Development of dark-striped field mice, *Apodemus agrarius coreae*, as a biological dosimeter in a radio-ecological monitoring system: 2. Survival rates and hematology

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1. Introduction

Regarding the management of nuclear power plants and the installation of facilities for radiation waste storage: social concerns over radiation safety are increasing. To understand how environmental radiation affects on human beings, the development of an reasonable monitoring system is required. The existing radio-environmental surveillance systems can be classified into physical and biological monitoring systems. The wild small animals and livestocks were reported to be effective biological indicators of environmental radiation [1.2,3,4] This study investigated the possibility of using dark-striped field mice as a biological dosimetric model to assess the effect of radiation on the human environments. For this study, the criteria for the biological dosimeters of environmental radiation were established as the following: first, it should be an animal from a clear background of species; second, it should inhabit a broad range of areas and in considerable numbers; third, it should maintain identical ecological characteristics; fourth, it should be cohabitating with humans; fifth, it should have been consuming food found in their habitat; and finally, it should indicate a clear dose-response relationship with high sensitivity. Based on such criteria, this study investigated the possibility of using dark-striped field mice as an effective biological dosimeter. Primarily, their species were classified based on their morphological external characteristics and isoenzymic patterns. The taxonomically classified dark-striped field mice, *A. agrarius coreae,* were then irradiated to investigate their radiation sensitivity based on the survival rate and hematology in this study.

2. Materials and Methods

2.1 Animal

For this study, dark-striped field mice, sampled from five regions in Korea, were collected in a single month (October). After assessing the morphological external characteristics, the livers were collected and analyzed for isoenzymes as instructed by Murphy et al [3]. In order to examine the radiation sensitivity of field mice, the five groups with different doses were irradiated with gamma rays (^{137}Cs, 0.8 Gy/min).

2.2 Survival rate

After irradiating 15 mice, the said mice were kept in three sterilized cages in groups of five to examine their survival rate for 30 days. The chow (Samyang, Korea) and beading (JRS, Germany) were used with those exposed to gamma rays. The mice were given feed and acidified (pH 2.5) water freely. For the duration of the study, the cage and diet were replaced once every week and the water twice every week. For this study, the survival rate of the mice for 30 days from irradiation was examined and it was determined that the dose ($LD_{50/30}$) eventually killed about half of the mice. As the birth rate of wild mice is low, the number of mice was restricted to fifteen per dose in this study.

2.3 Hematology

All the mice that survived for 30 days after irradiation were examined to assess the changes in their haematoloty in blood.

2.4 Statistical analysis

The micronuclei frequency in erythrocytes and hematological changes for different doses of radiation were analyzed using SAS (Version 8.1).

3. Results and Discussion

3.1 Survival rates

This study examined the survival rate of *A. agrarius coreae* after irradiation. To our surprise, most of those exposed to 3 Gy to 9 Gy of radiation died within 10 days (Fig. 4). Although this study could only use

fifteen mice for each group, as field mice with low reproductive rates were difficult to find, the dose that killed 50% of the mice within 30 days ($LD_{50/30}$) was 5 Gy (Fig. 1).

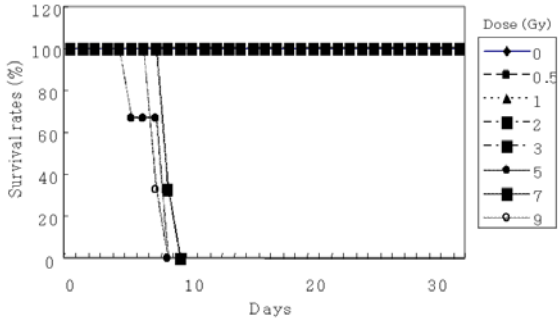

Figure 1. Survival rates of *A. agrarius coreae* after γ-irradiation (n=15/dose).

The changes in physiological and biochemical blood marker were examined in the *A. agrarius coreae* that survived for 30 days after irradiation. The white blood cells increased in the 0.5 Gy group ($P<0.003$). The overall number of platelets increased about two times in 1Gy group after irradiation ($P<0.05$). Akaline phosphatase ($P<0.0001$), calcium ($P<0.0001$) and phosphorus ($P<0.01$) rapidly drop down more than thirty-five times ($P<0.0001$) and alanine aminotransferase decreased slowly after irradiation. Creatinine increased to the highest levels at 3 Gy irradiation ($P<0.01$). Amylase decreased from 1 Gy after irradiation ($P<0.01$). Sodium levels increased rapidly from 0.5 Gy irradiation ($P<0.0001$). However, Albumin, total bilirubin, blood urea nitrogen, total protein, and globulin did not show any visible change after irradiation.

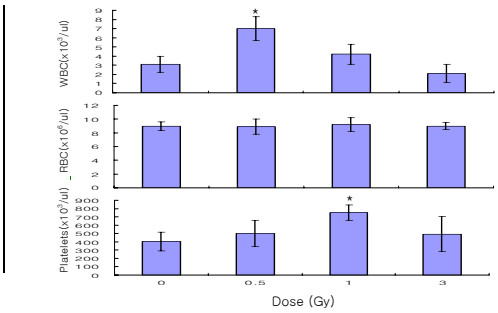

Figure 2. Hematology of *A. agrarius coreae* at 30 days after γ-irradiation with ^{137}Cs. * White blood cell (WBC): 0.5Gy *vs* 0, 1, 3Gy ($P<0.003$); platelets: 1Gy *vs* 0, 0.5, 3Gy ($P<0.05$).

4. Conclusion

This study examined the possibility of using striped field mice as a biological dosimeter or indicator for the surveillance of the ecological effects of boundary radiation emitted by nuclear power plants. For this study, the external morphological characteristics and isoenzymic electrophoretypes of Korean domestic dark-striped field mice were studied after they were captured, controlled for reproduction, and their exact species was identified. Among the morphological external characteristics, the dark-brown coat, dark back stripe, head-to-tail length, tail length, and ear length matched the taxonomical characteristics of dark-striped field mice. Among the isoenzymic electrophoretypes, the analyses on LDH, AAT, and MDH revealed that one species of dark-striped field mice, called *Apodemus agrarius coreae,* was scattered throughout a wide range of habitats. On the other hand, the *A. agrarius coreae* were irradiated to analyze their survival rate and their $LD_{50/30}$ was approximately 5 Gy. Moreover, those with 0.5 Gy and higher showed an increase in white blood cells and platelets. The results of the study reveal that wild *A. agrarius coreae* mice have a high potential as a biological monitoring system to determine the radiation effects in human environments such as those within the vicinity of nuclear power plants.

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