

**Thesis****On Variation of DK and pH Values of Adenosine-5'-phosphate Solution by  $\gamma$ -Ray Irradiation**

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By the irradiation of  $\gamma$ -ray on aqueous solution of adenosine-5'-phosphate and its sodium salts, a large change of DK (dielectric constant) value in the  $0.5 \times 10^{-4}$ M solution at the range between  $10^4$  and  $10^5$ R were recognized, but favorable results were not able to found out on the change of pH.

**KEYWORDS**

$\gamma$ -Ray, UV-absorption, AMP, ADP, ATP

The studies on an influence of radiant ray to various ingredient in a nucleic acid has been practised in the many ways and means. Vliana and his collaborator<sup>1),2)</sup> carried out a study of the burst of a ring in purine and pyrimidine bases in DNA, aqueous solution containing air, with the irradiation of  $\gamma$ -ray by a spectrophotometry. Hulectt<sup>3)</sup> researched a dissociation of adenosine-3'- and -5'-phosphate combined with various kind of bases by  $\gamma$ -ray irradiation under the reptition with nitrogen gas. Furthermore, Ralfeigh et al.<sup>4)</sup> enforced a nonenzymatic hydrolysis of adenosine phosphate, and found out that hydrolysis progressed in order of ATP, ADP and AMP in pH 8 solution and it depended on a temperature in the range of 5-140°C.

The authors tried the following experiments; the aqueous solution of adenosine-5'-phosphate and its sodium salt irradiated with  $\gamma$ -ray and the difference of those hydrolyzed amount by disparity of dose or dose rate were examined by UV-spectra and pH values.

**Experimental**

**1. Sample** Adenosine-5'-monophosphate, adenosine-5'-diphosphate monosodium salt, adenosine-5'-diphosphate disodium salt and adenosine-5'-triphosphate disodium salt on the market were used.

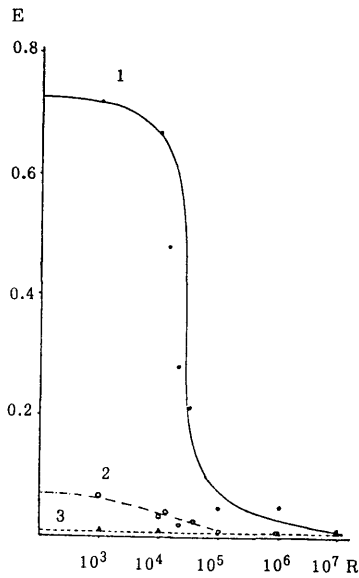
**2.  $\gamma$ -Ray** Aqueous solution of these reagents ( $0.5 \times 10^{-4}$ ,  $\times 10^{-5}$  and  $\times 10^{-6}$ M) put into the tube for the irradiation ( $15 \times 150$  mm) and those were irradiated with  $\gamma$ -ray(<sup>60</sup>Co) as following dose and dose rate;  $10^2$ R;  $2 \times 10^2$ R/h,  $10^3$ ,  $10^4$ R;  $2.3 \times 10^3$ R/h,  $10^5$ ,  $10^6$  and  $10^7$ R;  $5.6 \times 10^6$ R/h.

**3. Apparatus** pH meter; TOA, Model HM-208, UV-spectrometer; JASCO UVIDEC-505. (measured at 260 nm)

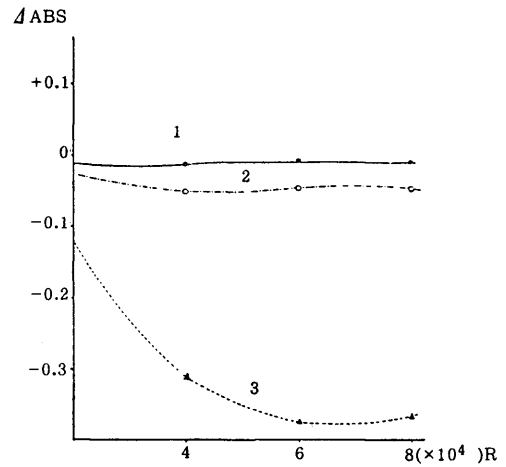
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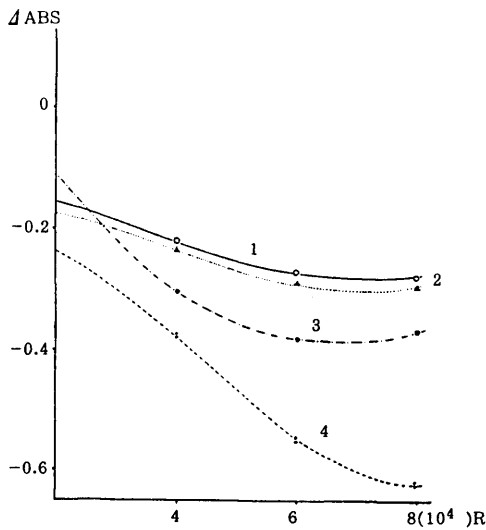
\*\* Radiation Center of Osaka Prefecture



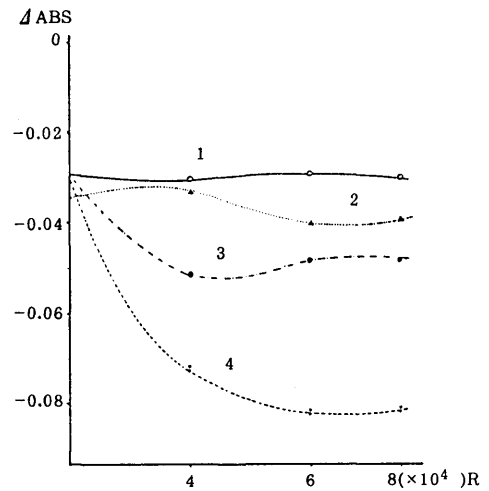
**Fig. 1**  $\Delta$ ABS (at 260nm) of Adenosin-5'-monophosphate Soln. irradiated by  $\gamma$ -Ray on Different Dose  
1;  $0.5 \times 10^{-4}$ M 2;  $0.5 \times 10^{-5}$ M.  
3;  $0.5 \times 10^{-6}$ M Soln.



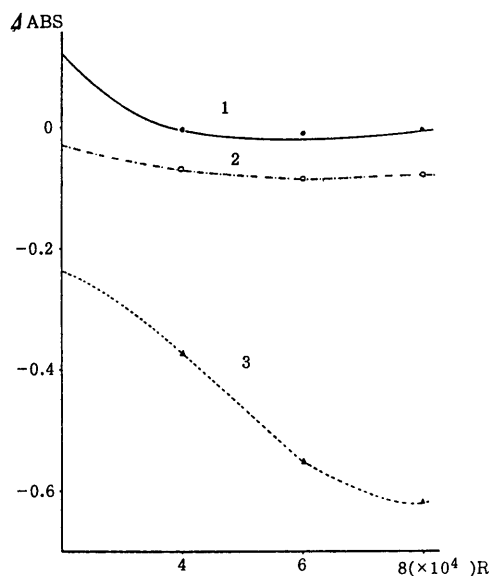
**Fig. 2**  $\Delta$ ABS (at 260nm) of Adenosin-5'-monophosphate Soln. irradiated by  $\gamma$ -Ray on Various Concentration  
1;  $0.5 \times 10^{-6}$  2;  $0.5 \times 10^{-5}$   
3;  $0.5 \times 10^{-4}$ M Soln.



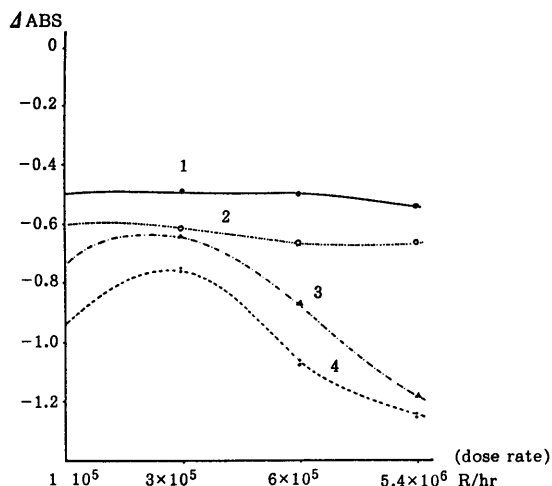
**Fig. 3**  $\Delta$ ABS (at 260nm) of Adenosin-5'-phosphate and its Sodium Salt Soln. ( $0.5 \times 10^{-4}$ M) irradiated by  $\gamma$ -Ray  
1; Adenosin-5'-diphosphate monosodium salt  
2; Adenosin-5'-diphosphate disodium salt  
3; Adenosin-5'-monophosphate  
4; Adenosin-5'-triphosphate disodium salt



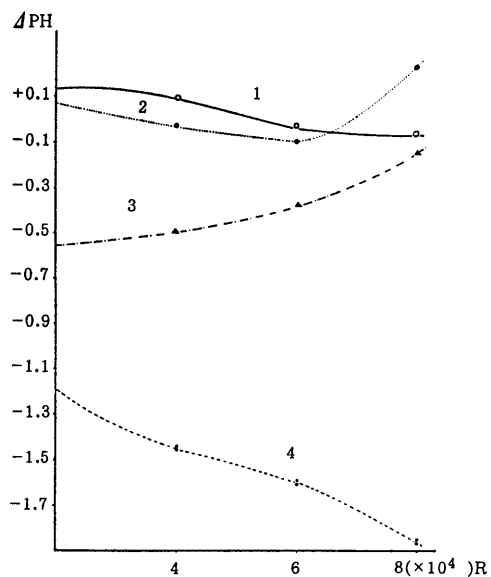
**Fig. 4**  $\Delta$ ABS (at 260nm) of Adenosin-5'-phosphate and its Sodium Salt Soln. ( $0.5 \times 10^{-5}$ M) irradiated by  $\gamma$ -Ray  
1; Adenosin-5'-diphosphate monosodium salt  
2; Adenosin-5'-diphosphate disodium salt  
3; Adenosin-5'-monophosphate  
4; Adenosin-5'-triphosphatedisodium salt



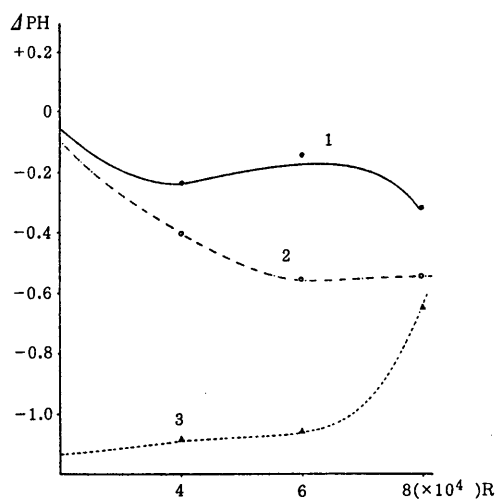
**Fig. 5** ΔABS (at 260nm) of Adenosin-5'-triphosphate disodium Salt Soln. irradiated by γ-Ray on various Concentration  
 1;  $0.5 \times 10^{-6}$ M 2;  $0.5 \times 10^{-5}$ M  
 3;  $0.5 \times 10^{-4}$ M Soln.



**Fig. 6** ΔABS (at 260nm) of Adenosin-5'-phosphate and its Sodium Salt Soln. irradiated to  $10^5$ R by γ-Ray  
 1; Adenosin-5'-monophosphate  $0.5 \times 10^{-4}$ M Soln.  
 2; Adenosin-5'-diphosphate monosodium salt  $0.5 \times 10^{-4}$ M  
 3; Adenosin-5'-diphosphate monosodium salt  $1.0 \times 10^{-4}$ M  
 4; Adenosin-5'-monophosphate  $1.0 \times 10^{-4}$ M

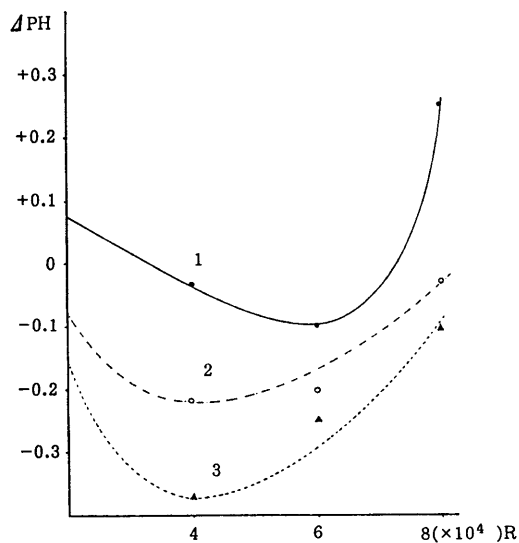


**Fig. 7** ΔpH of Adenosin-5'-phosphate and its Sodium Salt irradiated γ-Ray on  $0.5 \times 10^{-4}$ M Soln.  
 1; Adenosin-5'-diphosphate monosodium salt  
 2; Adenosin-5'-monophosphate  
 3; Adenosin-5'-triphosphate disodium salt  
 4; Adenosin-5'-diphosphate disodium salt

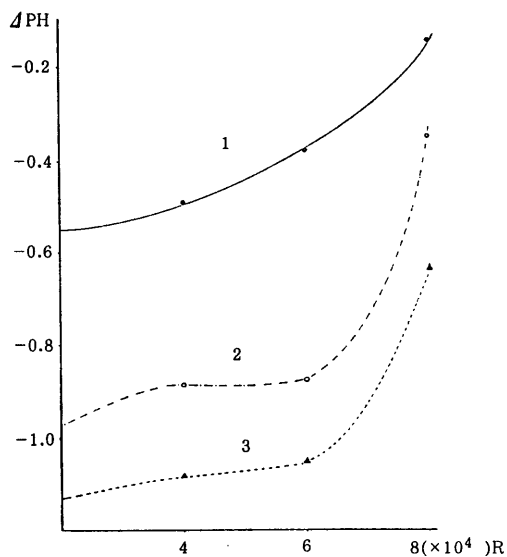


**Fig. 8** ΔpH of Adenosin-5'-phosphate and its Sodium Salt irradiated by γ-Ray on  $0.5 \times 10^{-5}$ M Soln.  
 1; Adenosin-5'-monophosphate  
 2; Adenosin-5'-diphosphate monosodium salt  
 3; Adenosin-5'-triphosphate disodium salt

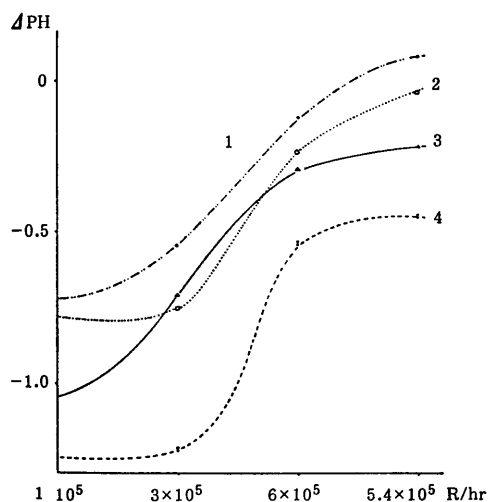
OGURA etc : On Variation of DK and pH Values of Adenosine-5'-phosphate Solution by  $\gamma$ -Ray Irradiation



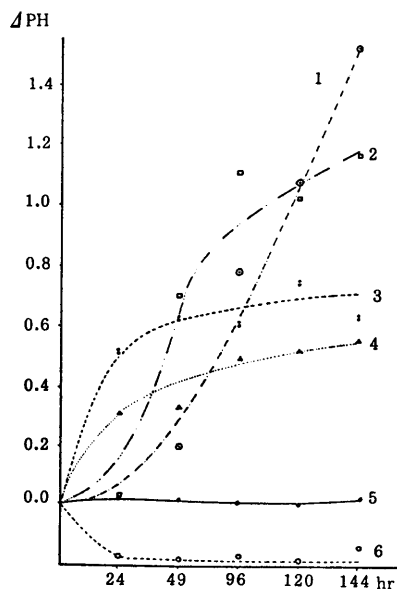
**Fig. 9**  $\Delta$ pH of Adenosin-5'-monophosphate irradiated by  $\gamma$ -Ray on various Concentration  
 1;  $0.5 \times 10^{-4}$  2;  $0.5 \times 10^{-5}$   
 3;  $0.5 \times 10^{-6}$ M Soln.



**Fig. 10**  $\Delta$ pH of Adenosin-5'-triphosphate disodium salt irradiated by  $\gamma$ -Ray on various Concentration  
 1;  $0.5 \times 10^{-4}$  2;  $0.5 \times 10^{-5}$   
 3;  $0.5 \times 10^{-6}$ M Soln.



**Fig. 11**  $\Delta$ pH of Adenosin-5'-phosphate and its Sodium Salt Soln. irradiated by  $\gamma$ -Ray to  $10^5$ R at Difference Dose Rate  
 1; Adenosin-5'-diphosphate monosodium salt  $1.0 \times 10^{-4}$ M  
 2; Adenosin-5'-monophosphate  $1.0 \times 10^{-4}$   
 3; Adenosin-5'-diphosphate monosodium salt  $0.5 \times 10^{-4}$   
 4; Adenosin-5'-monophosphate  $0.5 \times 10^{-4}$



**Fig. 12**  $\Delta$ pH of Adenosin-5'-monophosphate Soln. laid aside in Room  
 1;  $0.5 \times 10^{-4}$  2;  $0.5 \times 10^{-5}$  3;  $0.5 \times 10^{-7}$   
 4;  $0.5 \times 10^{-6}$  5;  $0.5 \times 10^{-2}$   
 6;  $0.5 \times 10^{-3}$ M Soln.

## Results and Consideration

The results irradiated to  $10^3$ ,  $10^4$ ,  $10^5$ ,  $10^6$  and  $10^7$ R on  $0.5 \times 10^{-4}$ ,  $\times 10^{-5}$  and  $\times 10^{-6}$ M aqueous solution were shown in Fig. 1. When the  $0.5 \times 10^{-6}$ M solution was irradiated with  $\gamma$ -ray more than  $10^3$ R, very small values were obtained in UV-spectrum and the difference by disparity of dose hardly recognized. On the  $0.5 \times 10^{-5}$ M solution, these values became gradually to small according to a increase of dose, and the limits of the measurement was indicated at  $10^5$ R. The remarkable change appeared between  $10^4$  and  $10^5$ R on  $0.5 \times 10^{-4}$ M solution. For survey in detail, it was over again irradiated to 2, 4, 6 and  $8 \times 10^4$ R and almost similar values to the former were obtained.

The difference of absorption ( $\Delta$ ABS) of sample and irradiated one were showed in Fig. 2. The  $0.5 \times 10^{-4}$ M solution of adenosine-5'-phosphate and its sodium salts were irradiated to 2, 4, 6 and  $8 \times 10^4$ R too, these  $\Delta$ ABS were showed in Fig. 3.

Although the values of the  $0.5 \times 10^{-5}$ M solution of mono- and disodium salt of ADP by the irradiation to 2, 4, 6 and  $8 \times 10^4$ R were not showed a big difference with each other, that of ATP had a pretty different values by dose. The results showed in Fig. 4.

For the inspection of the state of change under the same dose or dose rate, the  $0.5 \times 10^{-4}$ ,  $\times 10^{-5}$  and  $\times 10^{-6}$ M solution of AMP and ATP disodium salt were irradiated to 4, 6 and  $8 \times 10^4$ R. The obtained results showed in Fig. 2 and 5, but not found a large difference in these concentration. Then  $0.5$  and  $1 \times 10^{-4}$ M solution of AMP, ADP and these sodium salts were irradiated to the same dose under the different dose rate. In these cases, the curves having a considerable difference as shown in Fig. 6 were obtained.

The change of pH was anticipated for the formation of phosphoric acid from the hydrolysis of sample by  $\gamma$ -ray irradiation. Therefore, the measurement of pH was enforced and the results on  $0.5 \times 10^{-4}$  and  $\times 10^{-5}$ M solutions of AMP, ADP, ATP and these sodium salts were showed in Fig. 7 and 8. Generally, pH values descended in the early step but these curves took a various shape. The change in some concentration and in different dose rate were shown in Fig. 9, 10 and 11. By the influence of air, the pH values of these solution changed gradually as shown in Fig. 12. Consequently, the estimation of the change by pH was almost impossible.

As mentioned above, a large variation was brought by the irradiation between  $10^4$  and  $10^5$ R, especially it brought on the  $0.5 \times 10^{-4}$ M solution of adenosine phosphate and it enlarged according to the increase of dose rate in the same dose.

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## Reference

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