TRACE ELEMENTAL ANALYSIS OF RAT CATARACTOUS LENSES BY PIXE

Hu Zhaohui (胡朝晖), Zhong Ming (钟 溟)

(Institute of High Energy Physics, Academia Sinica, Beijing 100080, China)

Zhang Jiaping (张家萍), Liu Shirong (刘世蓉) and Zhang Changying (张昌颖)

(Department of Biochemistry, Beijing Medical University, Beijing 100083, China)

(Received September 1991)

ABSTRACT

Cataracts were observed in the eye lenses of a group of Wistar rats that had been injected with Na_2SeO_3. The trace elemental analysis of their lenses was carried out by PIXE. The results showed that the variations of elemental contents were different between the injected rats and the controls. The elemental concentrations, which exhibited a certain regularity in their variations,could be related to the time of formation of cataract and to its state.

Keywords: Cataract Trace element PIXE

1 INTRODUCTION

A cataract is a pathological change of eye lens. It is a common disease, especially for old people. It seriously endangers a patient's physical and mental health. Therefore, some scientists in the medical circles have been researching on the cause of formation of a cataract. In recent years, the function of the trace elements in the formation of a cataract has also been paid considerable attention[1-3]. We induced Wistar rat's cataract by injecting Na_2SeO_3 and analysed the trace elements in their lenses. This paper presents the preliminary experimental results.

2 EXPERIMENTAL

A large number of young Wistar rats living in identical colony and feeding condition were employed in this study. Randomly, a group of rats was selected from them and injected with Na_2SeO_3 in order to induce cataract. The remaining ones were used as control. On the 8th day after injecting Na_2SeO_3, the cataractous state was observed in the lenses of some of the induced rats. Thus beginning from 8th day a sampling was done every five days, i.e. on the 8th, 13th, 18th, 23th and 28th day. The sampling consisted by killing all the rats with turbid lenses and taking out the lenses. The lenses of some control rats were simultaneously taken out (we did not take out

control lenses at 23th and 28th day). The lenses of rats injected were divided into three states according to their turbid levels the first state was the advanced cataract and the second one was the nuclear opaque cataract. Up to 28th day

Table 1

The trace element concentration in rat's lenses of various states in ppm (μ g/g, dry weight)

State		P	S	Cl	K	Ca	Fe	Zn	Rb
A	Con	4280.0	2670.0	829.8	6790.5	423.8	57.3	14.0	56.8
	Dev	670.8	418.2	131.5	1060.0	66.8	9.2	2.4	13.3
	%	±15.6	±15.7	±15.8	±15.6	±15.8	±16.0	±17.1	±23.4
B	Con	4400.5	3299.9	1210.4	6943.1	587.5	58.8	17.6	53.4
	Dev	693.2	518.8	191.5	1088.0	92.6	9.5	3.3	16.2
	%	±15.7	±15.7	±15.8	±15.7	±15.7	±16.1	±18.7	±30.3
C	Con	4855.0	2549.2	1371.9	7517.9	450.6	53.0	18.2	73.2
	Dev	236.1	124.2	67.3	364.7	22.3	2.8	1.0	5.3
	%	±4.8	±4.9	±4.9	±4.9	±4.9	±5.3	±5.5	±7.2

Where Con is concentration, Dev is a total error and % is the relative error

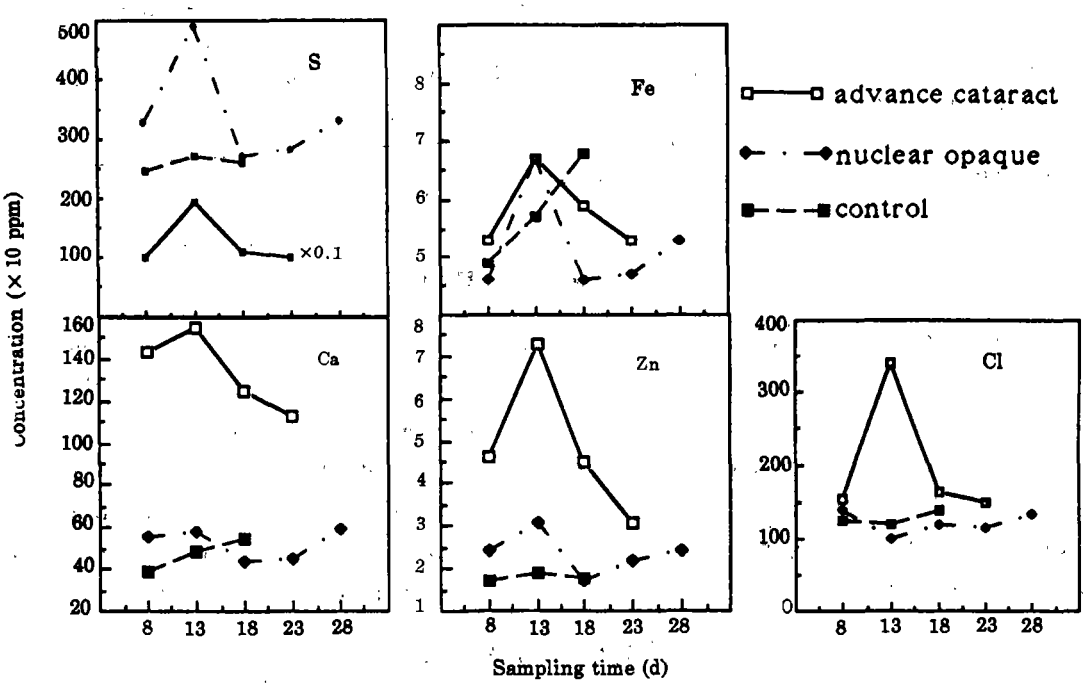

Fig.1 S, Cl, Ca, Fe and Zn contents in the cataractous lenses formed after injecting Na_2SeO_3

a few rats did not suffer from cataract, and their lenses were also taken out to be observed the variation of trace elements and their state, i.e. non-cataract, was defined as the third state. The sample number of lenses obtained was different for the various states and periods. The number of lenses in every sampling was more than 10 for the advanced cataract, 16–20 for the nuclear opaque, 10 for the control and 6 for the non-cataract.

The lenses of various states were all incinerated at a temperature of 120°C. The ashes were separately dissolved in the superpure water to prepare solutions of a certain concentration and Y (yttrium) was added as an internal standard. Subsequently, targets of the various samples were prepared according to the condition of thin target (thickness < 1 mg/cm^2) required by the PIXE method.

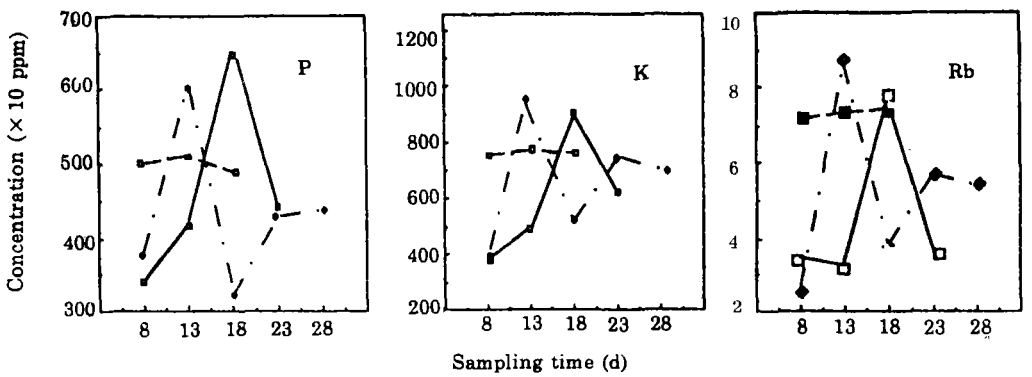

Fig.2 P, K and Rb contents in the cataractous lenses formed after injecting Na_2SeO_3

Symbols as in Fig.1

A number of targets ranging from 5 to 7 were used for the various states taken at different time. The analysis for all the targets was performed by the PIXE setup of the Institute of High Energy Physics (IHEP). The obtained spectra were analysed using a non-linear least-squares fitting procedure. The calibration of the system was achieved by two types of standards: thin mono-elemental standards purchased from Micro-Matter Co., USA and several multi-elemental standards prepared in this laboratory. The results of the two types of standards are in sufficiently good agreement each other.

3 RESULTS AND DISCUSSION

3.1 The results showed that Na_2SeO_3 disturbed the normal equilibrium for the contents of various elements in the rats' lenses.

3.2 In this study, we attempted to analysc 12 elements: P, S, Cl, K, Ca, Mn, Fe, Cu, Zn, Be, Br and Rb in the various kinds of lenses at different sampling times. Concentration of Mn at various states did not vary with time; Cu and Se were below their detection limits and Br was very low and was affected by large statistical errors. Thus we analysed only P, S, Cl, K, Ca, Fe, Zn and Rb. The results are shown in Fig.1 and 2. The relative errors of the data in the figures are in agreement with the errors of the concentrations in Table 1. We have found that the elemental concentrations in the control samples do not change with time in the error limits except for Ca and Fe which show a rising tendency, and the variations of content in the cataractous lenses show a certain regularity as it can be seen in the figures. According to their

behaviour the investigated elements can be clearly divided into two sets: Set 1 including S, Cl, Ca, Fe and Zn, and Set 2 including P, K and Rb. The main observed features are: (a) For Set 1, the concentrations of every element in the cataractous lenses during the early period rapidly increase, are higher than the control values, and all attain their maximum at the same time, and obviously S, Ca and Zn are the most typical. These features indicate that lenses of induced rats were enriched in the elements of Set 1 during the formation of a cataract. In addition, the concentrations of all these elements in the advanced cataract were higher than those in the nuclear opaque. This fact shows that the formation of different cataractous states in the same period could be related to the raised values of such elements. (b) The Set 2 is different from the Set 1. At most times the content of each element was lower than the contol value and the variations of the elemental contents in the advanced cataract and in the nuclear opaque were not synchronous.

3.3 The results of the non-cataract *A* and the nuclear opaque *B* in the same period (when sampled on the 28th day, no advanced cataract) and the control *C* are shown in Table 1. It is clearly seen that *A* and *C* are identical in the error limits except for Cl, the difference between *A* and *B* is due mainly to S, Cl and Ca in Set 1. This fact could indicate that the content variation of these elements plays a certain role in the formation of cataract in that period.

3.4 Since the method of injecting Na_2SeO_3 was used to induce cataract in this study, it naturally made us interesting in the variation of Se concentration in the formation of a cataract. But the results have shown that Se concentrations were all lower than its detection limit in the various kinds of cataractous lenses. It is possible that Se was lost in the process of incineration. This indicates that the preparation method of sampling targets still needs a further improvement. Further studies are still in progress.

ACNOWLEDGEMENTS

The authors are grateful to the staff of the Van de Graff Accelerator, IHEP for their valuable support in running this experiment, and to Prof. Zhang Runhua and Mrs. Liu Qixin for their help.

REFERENCES

[1] Koyama-ito H, Jahnke A, Wada E. *Nucl Instr Meth*, 1979, 166:269.

[2]Kouris T, Papadopoulou C, Kanias G D. *MTAA*, 1986, 2:893.

[3] Zhang Jiaping, Hou Weinin, Liu Shirong. *Chinese Biochemical Journal*, 1985, 1(5):15.