

## A comparative study on the mineral composition of the poultry cestode *Raillietina tetragona* Molin, 1858 and certain tissues of its host

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MS received 5 March 1981 ; revised 26 December 1981

**Abstract.** The amounts of cations Ca, P, Na, K, Cu and Zn in *Raillietina tetragona* (Cestoda) and in liver, intestinal tissues and blood serum of its host (*Gallus gallus domesticus*) were determined using spectrophotometry, titrimetry, flame photometry and atomic absorption spectrophotometry. Quantitative variations were observed in the distribution of these minerals in the immature, mature and gravid regions of the worm, on dry weight basis. There was a gradual decrease in Ca content of worm along the antero-posterior axis. The Na content, on the other hand showed a reverse trend with the greatest amount in the gravid proglottids. The immature region contained the highest levels of P, K and Cu. The worms showed significantly higher levels of Ca, P, Cu and Zn than the liver and intestinal tissues on dry weight basis. *R. tetragona*, like host liver and intestinal tissues (but unlike blood serum), had quantitative excess of K over Na and other cations.

**Keywords.** Mineral composition ; poultry cestode ; *Raillietina tetragona* ; host tissues.

### 1. Introduction

Most of the earlier studies on the biochemistry of cestodes have dealt extensively with their organic constituents, especially the carbohydrates, lipids and proteins. More recently several attempts have been made to identify and quantify the inorganic contents of tapeworms (Salisbury and Anderson 1939 ; Wardle and McLeod 1952 ; Goodchild *et al* 1962 ; Nadakal *et al* 1975 ; Singh *et al* 1978 ; Jakutowicz and Korpaczewska 1979). The data available so far are largely concerned with the larval cestodes and so little is known about the inorganic composition of the adult cestodes. Hence a study was designed to throw some light on the mineral composition of a cosmopolitan poultry cestode, *Raillietina tetragona* and certain tissues of its host, by way of comparison.

### 2. Materials and methods

Day-old white leghorn chicks were procured and maintained in the laboratory on a basal diet adequate in all nutrients. When three weeks old, 20 healthy birds

of uniform weight were selected. 25 cysticercoids of *Raillietina tetragona* recovered from naturally infected ant vectors (Nadakal *et al* 1971) were administered *per os* to each of the 20 birds. Three weeks post-infection, blood was collected from the wing veins for obtaining serum and then the birds were autopsied. The intestines were split and the worms carefully recovered. The liver, intestines and the worms were washed thoroughly in distilled water and blotted dry with low ash filter paper. 100 worms were pooled and each worm was cut into immature, mature and gravid regions. 40 worms were set apart and sampled as whole worms. The tissue samples were immediately processed for biochemical estimations of ionic Na, K, Ca, P, Cu and Zn. For estimations of Ca and P, 5 samples of each tissue were taken. Each sample was divided into 2 weighed portions. One part was extracted with 10% trichloro-acetic acid for Ca and P determinations and the other part was used for determining percentage of dry matter. For Na, K, Cu and Zn estimations 5 samples from the pooled tissues were dried at 80-100°C. Measured quantities of these dried tissues and serum were ashed separately and extracted with concentrated nitric acid and diluted with glass distilled water, the diluted extracts being used for the estimation of Na, K, Cu and Zn.

Ionic Ca and P were determined following the methods of Clark and Collip (1925) and Fiske and Subba Row (1925) respectively. Na and K were estimated using a flame photometer (Elico Pvt. Ltd., CL 22A), while Cu and Zn were determined using an atomic absorption spectrophotometry (Unicam, SP 1900).

The data obtained for the different regions of the worm were statistically analysed using student's *t* test for the probability of significance of difference between means. The data for the whole worms were compared with those for the host liver and in-testinal tissues and blood serum. *P* values at 5% level are considered to represent significant differences.

### 3. Results

Quantitative findings for percentages of Ca, P, Na, K, Cu and Zn in the three different regions of the worm are shown in table 1 and those in the whole worms and in the host tissues and blood serum are presented in table 2.

There was a gradual decrease in the Ca content of the worm along the antero-posterior axis. The Ca content of whole worms was 2.64 times and 7.9 times greater than those in liver and intestine, respectively. The immature region contained the greatest amount of phosphorus. The phosphorus content in whole worms was 1.27 times and 2.53 times greater than those in liver and intestine, respectively. A gradation in the amount of Na was observed along the antero-posterior axis of the worm; the peak value being noticed in the gravid region. The whole worms contained 2.53 times less Na than that in the liver. The contents of K and Cu were highest in the immature region. The K content in the worms was twice as much as that in the intestinal tissues and less than half as much as that in liver. The amount of Cu in the worms was considerably less than the amount of Zn. The worms contained significantly higher levels of Cu and Zn than the liver and intestinal tissues. The worms had a quantitative excess of K over the other cations studied.

Table 1. Percentages of Ca, P, Na, K, Cu and Zn in dry weight of *Raillietina tetragona*.

		Region		
		Immature	Mature	Gravid
Ca	mean $\pm$ SE	0.099 $\pm$ .006	0.082 $\pm$ .003	0.066 $\pm$ .005
	P values	<0.05*	<0.05**	<0.002***
P	mean $\pm$ SE	0.184 $\pm$ .013	0.110 $\pm$ .009	0.122 $\pm$ .013
	P values	<0.002*	>0.1**	<0.01***
Na	mean $\pm$ SE	0.091 $\pm$ .009	0.120 $\pm$ .008	0.156 $\pm$ .012
	P values	<0.05*	<0.05**	<0.01***
K	mean $\pm$ SE	0.538 $\pm$ .018	0.472 $\pm$ .021	0.498 $\pm$ .016
	P values	<0.05*	>0.1**	<0.1***
Cu	mean $\pm$ SE	0.008 $\pm$ .0008	0.005 $\pm$ .0005	0.004 $\pm$ .0005
	P values	<0.01*	>0.1**	<0.002***
Zn	mean $\pm$ SE	0.036 $\pm$ .004	0.021 $\pm$ .001	0.035 $\pm$ .003
	P values	<0.01*	<0.01**	>0.1***

Probability of significance of difference between: \* immature and mature; \*\* mature and gravid; \*\*\* gravid and immature.

#### 4. Discussion

The importance of inorganic substances to adult cestodes is often demonstrated by experimental studies involving mineral deficiencies in the host's diet (Chand 1969; Deo and Srivastava 1962; von Brand 1966; Mathur and Pande 1969; Nadakal *et al* 1975). Ca deficiency in the diet of the host birds, for instance, leads to dwarfing of the tapeworm *Raillietina cesticillus* (Mathur and Pande 1969) and dwarfing and reduction in the ash and Ca contents of *R. tetragona* (Nadakal *et al* 1975). These findings indicate that the amount of mineral components of these worms depends on the nutritional condition of the host. In the present study, since the host birds were maintained on a basal diet containing sufficient amount of all the essential nutrients, the mineral levels shown by the worms may be considered to be normal.

A sizeable quantity of mineral components of cestodes is known to be incorporated in the calcareous corpuscles (Scott *et al* 1962; von Brand 1966). Large numbers of calcareous corpuscles have been reported in *R. tetragona* (Chowdhury and Singh 1978). The variations observed in the quantitative distribution of the minerals along the antero-posterior axis of *R. tetragona* may reflect a metabolic gradient that might exist in the strobila.

The pattern of distribution of calcium in the three different regions of *R. tetragona* is in conformity with that in *Hymenolepis diminuta* as reported by Goodchild *et al* (1962). The decrease in Ca content in the gravid proglottids may be correlated with the loss of muscular contraction in this region. Shedding of gravid proglottids may be facilitated by reduction in Ca content posteriorly, since its absence or scarcity affects the integrity of intercellular cement substances (Heilbrunn 1952)

Table 2. Percentages of Ca, P, Na, K, Cu and Zn in dry weights of whole worms (*Raillietina tetragona*) and certain tissues of its host (*Gallus gallus domesticus*).

		Tissues		
		Whole worms	Liver	Intestine
Ca	mean $\pm$ SE	0.087 $\pm$ 0.004	0.033 $\pm$ 0.004	0.011 $\pm$ 0.002
	P values	<0.001*		<0.001**
P	mean $\pm$ SE	0.139 $\pm$ 0.005	0.110 $\pm$ 0.012	0.056 $\pm$ 0.008
	P values	<0.05*		<0.001**
Na	mean $\pm$ SE	0.112 $\pm$ 0.01	0.284 $\pm$ 0.012	0.098 $\pm$ 0.011
	P values	<0.001*		>0.1**
K	mean $\pm$ SE	0.501 $\pm$ 0.008	1.198 $\pm$ 0.192	0.261 $\pm$ 0.029
	P values	<0.01*		<0.001**
Cu	mean $\pm$ SE	0.006 $\pm$ 0.0003	0.004 $\pm$ 0.0004	0.003 $\pm$ 0.002
	P values	<0.01*		<0.001**
Zn	mean $\pm$ SE	0.031 $\pm$ 0.002	0.018 $\pm$ 0.002	0.017 $\pm$ 0.001
	P values	<0.001*		<0.001**
		Blood serum		
Ca	mg/100 ml	11.588 $\pm$ 0.636		
P	mg/100 ml	4.866 $\pm$ 0.237		
Na	mg/ml	3.210 $\pm$ 0.124		
K	mg/ml	0.190 $\pm$ 0.012		
Cu	$\mu$ g/ml	0.200 $\pm$ 0.014		
Zn	$\mu$ g/ml	0.706 $\pm$ 0.028		

Probability of significance of difference between : \* worm and liver ; \*\* worm and intestine

The higher phosphorus content in the immature region may be attributed to higher metabolic activity in this region. Singh *et al* (1978) observed a significantly higher level of phosphorus in the mature region of *Thysanotia giardi* than in its gravid region. The Ca:P ratios in the worms were higher than those in the liver and intestine.

A gradual decrease in Na content along the antero-posterior axis observed in *R. tetragona* has also been noticed in *H. diminuta* (Goodchild *et al* 1962). The reasons for this regional difference in distribution is not known. The immature region contained the greatest amount of K. Potassium, being the major 'base' of the body cells, may subserve the general functions relating to osmotic pressure regulation and acid-base balance. The tissues of *R. tetragona* like liver and intestinal tissues but unlike the serum, showed quantitative excess of K over Na and other cations. Goodchild *et al* (1962) reported a similar situation in *H. diminuta*. The K:Ca ratios in the worms were considerably lower than those in liver and intestinal tissues, but higher than those in blood serum.

Copper and Zinc are co-factors associated with a number of enzymes including oxidative enzymes, several dehydrogenases, phosphatases and cytochrome oxidases.

Appreciable amounts of these enzymes in the cestode body have been demonstrated (Smyth 1969 ; Enigk *et al* 1976 ; Vasilev *et al* 1976). The higher concentration of Cu and Zn in the immature region of *R. tetragona* may possibly be due to the higher enzymatic activity in this region.

Enigk *et al* (1976) found considerably higher levels of electrolytes in the cyst fluid than in the blood plasma of host and Greichus and Greichus (1980) observed statistically different concentration of minerals in *Ascaris lumbricoides* and the tissues of its host. The presence of higher amounts of cations in *R. tetragona* than in the tissues of its host birds may be due to an efficient selective absorption mechanism prevailing in this worm. Apparently an equilibrium between the parasites and the host tissues with respect to the minerals was not discernible.

#### Acknowledgements

Thanks are due to the authorities of Mar Ivanios College, Trivandrum, for the space and facilities provided and to Dr P K Joy, R & D Manager, Travancore Titanium Products for permission to use the flame photometer and atomic absorption spectrophotometer. The senior author is thankful to the University Grants Commission (New Delhi) for financial assistance under USRT Scheme.

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