed reduced growth and feed intake when raw kidney beans were administered from 0 to 21 days of age. Huisman et al. (1990) did not observe a significant effect on feed intake when kidney beans were fed at 200g/kg feed. However, growth was also reduced and feed conversion increased. We observed different effects when kidney beans were fed during starter or grower phase. Feeding 7,5% of kidney beans during the starter phase (KBS) resulted in 7% growth reduction during the starter phase and 3% growth reduction during the finisher phase. However, for the whole trial, feed intake of the groups KBS and KBS-SB was not different from the control group but feed conversion was highest for the group KBS. This could be due to binding of the lectins in kidney beans to the glycocalix which can lead to severe damage to the brush border of the gut that is maturing in this period (Huisman and Jansman, 1991). The high feed conversion of group KBS suggests that the damage that lectins can bring to the intestinal wall in this phase of development could lead to permanent lesions resulting in decreased digestive capacity of the gut. When 250ppm SB was included in the starter and grower feed (KBS-SB) growth reduction compared to group C was limited to only 2%. This suggests that SB increases the capacity of the intestinal epithelium to recover from the damage to the glycocalix caused by the lectins. When the animals were individually weighed at 26 days of age, average body weight of group C and KBS-SB were equal, showing that the animals that received SB completely recovered from the stress in the starter phase.

Table 3 : Body weight at 26 days of age (individual weights)

		C	KBS	KBG	KBS-SB	KBG-SB
Body weight	g	963	924	850	969	926
Standard deviation	g	90	60	89	92	92
Significance		a	ab	b	a	a
% of the Control group		100	96	88	101	96

The growth reduction was most pronounced when the kidney beans were fed during the grower phase (11-21 days of age ; KBG and KBG-SB). Feed conversion was similar to group C but feed intake was lower during the grower and finisher phase. Feeding KB in the grower phase thus reduced the normal exponential increase in feed intake leading to reduced growth up to the end of the fattening. Including SB in starter and grower diet also reduced the effect of KB in the grower phase. The animals recovered sooner from the negative effect of lectins leading to an ADG in the finisher period in group KBG-SB that was as high as in group C while growth was still retarded in that period in group KBG. However, unlike for group KBS-SB, the negative effect of KB on growth could not fully be compensated in group KBG-SB as ADG for the whole trial period was still 3% lower than in group C.

We can conclude that KB have a clear suppressive effect on feed intake and growth that is greater in the grower than in the starter phase. Due to the addition of SB in starter and grower feeds, feed intake and growth could be restored up to the level of the control group if KB were only used in the starter phase. When KB were used in the grower phase fifty percent of growth reduction could be compensated by the use of SB.

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