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Original article

Effect of in feed talc supplementation on broiler performance

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Abstract – Four experiments were performed to study the effects of the addition of 1 or 2% of talc to the diets of broiler chickens compared to an unsupplemented diet and a control diet containing 5 ppm of avilamycin. Both additives improved bird performance, weight gain (W.G.) and feed conversion ratio (F.C.R.) especially when poor performances were observed for the unsupplemented control group. Overall, when all the experiments were computed together, avilamycin significantly improved bird performance (W.G. and F.C.R.) compared to the unsupplemented diet. The effect of talc was positive but lower than avilamycin. No dose effect was observed with talc. Intestinal microflora, tested in the excreta, was decreased by avilamycin but no effect was observed with talc.

additives / talc / avilamycin / broiler performance / intestinal microflora

Résumé – **Effet du talc dans l'aliment sur les performances du poulet de chair.** Quatre expérimentations ont été réalisées pour étudier les effets du talc incorporé à 1 ou 2% dans l'alimentation de poulets de chair en croissance en comparaison avec un témoin non supplémenté et un témoin positif contenant 5 ppm d'avilamycine. Les deux additifs ont montré un effet bénéfique sur les performances des poulets, le gain de poids (G.P.) et l'indice de consommation (I.C.) surtout dans les essais où les performances des animaux témoins étaient moins bonnes. Globalement, en regroupant tous les essais, l'avilamycine a amélioré significativement les performances (G.P. et I.C.) par rapport au témoin non supplémenté. Le talc a eu un effet bénéfique, inférieur à celui de l'avilamycine. Aucun effet dose n'a été observé pour le talc. La microflore intestinale testée dans les excréta était diminuée par l'avilamycine mais le talc était sans effets.

additifs / talc / avilamycine / performances du poulet / microflore intestinale

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1. INTRODUCTION

The progressive suppression in poultry diets of growth factors such as antibiotics, suspected to induce some resistance in human bacterial strains [7], has motivated the research of new alternatives but also an emerging interest for substances already known but not yet extensively used as feed additives for poultry, especially for their zootechnical properties.

Talc, a hydrated magnesium silicate, is a mineral belonging to the class of Phyllosilicates such as bentonite, kaolinite or sepiolite. These substances are mainly used in the feed industry for their technological properties that are different from one type to another according to their composition [2, 19]. Talc has been approved as a technological additive in the animal feed industry under the European code E560. Its composition is thus defined as a natural mixture of steatite and chlorite with a minimum purity of 85% and free of asbestos [12].

The advantages of Phyllosilicates as zootechnical additives in animal feed are well documented and improvements of weight gain or of feed consumption ratio have been observed for broilers in some experiments [4, 11, 19]. Nevertheless, these effects are highly variable according to the type of product or experimental conditions. Concerning the use of talc, some experiments were performed but relatively few studies have been published. Talc is named Stealim® in referenced studies. In 1973 and 1976, Ferrando [5, 6] noted that, on the contrary to what occurred with some other Phyllosilicates, adding 3 to 6% of talc to the diet of rats, previously deprived of vitamin A, did not affect its absorption but improved its hepatic storage. In 1974, Bourdillon [1] observed that adding 3% of talc to the diet did not affect the performance of pigs and that, as previously observed by Ferrando with rats, vitamin A absorption was maintained and its hepatic storage improved. In 1975, Tournut et al. [18] observed a significant decrease of ulceration by adding talc to the diet of pigs with gastro-oesophageal ulcers experimentally induced by overcrowding and finely milled feed. In 1977, Ladrat [8] observed that the iron atoms present in talc were not used by calves (unchanged hematocrit level) and that, when diluted up to 1.18% in the diet, talc addition did not affect the feed conversion ratio. In 1978, Tournut [17] reported a positive effect of talc on the intestinal flora of rabbits experimentally exposed to mucoid enteritis with, as a consequence, a significantly increased weight gain. In 1994, Lebas et al. [9] observed that adding 2% of talc in the diet of rabbits did not affect their performance, even if the energy value of the feed was reduced by 2%.

As only few data were published on the effect of talc on poultry performance, we studied the effects of this mineral in four experiments involving broilers fed diets containing two additional levels of Luzenac talc or a growth promoter.

2. MATERIALS AND METHODS

2.1. Animals and experimental design

Four experiments were performed over a 3-year period in two experimental facilities in France according to similar experimental protocols (Tab. I). One-day-old male broiler chickens (Ross PM3) were weighed the day of arrival (D0) and randomly allocated to floor pens (3 m^2) littered with wood shavings (one pen for each treatment group). The birds were reared together during the starter period in order to allow a better and more homogenous bacterial contamination of their digestive tract. At the end of the starter period, the birds were weighed and allocated to individual cages for the growing period. Birds with extreme weights (lowest and highest) were discarded in order to maintain, during the growing period in each treatment group, the same mean weight value as the one measured at the end of the starter period.

Table I. Experimental design of the four experiments performed in two locations.

Exp	Location	Diet[1]		Experimental groups				Feeding periods	
			Birds[2]	control	Avila.	Talc 1%	Talc 2%	Starter[3]	Grower[4]
1	SRA	Std.	36	+	+	+	+	D0–D11	D12–D20
2	SRA	Std.	36	+	+	+	+	D0–D11	D12–D25
3	Magneraud	Std.	48	+	+	+	–	D0–D10	D11–D24
		L.C.	48	+	+	+	–	D0–D10	D11–D24
4	Magneraud	Std.	48	+	+	+	–	D0–D13	D14–D28
		L.C.	48	+	+	+	–	D0–D13	D14–D28

[1] Std. = standard diet, L.C. = low calorie diet.
[2] Number of birds per experimental group; Avila.: Avilamycin.
[3] 1 pen per treatment.
[4] 36 or 48 cages per treatment.

2.2. Experimental diets

The birds were fed either standard diets (Std.) (Exps. 1–4) or low calorie diets (L.C.) in which nutrient contents were reduced by approximately 5% (Exps. 3, 4). Moreover, in these latter diets, high levels of water soluble non-starch polysaccharides were introduced by viscous wheat (Rialto variety). Palm oil of poor digestibility [10] was also added instead of rapeseed oil. The composition of the diets is presented in Table II.

In experiments 1 and 2, the birds were fed the standard diet and two diets containing respectively 1% and 2% of Luzenac talc (Stealim®). These three diets were compared to a diet containing 5 ppm of avilamycin (Maxus G200). In experiments 3 and 4, only the dose of 1% of talc was used. Talc was substituted by the same amount of cellulose (not assimilated by the birds) in order to maintain the same characteristics without any dilution due to talc addition for all the treatment groups. All the diets were pelleted (∅ 2.5 mm).

2.3. Measurements

The chickens were weighed individually at D0, at the end of the starter period and at the end of the experiment. The weight gains (W.G.) were calculated for each animal and each experimental period. The feed was weighed at D0 and at the end of each experimental period. The Feed Conversion Ratio (F.C.R.) was calculated for each animal during the growing period (Feed Consumption/Weight Gain).

Bacteriological studies were performed in experiments 1, 2 and 3. For each treatment group, excreta were collected and analysed individually for 20 animals (Exps. 1, 2) or for 4 pools of 10 animals (Exp. 3). They were stored at –80 °C pending bacterial numerations. Viable bacteria were counted [3] after successive 1/10 dilution in 0.5% NaCl. Lactobacilli, coliform and total aerobic bacteria were counted using MRS agar, Drigalski agar and BHI agar growth culture media respectively. The media were incubated aerobically at 37 °C for 24 h (Drigalski agar) or 48 h (MRS and BHI agar). The results are expressed as the Log of Colony Forming Units (CFU) per g of faeces.

2.4. Statistics

Data were computed using Statview 5® software. Significant differences between treatment group means were determined by analysis of variance and the means were separated using the Fisher test ($P \leq 0.05$). When the experiments were tested together,

Table II. Composition (%) and calculated nutritional values of the diets.

	Experiments 1, 2		Experiment 3				Experiment 4			
	Standard diet		Standard diet		Low calorie diet		Standard diet		Low calorie diet	
	Starter	Grower	Starter	Grower	Starter	Grower	Starter	Grower	Starter	Grower
Corn	45.64	32.76	46.64	33.76	7.2		53.07	55.1	10.28	5.08
DL-Methionine	0.14	0.06	0.14	0.06	0.13	0.08	0.17	0.13	0.17	0.14
Lysine HCl		0.14		0.14	0.01		0.13	0.01	0.16	
Threonine									0.03	
Standard wheat	3.5	25	3.5	25						
Viscous wheat					50	62.5			50	57
Soybean meal	37.3	25.7	37.3	25.7	33.7	28.2	35.1	31.84	30.24	28.9
Corn gluten meal	1	5.55	1	5.55		1	1	2.92		
Rapeseed oil	6	5	6	5			6	6		
Palm oil					3.9	3.7			4.83	5.16
Calcium carbonate	1.4	1.15	1.4	1.15	1.5	1.2	0.8	0.49	1	0.7
Dicalcium phosphate	2.02	1.64	2.02	1.64	1.57	1.25	1.92	1.7	1.47	1.2
NaCl	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.3
Vitamins and minerals[1]	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Cellulose	2	2	1	1	1	1	1	1	1	1
Diclazuril (Clinacox)	0.05	0.05	0.05	0.05	0.05	0.05	0.02	0.02	0.02	0.02
Calculated nutritional values										
Metabolisable energy (kcal per kg)	3050	3100	3094	3141	2940	2983	3081	3140	2940	2980
Crude protein (%)	22.0	20.6	22.3	20.9	21.2	19.9	21.2	20.9	20.3	19.9
Lysine (%)	1.20	1.05	1.21	1.06	1.15	1.01	1.21	1.06	1.15	1.00
Methionine + cystine (%)	0.85	0.80	0.87	0.84	0.82	0.76	0.86	0.82	0.82	0.79
Calcium (%)	1.10	0.90	1.11	0.91	1.06	0.86	1.10	0.91	1.05	0.86
Available P (%)	0.42	0.38	0.42	0.38	0.40	0.36	0.42	0.38	0.40	0.36

[1] Premix composition *Vitamins* (*for 100 g of diet*): A (retinyl acetate) 1000 IU, D3 (cholecalciferol) 200 IU, E (DL-α-tocopherol acetate) 3 mg, B1 (thiamine mononitrate) 0.15 mg, K3 (M.N.B. or M.P.B. form) 0.2 mg, B2 (riboflavin) 0.4 mg, B6 (pyridoxine chlorhydrate) 0.25 mg, B12 (cyanocobalamine) 0.0015 mg, calcium Pantothenate 1 mg, Folic acid 0.04 mg, Biotin 0.02 mg, Choline 50 mg, PP (nicotinic acid or amide, niacin) 3 mg. *Minerals* (*mg for 100 g of diet*): Co (Carbonate) 0.06, Cu (Sulphate) 2.5, Fe (Sulphate) 5, I (calcium Iodate) 0.1, Mn (Oxide) 8.5, Se (sodium selenite) 0.025, Zn (Sulphate) 6. *Others*: B.H.T 12.5 mg for 100 g of diet.

Table III. Effect of talc 1% and avilamycin 5 ppm on the performance of broilers fed the standard diet: total weight gain (W.G.) and feed conversion ratio (F.C.R.) of grower period. Mean values ± standard error in the four experiments (1–4).

	W.G.			F.C.R.		
Exp.	Control	Avila.	Talc 1%	Control	Avila.	Talc 1%
1	616 ± 15^b	692 ± 9^a	665 ± 9^a	1.73 ± 0.03	1.60 ± 0.01	1.67 ± 0.03
2	1018 ± 12^b	1057 ± 14^a	1024 ± 15^{ab}	1.65 ± 0.01^c	1.57 ± 0.01^a	1.61 ± 0.01^b
3	1021 ± 12^b	1086 ± 11^a	1015 ± 10^b	1.38 ± 0.01^b	1.36 ± 0.01^a	1.38 ± 0.01^b
4	1433 ± 15	1423 ± 6	1433 ± 15	1.50 ± 0.01	1.49 ± 0.01	1.50 ± 0.01
Mean	1054 ± 24^b	1094 ± 21^a	1060 ± 3^b	1.54 ± 0.01^b	1.51 ± 0.01^a	1.52 ± 0.01^a
ANOVA[1]						
Additive		***			***	
Experiment		***			***	
Interaction		**			NS (P = 0.058)	

[1] P value: *, $P < 0.05$; **, $P < 0.01$; ***, $P < 0.001$; NS, Not significant.
[a, b, c] Means in the same line with no common subscripts differ significantly ($P < 0.05$).
Avila.: Avilamycin.

the experiment number was used as a second independent variable in order to take into account all the differences between experiments (location, diet, duration of rearing periods). When comparing experiments 3 and 4, the effect of diet (Standard or low calorie) was also tested to compare the potential interaction between the diet and additive effect.

3. RESULTS

3.1. Effect of avilamycin

In birds fed the standard diet, W.G. or F.C.R. was significantly improved by the antibiotic (Tab. III). The overall mean response of chickens was +3.8% for W.G. and –1.9% for F.C.R. The responses varied among the four experiments from –0.7 (Exp. 4) to +12.3% (Exp. 1) for W.G. and from –0.9 (Exp. 4) to –7.5% (Exp. 1) for F.C.R.

3.2. Effect of talc

3.2.1. Dose effect

The incorporation of 1 or 2% of talc was compared in experiments 1 and 2. No difference was observed between the two doses for the mean W.G. (talc 1%, 829 ± 24 g; talc 2%, 827 ± 22 g) or F.C.R. (talc 1%, 1.64 ± 0.02; talc 2%, 1.65 ± 0.02).

3.2.2. Effect of 1% talc

When the results of birds fed standard diets were pooled (Tab. III), the effect of 1% talc appeared intermediate between the control and avilamycin treatment. For W.G., the effect was low (+0.6%) and not significantly different from the unsupplemented control group but, for F.C.R., it was significantly different (–1.3%) and similar to avilamycin. When comparing the effect in the different experiments, the range was, for W.G., –0.6 to +7.8% in experiments 3 and 1 respectively and, for F.C.R., +0.3 to –3.5% in experiments 4 and 1 respectively. The highest improvements were observed in experiments 1 and 2.

3.3. Effect of low calorie diet

By comparison with the standard diet, the low calorie diet in experiments 3 and 4 (Tab. IV) significantly reduced bird performance (by 3% for W.G. and 13% for

Table IV. Effect of a low calorie diet on the efficacy of 1% talc and 5 ppm avilamycin on bird performance (Exps. 3, 4, total period); mean values ± standard error of 72 birds per experimental group.

Additive	W.G.		F.C.R.	
	Std.	L.C.	Std.	L.C.
Control (no additive)	1232 ± 23[b]	1188 ± 19[b]	1.44 ± 0.01[b]	1.63 ± 0.02[b]
Avilamycin 5 ppm.	1257 ± 20[a]	1216 ± 20[a]	1.42 ± 0.01[a]	1.58 ± 0.02[a]
Talc 1%	1222 ± 24[b]	1193 ± 19[b]	1.44 ± 0.01[b]	1.62 ± 0.02[b]
ANOVA[1]				
Additive effect	**		***	
Experiment effect	***		***	
Diet effect	***		***	
Interaction diet × additive	NS		NS ($P = 0.052$)	
Interaction exp.× additive	NS		NS	

Std. = standard diet, L.C. = low calorie diet.
[1] P value : *, $P < 0.05$; **, $P < 0.01$; ***, $P < 0.001$; NS, Not significant.
[a, b, c] Means in the same column with no common subscripts differ significantly ($P < 0.05$).

Table V. Numeration of coliforms, lactobacilli and total aero-tolerant bacteria in the excreta of broilers (mean values ± standard error) collected in experiments 1, 2 (40 birds per treatment group) and 3 (8 pools of 10 birds per treatment group).

Additive	bacterial counts (Log. C.F.U. per g)		
	coliforms	lactobacilli	total aerobic
Control (no additive)	4.41 ± 0.17	8.35 ± 0.19[a]	7.46 ± 0.28
Avilamycin 5 ppm	4.12 ± 0.21	7.60 ± 0.23[b]	6.91 ± 0.28
Talc 1%	4.50 ± 0.18	8.27 ± 0.29[a]	7.21 ± 0.25
ANOVA[1]			
Additive effect	***	*	NS
Experiment effect	***	***	***
Interaction	*	NS	NS

[1] P value: *, $P < 0.05$; **, $P < 0.01$; ***, $P < 0.001$; NS, Not significant.
[a, b] Means in the same column with no common subscripts differ significantly ($P < 0.05$).

F.C.R.). No significant interaction was observed between diet and additive effect, nevertheless, the interaction was close to the significance level ($P = 0.052$) for F.C.R. Even if it was not significant, the mean effects of talc were higher in the low calorie (+0.4% for W.G. and –1% for F.C.R.) compared to the standard diet (–0.1% for W.G. and no effect for F.C.R.). The effect of the low calorie diet was also similar with avilamycin for F.C.R. (–3% with low calorie compared to –1% with the standard diet) but not for W.G. (+2% with both low calorie and standard diets).

3.4. Bacterial counts

Bacterial counts (Tab. V) were significantly different between the experiments. A decrease of all the bacterial populations tested was observed with avilamycin but it was significant only for lactobacilli. No difference was observed with talc supplemented feed compared to the control group.

4. DISCUSSION

Differences were clearly observed between the experiments regarding the effect of talc and avilamycin on bird performance. In their review, Thomke and Elwiger [14] noted an overall response of broiler chickens to different antibiotic growth promoters in comparison with the unsupplemented control diet that may be calculated to be, on average, +3.9 for W.G and –2.9% for F.C.R. with values ranging respectively from –0.8 to +10.2% and from –0.9 to –5.5%. The effects observed in the present experiments for avilamycin were in the same range, thus confirming that they were representative of what might be observed in field conditions. It was also noted [14] that the promoters, especially antibiotics, were more effective when used in diseased rather than in healthy birds and that the expected response level for performance should be lower for animals in production systems with high standards of hygiene. In the present experiments, the interaction between experiment and additives was almost significant ($P = 0.058$) and a clear tendency was observed for a higher effect of the additives in birds with low performance. Thus, the higher improvement was observed with avilamycin and talc supplemented diets in experiments 1 and 2 presenting the lower performances while, on the contrary, the lower effect was observed in experiment 4 presenting the higher performances of the unsupplemented control group. This was confirmed by the higher improvement observed with both additives in the low calorie diet compared to the standard diet, also with a clear tendency for F.C.R (interaction diet-additive, $P = 0.052$).

Even though the efficacy and mode of action of antibiotic growth promoters is now well documented [14, 15], the effect of the different additives recently developed as alternatives is a more controversial subject. The improvement of performance, when observed, is generally lower than with antibiotics, inconstant and rarely significant, even with well known and widely used additives such as probiotics [13, 16]. In the present experiments, except for experiment 4 in which performances were high and with no effect of avilamycin, a beneficial effect of talc was observed on W.G. and F.C.R. Even if this effect was only statistically significant in two of the four experiments, when standard diets of all the experiments were computed together, the beneficial effect was significant on F.C.R. compared to the negative control group and similar to avilamycin. This was in accordance with the beneficial effects observed with clay minerals, sometimes up to 5% on W.G. and F.C.R [4, 11, 19] or with talc that showed beneficial effects on health [17, 18] or no detrimental effects on performance [1, 5, 6, 8, 9].

As reported in the literature [15], avilamycin, known to be active on gram-positive bacteria, decreased bacterial populations. No effect on microflora was observed with talc and the improvement of performances could not be explained by a modification of the level of the bacterial populations tested. As for the other phyllosilicates used in the feed industry, more work will be necessary to explain how talc improves feed efficiency. With clay minerals, it has been suggested that adsorbent aptitudes increase nutriment absorption by lowering the time of feed intestinal transit; also, a protective effect on intestinal mucosa may act on the improvement of feed efficiency but these potentialities depend on the type and physical properties of the additive and have rarely completely explained the effects observed [4, 11, 19].

In conclusion, positive effects were observed with the incorporation of 1% of talc in the diet, especially on F.C.R. As for avilamycin, the improvements of broiler performance were variable from one experiment to another. Even when the positive effects of avilamycin were low, talc never significantly reduced bird performance. When an improvement was observed with talc, it was lower than that observed with avilamycin. In two of the four experiments, when the effects of avilamycin were high, talc significantly improved W.G. or F.C.R.

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