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Citation	Japanese Journal of Veterinary Research, 12(3), 39-46
Issue Date	1964-09
DOI	https://doi.org/10.14943/jjvr.12.3.39
Doc URL	https://hdl.handle.net/2115/1795
Type	departmental bulletin paper
File Information	KJ00002369102.pdf



STUDIES ON STRONGYLOIDIASIS OF THE PEACOCK

I. THE ANTHELMINTIC ACTION OF PHENOTHIAZINE, KAMALA AND DITHIAZANINE IODIDE AGAINST PARASITES IN THE PEACOCK

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(Received for publication, April 23, 1964)

PREFACE

Although some works about the parasites of the peafowl have been reported up to the present, few reports on anthelmintic efficiency against parasites in the peafowl are found as far as the authors know.

The authors encountered a natural case of peacock harbored *Strongyloides* sp., *Heterakis* sp., *Capillaria* sp. and a cestode species. Three anthelmintics were tested against those parasites. The present paper deals with two problems; 1) the differences in efficiency among the anthelmintics and 2) the differences of the course of elimination among the parasites.

MATERIALS AND METHODS

The patient is a male green peacock (*Pavo muticus muticus* L.) which was imported into Japan from Hong Kong, and purchased by Maruyama Zoo on April 22, 1962. The bird's age and habitat is unknown, but he seems to be young and a native of Southeast Asia. On entering the Zoo, he weighed about 8 kg and suffered from diarrhoea and lack of appetite, which continued without interruption for about a week. Accordingly, the patient became much weakened and emaciated. Therefore, fecal examination was carried out, and the above-noted parasites were found.

Critical anthelmintic trials consisted of three experiments as follows.

In the 1st experiment, daily doses of 2.5 g of phenothiazine, a dose rate of about 0.3 g per kg, were given for two days, April 28 and 29, 1962. That is to say, a total dose of 5 g; a dose rate of 625 mg per kg.

In the 2nd experiment, a single 2 g dose of kamala was given on May 7, 1962.

Before the 3rd experiment, a critical test of dithiazanine iodide was carried out with

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a turkey for the determination of a dose rate.

In the 3rd experiment, daily doses of 150 and 100 mg of dithiazanine iodide, with dose rates of 19 and 12.5 mg per kg, were given on two days January 29 and 30, 1963.

To determine the efficiency of the drugs, clinical and fecal examinations were always carried out in the above experiments. Whole feces were examined daily for parasites both grossly and under the dissection microscope, and the numbers of parasites eliminated were recorded.

RESULTS

Experiment 1 (The efficiency of phenothiazine)

After entering the Zoo, the patient suffered from continuous diarrhoea and lack of appetite, and showed extreme weakness and emaciation. His feathers ruffled and lost their gloss. The crest wore off extremely. The bird was huddled up and was somnolent. The upper tail-covert was not yet developed. The feces were always paplike, and were of a greenish color and bad smell. Fecal examination showed many active rhabditiform larvae, which were considered to be identical with larvae of *Strongyloides* sp., and a few eggs of *Heterakis* sp., *Capillaria* sp. and cestode. Daily doses of 2.5 g of phenothiazine, a dose rate of about 0.3 g per kg, were given in the food for two days, April 28 and 29, 1962. After the treatment, the condition became somewhat better, and the appetite increased, but the diarrhoea did not stop. In the fecal examination on the 3rd day after treatment, May 1, 1962, many dead rhabditiform larvae, a few eggs of cestode and rare eggs of *Heterakis* sp. and *Capillaria* sp. were recognized.

Experiment 2 (The efficiency of kamala)

After treatment with phenothiazine, the condition and appetite became considerably better, but the number of larvae and eggs in the feces did not show a comparable decrease with the number before treatment. The bird was given a single dose of 2 g of kamala in capsule form on May 7, 1962.

On the next day after medication with kamala, the appetite was lost absolutely, and the bird became inactive. This condition continued for two days after medication. In the fecal examination, many dead larvae were recognized, but no cestode egg was found. On the 3rd day after medication, the appetite was recovered, and subsequently, the general state became gradually better. The gloss of the feathers appeared and increased day by day. But a decrease in the number of larvae of *Strongyloides* sp. in the feces was not noticed.

Toxicity test for the maximum dose of dithiazanine iodide against a turkey

For a critical test of dithiazanine iodide, a turkey was used, because the authors could not find data of the medical dose.

The turkey-hen used was a healthy two-year-old. Dithiazanine iodide, each dose 50 mg, was administered twice per day for two days, on January 23 and 24, 1963. Thus, the bird was given a total dose of 200 mg, but no alteration of the general state was recognized except a purplish coloring of the feces. On the next day, January 25, 1963, the turkey received additionally 250 mg of dithiazanine iodide. From the following day, January 26, the bird suffered from complete loss of appetite. The bird was found dead in the early morning of January 30. On autopsy, general congestion and haemorrhagic enteritis were recognized.

TABLE 1. Efficiency of Dithiazanine Iodide against Parasites in the Peacock

	NAME	BEFORE TREATMENT JAN. 28	AFTER TREATMENT					
			2nd day* (Jan. 30)	3rd day (Jan. 31)	4th day (Feb. 1)	5th day (Feb. 2)	8th day (Feb. 5)	10th day (Feb. 7)
Removed parasites**	<i>Strongyloides</i> sp.	0	0	60	78	58	3	0
	<i>Heterakis</i> sp.	0	1	122	11	0	0	0
	<i>Capillaria</i> sp.	0	0	10	4	1	1	0
***1)	Larvae of <i>Strongyloides</i> sp.	37	0	0	0	0	0	0
Voided eggs***2)	<i>Strongyloides</i> sp.	4	3	5	5	5	0	0
	<i>Heterakis</i> sp.	5	5	6	2	0	0	0
	<i>Capillaria</i> sp.	10	4	7	3	3	0	0

* The day of the 1st medication presupposes the 1st day.

** The number of parasites in the feces voided daily.

*** The number of larvae¹⁾ or eggs²⁾ in 0.025 cc of 5 cc precipitate which was made by refining 10 g of feces

The histological picture showed lung haemorrhage, and enteritis catarrhalis ulcerosa in the intestine. The bird weighed 3.5 kg in the postmortem.

Experiment 3 (The efficiency of dithiazanine iodide)

After the 2nd experiment, the condition became much better, and the appetite recovered considerably. As Table 1 shows, many eggs and larvae of *Strongyloides* sp. and some eggs of *Heterakis* sp. and *Capillaria* sp. were recognized in fecal examination before the 3rd experiment.

150 and 100 mg of dithiazanine iodide, with dose rates of 19 and 12.5 mg per kg, was given daily on January 29 and 30, 1963. On the day of the 2nd medication, January 30, the larvae of *Strongyloides* sp. disappeared completely. From that time, the number of eggs decreased gradually; the eggs of *Heterakis* sp. disappeared on the 5th day, and the eggs of *Capillaria* sp. and *Strongyloides* sp. on the 8th day.

Feces were examined daily for removed parasites. Ten specimens of *Capillaria* sp. were found on the 3rd day, decreasing gradually after that time, and the last one was found on the 8th day. One specimen of *Heterakis* sp. was found on the day of the 2nd medication, the number of removed parasites reached 122 on the next day, decreased to 11 on the 4th day, and disappeared afterwards. With *Strongyloides* sp., 60 parasites appeared on the day after the 2nd medication, the removed parasites reached a maximum 78 on the 4th day, and the number decreased slowly afterwards. Three *Strongyloides* parasites were still recognized on the 8th day, but no parasite was found after the 10th day. The fecal examination for parasites showed negative a month after medication.

DISCUSSION

The authors could not find any report of the three anthelmintics above-noted being administered to a peafowl. Therefore, an attempt was made to review the literature on the dosage of those anthelmintics in poultry. For phenothiazine, GIBSON (1960) quotes the following references in his book reviewing the literature up to 1960. MCCULLOCH and NICHOLSON (1940) carried out critical tests of phenothiazine for *Heterakis gallinae* on 12 naturally infected hens using doses of 0.05 g to 1 g per bird given either in the food or in a capsule. Except in two birds, which consumed only small amounts of the medicated food, efficiency for *Heterakis gallinae* was high—80% to 100%. Accordingly, it was concluded that a satisfactory individual dose for a chicken would be 0.05 g to 0.5 g. If the average weight of the hens used by MCCULLOCH and NICHOLSON is 2 kg, the dose rate of phenothiazine is 25 to 250 mg per kg. A total dose of 5 g of phenothiazine used by the present authors, a dose rate of 600 mg per kg, is considerably higher than their dose rate. On the other hand, ROBERTS (1940) carried out critical tests on nine birds which were infected slightly with *Heterakis gallinae*. A dose rate of 880 mg per kg removed 5 of the 17 worms, whilst a dose rate of 2,200 mg per kg removed all the worms from one bird and 33% from another. At this latter dose rate, division of

the dose into three portions given on three successive days removed 85.7% and 100% of the worms from two birds. Thus, his dose rates are remarkably higher than that used by the present authors. COLGLAZIER et al. (1960) carried out critical anthelmintic trials against *Heterakis gallinae* and *Ascaridia galli*. Phenothiazine, given in single doses of 0.5 g in hard gelatin capsules, with dose rates of 128 to 227 mg per kg, removed 39% (128) of 326 *Heterakis* from 6 chickens weighing from 2.2 to 3.9 kg, and 21% (4) of 19 *Ascaridia* from 2 chickens. One gram doses, with dose rate of 323 to 527 mg per kg, removed 94% (865) of 913 *Heterakis* from 5 birds weighing from 1.9 to 3.1 kg, and 24% (5) of 21 *Ascaridia* from 2 birds. Each of the 6 birds, weighing from 2.5 to 4.0 kg, was given feed containing 0.74% of the drug for 3 days, and consumed an average 3.2 g (2.34 to 4.44 g) of phenothiazine, a dose rate of 800 to 1,280 mg per kg. The chemical removed 86% (188) of 217 *Heterakis* and 29% (23) of 78 *Ascaridia*. Curiously, the aggregate efficacy against *Heterakis* was slightly lower than that obtained with single one gram doses, despite the large amount of phenothiazine per bird. The total dose of phenothiazine used by the present authors seems to be higher than COLGLAZIER et al's single dose rate, but is less than their total dose in feed. Because efficiency at the authors' dose rate was low when added to feed, the increase of dose rate is considered to be necessary for the elimination of *Heterakis* sp. in peafowl.

On the other hand, the drug appeared to be ineffective against *Capillaria* spp. in the experiment by COLGLAZIER et al. NICKEL (1953) considered the drug to be ineffective against this parasite. The authors also got a similar result. Phenothiazine appeared to be completely ineffective against tapeworm. After medication with phenothiazine, some of the larvae of *Strongyloides* sp. voided were dead. But no significant difference in the number of larvae before and after medication was recognized. Therefore, the drug is considered to be ineffective against *Strongyloides* sp.

Concerning the dose of kamala, HALL and SCHILLINGER (1926) stated that 1 g of kamala for chickens, and 2 g for turkeys, were satisfactory doses of the drug for the removal of tapeworms. This was further substantiated by the independent work of BEACH and WARREN (1926). BEBRASSIER (1932) discusses the various drugs in use against tapeworm in chickens. He administered powdered kamala—with under 5 per cent ash—in doses of 7.5, 10 and 15 grains to chickens and found that the last dose completely eliminated all the tapeworms in the three birds. In all other cases (of which 43 were positive), worms were found on autopsy. HAWN (1933) had experimental evidence that kamala in doses of 0.25 to 5 grains did not prove to be an efficient anthelmintic for the removal of tapeworms in turkeys weighing from 2.5 to 80 ounces.

In accordance with a review of the above references and from toxicity, the

satisfactory doses for removal of tapeworm are considered to be about 1 g for chickens and 2 g for turkeys. If the weight of each chicken and turkey is 2 to 5 kg and 8 to 15 kg, the dose rates for chicken and turkey are 0.2 to 0.5 g per kg and 0.13 to 0.25 g per kg, respectively. The dose rate administered by the authors is similar to that for turkeys. There is suggestive evidence that kamala is effective against tapeworms, because the eggs of tapeworms in feces disappeared after medication. However, it was considered to be toxic, as the appetite was lost absolutely after medication with kamala. HAWN (1933) reported that, of the 63 young turkeys treated, 33 died a few hours after treatment. Accordingly, it seems that young birds like the peacock used in this experiment are sensitive to the toxicity of kamala. Therefore, care should be taken in administering kamala to birds. Reports on medication with dithiazanine iodide for birds are rare, there being only one by FRIEDHOFF (1963) as far as the authors are aware. FRIEDHOFF carried out critical test on two pigeons infected with *Capillaria obsignata*. Notwithstanding the fact that a total dose of 350 mg per bird was administered six times, dithiazanine iodide was ineffective. A total of 450 mg of dithiazanine iodide, in doses of 50 mg twice per day for two days and 250 mg on the next day, was given to the turkey in the preliminary test, and the bird died on the following day. In accordance with the result of the test, there is no doubt that a daily dose of 100 mg for two days is the maximum dose for turkeys, and a total dose of 450 mg, 125 mg per kg, is considered to be a lethal dose. Satisfactory efficiency was recognized for a total dose of 250 mg, 21.5 mg per kg, in the peacock. The results obtained by the authors differ from those in FRIEDHOFF's report in which a dose of 350 mg per pigeon was ineffective against *Capillaria*. The present authors are not able to explain how such differing results were obtained. It seems to be an interesting finding that the numbers of voided eggs and removed parasites in feces before and after medication with dithiazanine iodide showed a different course of elimination according to the species of parasite. This is considered to be presumptive evidence that decay of the egg-producing faculty or extinction of adult *Strongyloides* is caused by medication with the drug. Many adults of *Strongyloides* sp. were eliminated suddenly on the 3rd day, the number of removed parasites reach a peak on the 4th day, and, roughly speaking, the number of parasites on the 3rd, 4th and 5th day was equal. This result is considered to be suggestive evidence that the efficiency of medication twice for two days appeared after 48 hours. On the other hand, almost all of the *Heterakis* sp. thought to be harbored in the bird were eliminated on the 3rd day. The course of elimination of *Capillaria* sp. is similar to that of *Heterakis* sp., but the former takes longer, the parasites disappearing completely from the feces on the 10th day. From the above-mentioned facts it is conjectured that each parasite shows different sensibility to anthelmintics

according to the species. Furthermore, the authors feel it is necessary that the anthelmintic course should be observed in accordance with the species of parasites. Ultimately, the eggs and parasites disappeared from all feces voided after the 10th day. This result is considered to be evidence of the remarkable efficiency of dithiazanine iodide.

Reports on the anthelmintic examination for strongyloidiasis in birds are rare, and there is only one report by FREITAS and ALMEIDA (1936) as far as the authors know. They stated that gentian violet gave promising results against *Strongyloides oswaldoi* in the domestic fowl. The present authors cannot discuss the details of their data, for they have not been able to see FREITAS and ALMEIDA's original description. But, because of the prominent efficiency of dithiazanine iodide against *Strongyloides stercoralis* in humans, the drug is also considered to be more efficacious against *Strongyloides* spp. in birds than gentian violet. The morphology of parasitic adult females, which were eliminated from this peacock with the drug and were obtained from the chicken and Indian peafowl (*Pavo cristatus cristatus* L.) infected artificially, and the worms in the free-living stage of *Strongyloides* sp. were reported at the General Meeting of the Japanese Society of Parasitology (1963). The results of the parasitological study of the parasite will be reported in this journal in the near future.

SUMMARY

1. Infection of a green peacock, imported into Maruyama Zoo, with *Strongyloides* sp., *Heterakis* sp., *Capillaria* sp. and cestode was recognized, and critical anthelmintic trials were made with the bird to ascertain the efficiency of three drugs against those parasites.

2. By serial medication of phenothiazine for two days, dead larvae of *Strongyloides* sp. were found, but other efficiency was not recognized.

3. By the administration of 2 g of kamala, almost all cestodes were eliminated, and dead larvae of *Strongyloides* sp. were found, but lack of appetite appeared as a collateral effect.

4. A turkey treated with a total dose of 450 mg of dithiazanine iodide for three days died because of the toxicity.

5. Daily doses of 100 and 150 mg of dithiazanine iodide were administered serially for two days, and *Strongyloides* sp., *Heterakis* sp. and *Capillaria* sp. were eliminated completely.

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