Avian Pathology (1997) **26**, 83–95

Evaluation of combined antibiotic and competitive exclusion treatment in broiler breeder flocks infected with *Salmonella enterica* serovar Enteritidis

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SUMMARY

Strategic medication in breeding flocks of domestic fowl (*Gallus gallus*), using antimicrobial treatment followed by competitive exclusion, was evaluated in 13 trials between February and September 1993. In each trial, the flock had been confirmed as naturally infected with *Salmonella enterica* serovar Enteritidis and the effect of treatment was determined on salmonella isolation from tissues. Of 11 trials where enrofloxacin was used, a long-term reduction of salmonella was observed in two and a short-term reduction was measured in birds from another five trials. *Salmonella* Enteritidis was isolated from birds after treatment in four other trials with enrofloxacin and in two trials of medication with amoxycillin. After treatment with enrofloxacin significant reductions were found in the prevalence of *S.* Enteritidis in tissues from birds, and in levels and prevalence of salmonellas in their environment. No salmonella was identified in statutory meconium samples taken from the hatched chicks derived from the flocks after treatment.

The programme of antibiotic treatment and competitive exclusion offers an alternative to slaughter, but the approach must be part of a co-ordinated programme which will effect a decrease in the prevalence of *S.* Enteritidis over time by contemporary use of disease security measures. The risk of development of antimicrobial resistance is also discussed.

INTRODUCTION

There has been little published work to suggest whether a benefit could be derived from antimicrobial treatment of salmonella-infected breeding flocks. Harmonized rules for control of salmonella in breeding flocks are laid down in Annex III of Council Directive 92/117/EEC of the European Union. These rules stipulate that flocks found on investigation to be infected with *Salmonella*

Received 22 March 1996; Accepted 5 June 1996.

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0307-9457/97/010083-13

Enteritidis and *Salmonella* Typhimurium must normally be slaughtered unless provisions are made for suitable alternatives, such as antimicrobial therapy, for infected flocks or progeny. However, there is little data available on the benefits of alternative measures. Antimicrobial therapy may exacerbate the contamination rate in a treated flock. Certain antimicrobials disturb the ecological balance in the alimentary tract of animals and so favour the growth of and shedding of enterobacteria, particularly salmonella. The results of the many different experiments are often contradictory (Matthes, 1985) because of the different protocols that were used. Paradoxically, the use of antimicrobials may reduce or eliminate salmonella, but the effect on the normal intestinal microbiota may make them more susceptible to recontamination. Thus, Mead (1989) combined antimicrobial therapy followed by administration of intestinal flora to reduce the level of salmonella infection in chickens and turkeys.

In the Netherlands, 32 flocks treated with enrofloxacin, followed by the application of intestinal microflora were examined after completion of the programme and salmonella were re-isolated from the faeces of only four flocks (Edel, 1994; Goren, 1993). However, the samples examined did not include organs such as the ovary, which would be of value to assess the procedure for reduction of vertical transmission. Another promising development is the use of enrofloxacin treatment of salmonella-infected breeding stock and egg injection to produce salmonella-free eggs during the treatment period. These eggs can then be hatched in a clean environment and the resulting chicks used to establish salmonella-free breeding flocks (Köhler & Pöppel, 1994).

The trials described in this report were carried out in breeding flocks to determine if a treatment programme of antimicrobial therapy coupled with competitive exclusion would have beneficial effects with regard to re-infection and survival of salmonella in the environment.

MATERIAL AND METHODS

Selection of flocks for treatment trial

Owners of 13 broiler breeder flocks of domestic fowl in which *S.* Enteritidis had been detected during statutory monitoring of meconium at the hatchery or by private ELISA tests carried out by the poultry company, were invited to participate in a trial of treatment programmes of antimicrobial therapy and competitive exclusion (CE) product.

Treatment programme

The treatment programmes selected for 13 trials are shown in Table 1. Enrofloxacin (Baytril: Bayer, Bury St Edmunds, Suffolk, UK) was used in trials 1 to 11, at a dose rate of 10 mg/kg live weight, administered in drinking water for 5 or 10 consecutive days. Amoxycillin (Amoxypen SP: Mycofarm UK Ltd, Cambridge, UK) was used in trials 12 and 13 at the dose rate of 20 mg/kg in

drinking water for 5 or 10 consecutive days. The treatment period varied for financial reasons. Flock owners were required to finance treatment for their flocks, although a 10-day course was viewed as the most desirable. In trial 12 amoxycillin was combined with trimethoprim/sulphadiazine (Synutrim: Peter Hand Animal Health, Stanmore, Middlesex, UK) at a dose of 30 mg/kg.

The age of the birds ranged from 26 to 69 weeks on the first day of medication (Day 1) and flock size ranged from 3930 to 10,170 birds (mean 6083 birds, SD 2387). They were housed in separate buildings on a total of nine holdings (Table 2).

CE products were administered in drinking water, starting at least 24 h after medication ended and were given as two doses separated by an interval of 48 h. The CE products used were Broilact (Orion Corporation Farmos, Turku, Finland) in seven trials and Aviguard (Microbial Developments Ltd, Malvern, Worcester, UK) in six trials.

Tests for salmonella

Birds

The presence and prevalence of *S.* Enteritidis in the birds were confirmed before treatment began by removing a random sample of 59 birds and culturing tissues removed from them post-mortem. The number of birds examined was that required to provide a 95% chance of detecting one infected bird if infection was present in 5% or more of the birds in the flock.

Second and third samples, each of up to 59 birds, were examined for salmonella approximately 2 and 8 weeks after treatment began in 13/13 and 10/13 trials, respectively. This was to evaluate the effect of the programme on the presence of salmonellas in the caeca, and in a combined culture from liver and gonad. The actual sampling day for each trial is shown in Table 1. Birds were examined individually on 31 occasions, while on five occasions pooled tissues from batches of up to five birds were examined. The tissues were inoculated onto Brilliant Green agar (BGA: CM329 Oxoid, Basingstoke, UK) before and after enrichment in Selenite broth (Oxoid CM699) for 18 h at 37°C. All salmonella isolates were confirmed serologically at the Central Veterinary Laboratory. Salmonella isolates were also tested for susceptibility to a standard range of antibiotics including fluoroquinolones (Wray *et al.*, 1991).

Environment

Dust and litter from the environment of the poultry building were examined quantitatively for salmonella by a most probable number technique (MPN) in 11 of the 13 trials. A detailed audit was conducted in four trials, in the course of which swabs were taken from 84 locations which included beams, floor, feeders, drinkers and nest boxes. Samples were examined by enrichment in semi-solid

Table 1. *Details of birds, treatment programme and sampling in 13 trials*

	Birds			Action (days[a])				
Trial no.	No. in flock	Age (weeks)	No. sampled	Sample pretreatment	Antibiotic	CEP	Sample post-treatment 1	Sample post-treatment 2
1	4700	46	58	−1	1–5[c]	B8, 10, 11	14	NT
2[f]	4160	26	59	−1[b]	1–10[c]	B13, 15	16	65
3[f]	3930	59	59	−1[b]	1–10[c]	B13, 15	16	65
4[f]	4170	26	59	−1[b]	1–6[c]	B8, 10	16	65
5	6910	51	59	−1	1–10[c]	B12, 14	15	57
6	10,110	69	59	−2	1–5[c]	A7, 10	13	97
7	10,170	69	59	−2	1–5[c]	A7, 10	13	97
8[f]	4240	47	58	−1	1–10[c]	A12, 14	17	99
9[f]	3910	47	58	−1	1–10[c]	A12, 14	17	99
10[f]	8550	37	59	−1	1–10[c]	B12, 14	15	56
11	4680	51	59	−1	1–5[c]	B7, 9	14	57
12	8950	40	59	−2	1–5[de]	A9, 11	13	NT
13	4600	48	59	−43[b]	1–10[e]	A11, 13	14	NT
Mean	6083	45	NA	NA	NA	NA	15	76
SD	2387	13.6	NA	NA	NA	NA	1.4	18.5

[a] Day 1 was the first day of medication.
[b] Tissues batched in pools from up to five birds.
[c] Enrofloxacin (Baytril) 10 mg/kg in drinking water.
[d] Antimicrobial treatment: trimethoprim/sulphadiazine (Synutrim) 30 mg/kg in drinking water.
[e] Antimicrobial treatment: amoxycillin (Amoxypen SP) 20 mg/kg in drinking water.
[f] Trial based on evidence of seroconversion.
Competitive exclusion product (CE): A = Aviguard; B = Broilact; NA = not applicable; NT = not tested.

Table 2. *The percentage prevalence of S. Enteritidis: positive birds before and after treatment with antibiotics and CE products*

Trial details			% Prevalence of *Samonella* Enteritidis in tissues			% Prevalence of seropositive birds (*Salmonella* Enteritidis ELISA)		
No.	Holding building (1st No. = farm) (2nd No. = shed)	Medication	Sample pretreatment	Sample post-treatment 1	Sample post-treatment 2	Sample pretreatment	Sample post-treatment 1	Sample post-treatment 2
1	1	5 days[c]/CE	36.0	3.4	NT	NT	NT	NT
2	2–1	10 days[c]/CE	3.6	< 1.7	3.4	3.4	11.9	23.7
3	2–2	10 days[c]/CE	25.0	< 1.7	13.6	16.9	15.2	35.6
4	2–3	5 days[c]/CE	1.7	< 1.7	< 1.7	25.4	11.9	47.5
5	3–1	10 days[c]/CE	39.0	1.7	8.5	NT	NT	NT
6	4–1	5 days[c]/CE(A)	18.6	< 1.7	< 1.7	NT	NT	NT
7	4–2	5 days[c]/CE(A)	13.6	< 1.7	5.1	NT	NT	NT
8	5–1	10 days[c]/CE(A)	10.3	1.7	5.2	6.9	< 1.7	24.1
9	5–2	10 days[c]/CE(A)	31.0	< 1.7	6.9	8.6	< 1.7	22.4
10	6–1	10 days[c]/CE	37.3	< 1.7	3.4	37.3	37.3	46.6
11	7–1	5 days[c]/CE	13.6	6.8	8.5	62.7	84.7	76.3
12	8–1	5 days[d,e]/CE(A)	35.6	25.4	NT	NT	NT	NT
13	9–1	10 days[c]/CE(A)	1.7	5.7	NT	NT	NT	NT

For key, see Table 1.

Rappaport's medium (Lab150, LabM, Bury, UK), and plating on Rambach agar (7500 Merck, Poole, Dorset, UK; Davies & Wray, 1994).

ELISA testing

This was carried out on the same birds that were taken for post-mortem culture and used an LPS ELISA as described in Nicholas & Cullen (1991).

Monitoring of meconium from treated flocks

Meconium was taken and tested every 2 weeks for the remainder of the life of the flock according to regulations laid down in the Poultry Flocks and Hatcheries (Registration and Testing) Order 1993.

Statistical analysis

The Sign test was used to determine whether the measurements of salmonella increased from one occasion to another. The number of trials with an increase was compared to the number with a decrease (Table 4). The magnitude and significance of these individual changes are ignored. Where the individual changes could be assessed a Chi-square test was used, allowing for pooling of samples where appropriate.

RESULTS

Salmonellas were found in all 13 trials before treatment began, estimates of prevalence of *S.* Enteritidis (including O-rough: gm variants) in tissues of birds before and after treatment with antimicrobial and competitive exclusion are shown in Table 2. There was wide variation in rates of infection estimated before (prevalence from 1.7 to 39.0%) and after treatment (from <1.7 to 25.4%).

Salmonella Enteritidis was not isolated in 7/11 trials (prevalence estimate $<1.7\%$) from tissues of birds in the first post-treatment samples after treatment with enrofloxacin (Table 2). In each of the remaining four trials using enrofloxacin there was a reduction in the individual bird prevalence of *S.* Enteritidis. In the second post-treatment samples, *Salmonella* Enteritidis was isolated from 8/10 flocks at post-mortem.

In the two trials using amoxycillin, *S.* Enteritidis was isolated from birds examined in the first post-treatment samples taken 13 days after treatment ceased. In the absence of any significant reduction in salmonella in tissues, the two trials were concluded and a third sample was not taken.

Salmonella Enteritidis was found in the environment, including litter from 11/11 and of dust from 8/11 houses before birds were treated (Table 3) with the MPN estimates ranging from 3.6 to 1.1×10^5 organisms/100 g. Salmonellas were also found in 36.9 to 78.6% of individual environmental swabs where these were

Table 3. *The presence and numbers of* S. *Enteritidis in the environment of birds before and after their treatment with antibiotics and CE products*

		Sample pretreatment						
		Litter		Dust		Environmental audit		
Trial	Holding building	*Salm.* +/−	MPN	*Salm.* +/−	MPN	No. of samples	No. +	%
2	2–1	+	$>1.1\times10^3$	−	IS	NT	NT	NT
3	2–2	+	9.3	+	IS	NT	NT	NT
4	2–3	+	IS	+	IS	NT	NT	NT
5	3–1	+	2.8×10^4	+	7.5×10^3	84	66	78.6
6	4–1	+	9.1	−	4.6×10^2	NT	NT	NT
7	4–2	+	3.6	+	5.5×10^4	NT	NT	NT
8	5–1	+	3.6	−	<13.6	NT	NT	NT
9	5–2	+	24.0	+	9.5	NT	NT	NT
10	6–1	+	1.4×10^4	+	2.8×10^4	84	48	57.7
11	7–1	+	46.4	+	4.1×10^4	84	31	36.9
12	8–1	+	1.1×10^5	+	25.0	84	41	48.8
		Sample post-treatment (1)						
		Litter		Dust		Environmental audit		
		Salm. +/−	MPN	*Salm.* +/−	MPN	No. of samples	No. +	%
2	2–1	−	<3.0	−	<1.0/g	NT	NT	NT
3	2–2	−	<3.0	−	<1.0/g	NT	NT	NT
4	2–3	−	<3.0	−	<1.0/g	NT	NT	NT
5	3–1	+	0.9	+	0.7	84	2	2.4
6	4–1	−	<3.0	+	240.0	NT	NT	NT
7	4–2	−	<3.0	+	210.0	NT	NT	NT
8	5–1	−	<3.0	−	<3.0	NT	NT	NT
9	5–2	−	<3.0	+	23.0	NT	NT	NT
10	6–1	−	<3.0	−	<3.0	84	3	3.6
11	7–1	+	71.6	+	8.9	84	15	17.8
12	8–1	+	40.6	+	$>6.9\times10^3$	84	31	36.9
		Sample post-treatment (2)						
		Litter		Dust		Environmental audit		
		Salm. +/−	MPN	*Salm.* +/−	MPN	No. of samples	No. +	%
2	2–1	−	<3.0	−	<50.0	NT	NT	NT
3	2–2	−	<3.0	−	<17.1	NT	NT	NT
4	2–3	+	3.6	−	<9.7	NT	NT	NT
5	3–1	+	9.0	−	<3.0	84	15	17.8
6	4–1	−	<3.0	+	43.0	NT	NT	NT
7	4–2	−	<3.0	+	4.6×10^2	NT	NT	NT
8	5–1	−	<3.0	+	7.8	NT	NT	NT
9	5–2	−	<3.0	+	3.1	NT	NT	NT
10	6–1	NT	NT	NT	NT	NT	NT	NT
11	7–1	−	<3.0	+	74.7	84	16	19.0
12	8–1	NT	NT	NT	NT	NT	NT	NT

MPN in organisms/100 g sample; IS = insufficient sample; NT = not tested; + = *Salmonella* Enteritidis isolated; − = *Salmonella* Enteritidis not isolated.

Table 4. *Summary of changes in* S. *Enteritidis isolation*

Sampling regime		Number of trials			Significance
Sample type	Period	Increasing	Unchanging	Decreasing	*P* value
Tissues	0:1	1 (0)[a]	0	12 (11)	0.002 (0.001)
	0:2	0	0	10	0.001
	1:2	8	2	0	0.004
Litter	0:1	1	0	9 (8)	0.011 (0.02)
	0:2	0	0	8	0.004
	1:2	2	6	1	0.05
Dust	0:1	2 (1)	1	5	0.22 (0.11)
	0:2	0	1	5	0.03
	1:2	3	4	2	0.5 (0.001)
Environment swabs	0:1	0	0	4 (3)	0.06 (0.13)
	0:2	0	0	2	0.25 (0.001)
	1:2	2	0	0	0.25 (0.001)

Period 0 = sample pretreatment; 1 = first sample post-treatment; 2 = second sample post-treatment.
[a]Numbers in brackets are the number from among the 11 enrofloxacin trials where they differ from the number among all 13 trials. (Where total numbers are less than 13 this is because of missing information.)

taken. In the second sample, following treatment, salmonella was found in the litter from 3/11 trials and dust from 6/11 with MPN estimates from 0.7 to $>6.9\times10^3$ organisms/100 g and 3.6 to 36.9% of swabs contained salmonella. The third sample, following treatment, from the environment tested positive in litter and dust from 2/9 and 5/9 trials, respectively. Individual environmental swabs were tested in trials 5 and 11, with 17.8 and 19% yielding salmonella.

Changes in salmonella isolation rates (proportion of samples positive) measured during trials, for bird tissues and for environment, are summarized in Table 4. Low P values imply a statistically significant difference between the number of trials with an increase in isolation rate and the number with a decrease, looking across all the trials. Significantly more trials showed a reduction than showed an increase in frequency of isolation of salmonella from tissues from the first to the second examination and this was also true from the first to the third examination. From the second to the third, more trials showed an increase in frequency of salmonella isolation. Within the trials, changes in isolation rate were not always significant, but in all cases where they were (12 of the 33 tissue comparisons and five of the seven environmental comparisons possible, both at $P<0.05$ and $P<0.01$), the direction of the change was the same as that observed across all the trials.

No salmonellas were found in statutory meconium samples taken at the hatchery during the remaining life of any of the treated flocks.

All *S.* Enteritidis strains were fully sensitive to the range of antibiotics tested including those products used for treatment in this trial.

The ELISA results were somewhat inconsistent but overall showed a

continuing increase in the prevalence of seropositive birds after treatment (Table 2).

DISCUSSION

The study investigated the effect of antimicrobial therapy coupled to use of CE on salmonella infected birds. Significant reduction of *S.* Enteritidis isolates from tissues was achieved in samples taken 2 weeks after treatment with enrofloxacin, but by 8 weeks post-treatment the prevalence of infection in birds had increased in most of the flocks tested indicating a short-term effect. Similar findings were made in environmental samples where there was an initial reduction in the prevalence and level of *S.* Enteritidis, but which increased at the second sampling period. Despite this the trials were successful in that no further *S.* Enteritidis isolates were reported during regular hatchery monitoring of samples of meconium from the chick output of the treated flocks. It is likely, therefore, that a significant reduction in vertical transmission of *S.* enteritidis was achieved by this intervention. An additional benefit was a long-term reduction in environmental salmonella contamination in poultry houses where the birds had been treated with enrofloxacin which led to very low levels of salmonella in buildings at depletion (R. H. Davies, unpublished data). This suggests that the cleansing and disinfection programme for such buildings is more likely to be successful because of the reduced numbers of salmonellas for disinfection.

The minimal inhibitory concentration (MIC) of fluoroquinolone antibiotics for salmonella is low and high therapeutic concentrations are achieved in serum, tissues and faeces after oral administration (Goosens *et al.*, 1985). Fluoroquinolone excretion in man persists several days after cessation of therapy thereby effectively prolonging the duration of antibacterial activity. It is likely that the effective intestinal clearance of salmonellas, the low MIC and long-term persistence of a high level of enrofloxacin in the faeces of treated birds (Pequet *et al.*, 1990), plus a possible continued activity in the litter may have been responsible for the environmental effect. A similar effect was not seen following the use of amoxycillin to which the *S.* Enteritidis strains were fully sensitive.

The use of competitive exclusion bacterial cultures by themselves has been shown to be highly effective in reducing intestinal colonization of chicks by *Salmonella* spp. (Stavric *et al.*, 1992; Fowler & Mead, 1990; Nurmi & Rantala, 1973). The products used in our trials were an attempt to re-colonize the intestine with commensal bacteria and leave birds less susceptible to re-infection with salmonella from the environment. It is not known what the effect of the antibiotic treatment alone would have been, but enrofloxacin treatment in wild mice (*Mus musculus domesticus*) dramatically increases the duration and prevalence of *S.* Enteritidis carriage (R. H. Davies, unpublished data).

In man, fluoroquinolone antibiotics such as ciprofloxacin have been shown to be highly effective for the treatment of life-threatening bacteraemia, including multiresistant strains of *S. typhi* and *S. paratyphi* (Cheeseborough *et al.*, 1991; Rowe *et al.*, 1991, 1992; Asperilla *et al.*, 1990). Ciprofloxacin is also used for

treatment of outbreaks of salmonellosis in institutions because it can shorten the carriage period (Asperilla *et al.*, 1990; Lightfoot *et al.*, 1990; Neu, 1990), although in some cases excretion resumed after cessation of therapy (Picher *et al.*, 1987).

In Great Britain, fluoroquinolone resistance has been detected in salmonellas (McIntyre & Lyons, 1993; Wray *et al.*, 1990) albeit at a low prevalence. Likewise resistance to enrofloxacin has been described in Campylobacters following medical and veterinary use (McIntyre & Lyons, 1993; Reina, 1992; Endtz *et al.*, 1991; Rautelin *et al.*, 1991). Although resistance to fluoroquinolones is chromosomally mediated, mutation can occur very rapidly within a few days of the start of treatment (Anon, 1992; Howard *et al.*, 1990). Because of the therapeutic importance of the fluoroquinolone group it is desirable that its medical and veterinary use is considered carefully, and that the antimicrobial resistance is continuously monitored, as in England and Wales, by the appropriate reference laboratory.

Treatment of infected flocks with antibiotics followed by competitive exclusion could offer an alternative to slaughter in countries where prevalence of *S.* Enteritidis infections is so great as to make slaughter prohibitively expensive. This approach must, however, be part of a co-ordinated programme involving disease security measures which will effect a decrease in prevalence of *S.* Enteritidis over time on the animal units, and in the breeding pyramid as a whole. The approach is applicable for parent birds to restore a supply of broiler chicks with reduced vertical transmission of *S.* Enteritidis.

ACKNOWLEDGEMENTS

This study was undertaken by the Ministry of Agriculture, Fisheries and Food. The authors would like to thank flock owners and veterinarians for their support and assistance in the work, also colleagues in the State Veterinary Service who conducted post-mortem examinations and culture of birds, and scientific staff at CVL Mrs S. Bedford, Mrs K. McIntosh and Mr I. McLaren for bacteriology and technical support.

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RÉSUMÉ

Evaluation d'un traitement associé: antibiotique et flore de barrière, dans les troupeaux de poulets de chair infectés par *Salmonella enteritica* serovar Enteritidis

Le traitement stratégique des troupeaux de reproducteurs de l'espèce *Gallus gallus*, utilisant l'administration d'un antibiotique suivi d'une flore de barrière, a été évalué au cours de 13

essais, entre Février et Septembre 1993. Dans chaque essai, l'infection naturelle du troupeau par *Salmonella enteritica* serovar Enteritidis a été confirmée et l'effet du traitement a été vérifié par l'isolement de Salmonelle dans les tissus. Sur 11 essais où l'enroflaxacine a été utilisée, la réduction de l'isolement de salmonelle a été observée durant une longue période dans deux essais et durant une courte période dans 5 autres essais. *S.* Enteritidis a été isolée à partir d'oiseaux après traitements à l'enrofloxacine dans 4 essais et à l'amoxycilline dans 2 essais. Après traitement à l'enrofloxacine des réductions significatives de la prévalence de *S.* Enteritidis dans les tissus d'oiseaux ont été observées ainsi que de la prévalence des Salmonelles de l'environnement. Aucune Salmonelle n'a été identifiée dans les échantillons de méconium prélevé, selon la réglementation, chez les poussins issus des troupeaux après traitement.

Le programme comprenant un traitement antibiotique et l'administration d'une flore de barrière offre une alternative à l'abattage, mais cette approche doit être une partie d'un programme coordonné qui entraînera une diminution de la prévalence de *S.* Enteritidis, en appliquant durant cette période des mesures de sécurité sanitaire. Le risque du développement de résistance antimicrobienne est aussi discuté.

ZUSAMMENFASSUNG

Beurteilung der kombinierten Behandlung mit Antibiotika und kompetitiver Exklusion bei mit *Salmonella enterica*, Serovar Enteritidis infizierten Mast-Elterntierherden

Die strategische Medikation in Zuchtherden des Haushuhnes (*Gallus gallus*) durch antimikrobielle Behandlung, gefolgt von kompetitiver Exklusion wurde in 13 Versuchen zwischen Februar und September 1993 untersucht. Bei jedem Versuch war bestätigt worden, daß die Herde mit *Salmonella enterica*, Serovar Enteritidis natürlich infiziert war, und der Effekt der Behandlung wurde an Hand der Salmonellen-Isolierung aus Geweben ermittelt. Bei 11 Versuchen mit Enrofloxacin wurde eine langfristige Salmonellen-Reduzierung in zwei Versuchen festgestellt, und eine kurzfristige Reduzierung wurde in weiteren fünf Versuchen gemessen. In vier anderen Versuchen wurde *S.* Enteritidis nach Behandlung mit Enrofloxacin aus den Tieren isoliert und in zwei Medikations-Versuchen mit Amoxicillin. Nach der Behandlung mit Enrofloxacin wurden signifikante Reduzierungen bei der Prävalenz von *S.* Enteritidis in Geweben von Hühnern und bei den Konzentrationen und der Prävalenz der Salmonellen in ihrer Umgebung festgestellt. In den gesetzlich vorgeschriebenen Mekonium-Proben von den geschlüpften Küken, die von den Herden nach der Behandlung stammten, wurden keine Salmonellen nachgewiesen.

Das Programm der Antibiotika-Behandlung und kompetitiven Exklusion bietet eine Alternative zur Schlachtung, aber das Verfahren muß Teil eines koordinierten Programms sein, das durch die gleichzeitige Anwendung von Krankheitsverhütungsmaßnahmen im Laufe der Zeit eine Verminderung der Prävalenz von S. Enteritidis bewirkt. Das Risiko der Entwicklung eine Antibiotika-Resistenz wird ebenfalls diskutiert.

RESUMEN

Evaluación del tratamiento combinado con antibióticos y exclusión competitiva en reproductoras broiler infectadas con *Salmonella enterica* serovar Enteritidis

Se estudió el método de tratamiento antibiótico seguido de exclusión competitiva en reproductores de gallina doméstica (*Gallus gallus*) empleando para ello 13 experimentos entre Febrero

y Septiembre de 1993. En cada ensayo el grupo de aves empleadas había sido infectado espontáneamente con *Salmonella enterica* serovar Enteritidis y se determinó el efecto del tratamiento en el aislamiento de salmonelas de los tejidos. De los 11 experimentos en los que se empleó enrofloxacina, se observó una reducción de larga duración de salmonelas en dos experimentos y una corta reducción fue observada en aves procedentes de otras cinco pruebas. Se aisló *Salmonella* Enteritidis tras el tratamiento en aves procedentes de otros cuatro ensayos con enrofloxacina y en dos pruebas de tratamiento con amoxicilina. Se observaron reducciones significativas en la prevalencia de *S.* Enteritidis tras el tratamiento con enrofloxacina en los tejidos de aves y en los niveles y prevalencia de salmonelas en el medio ambiente. No se observaron salmonelas en muestras de meconio de las aves eclosionadas procedentes de grupos de aves que habían sufrido un tratamiento.

El programa de tratamiento con antibióticos y exclusión competitiva ofrece una alternativa al sacrificio pero debe formar parte de un programa coordinado lo que producirá una disminución en la prevalencia de *S.* Enteritidis eventualmente mediante el empleo de medidas sanitarias. Se discute también el riesgo de desarrollo de resistencia microbiana.