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Potential effects of ultraviolet-C radiation on the mole rats (*Spalax leucodon*) hematological values

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ABSTRACT

In this study, the effect of ultraviolet-C (UVC) radiation on hematologic parameters of mole rats (*Spalax leucodon*) was studied. Ten mole rats of both sexes, weighing 150 - 200 g, were used. The rats were exposed to 8 hours daily UVC radiation for 45 days. Before the radiation exposure (as a control) and on day 7, 14, 30 and 45, blood specimens were obtained from the experimental groups. Then blood samples were analyzed and compared to the control groups. A significant decrease or increase of hematological parameters was observed in some experimental groups in terms of the control groups of values ($p < 0.05$). Alterations in other hematological parameters were not found to be statistically significant ($p > 0.05$). These results showed that the UVC radiation has significant effects on some hematological parameters of mole rats according to the radiation exposure time and a dose.

Keywords: Ultraviolet Radiation; Mole Rats (*Spalax leucodon*); Hematological Parameters

1. INTRODUCTION

Sunlight exposure harms biologic systems via ultraviolet (UV) radiation due to its short wave length and high energy. The wave length of UV beams was emitted by sun changes between 200 - 400 nm. UV beams are classified according to their wavelength; UVA (320-400) UVB (280-320) and UVC (200-280) [1,2].

UVC radiation is especially important in terms of its harmful effects on the living beings. Fortunately, the majority of this radiation is filtered by the ozone (O_3) layer. As the thickness of this layer has reduced in recent years, it is estimated that skin cancer, cataract and immune deficiency syndrome cases will increase in the near future [3-5].

UV beams are known to enable photosynthesis in plants and vitamin D synthesis in human, kill pathogen microorganisms and provide heat for the survival of life. On the other hand, solar dermatitis, sun burn, pigmentation, cataract and skin cancer formation, acne, echymosis, keratosis, photodermatosis, light sensitivity, mutation, actinic elastosis and sensitivity to infections due to immune deficiency may be seen due to over exposure to UV beams [1,2,6,7]

To our knowledge, plenty of data have been gathered concerning the effects of UVA and UVB radiations on biochemical, hematological or histopathological characteristics of animals [8-18], but similar studies done with UVC radiation on the hematological cells on Mole rats (*Spalax leucodon*) have not been encountered.

For this reason, the mole rats were selected as they lived in the underground galleries, and had no UV exposure in their habitat. Therefore, they were exposed to an artificially produced UVC radiation in the lab, and the hematological changes were compared with the control group.

2. MATERIALS AND METHODS

Ten adult mole rats of both sexes (*Spalax leucodon*), weighing 150 - 200 g were used in this study. All animals were caught in the rural areas of Ankara, Turkey. All rats were kept at the laboratory for 10 days at a stable temperature (20 ± 2 degrees centigrade) in order to ensure adaptation of the animals to their new environment. And then they were placed in special cages called terrarium (**Figure 1**).

All rats were placed to terrarium separately and a constant UVC dosage was applied. All animals were fed with carrot, potato and plant roots, and no special diet was given.

A "Mazda TG" ultraviolet lamp in 30 W powers and in 90 cm length was placed to the upper cover of the terrarium. The intensity of the UV emitted from the lamp was

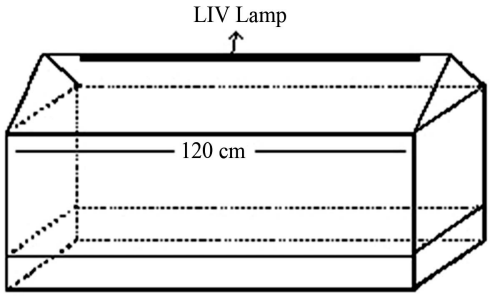

Figure 1. The terrarium where the rats were exposed to UVC radiation.

measured to be 254 nm in wavelength and the energy in one second was found to be 0.0014 joule/cm^2. Sunlight period was taken into account and rats were exposed to UVC for 8 hours per day (between 08:00 - 17:00 hours) during 45 days. A feeding interval was given at midday for 1 hour. A timer was used to control the UVC exposure times.

Blood specimens of 2 cc were obtained to 1 ml EDTA tubes from the intra cardiac route under light ether anesthesia, before UVC exposure (at day 0) and on days 7, 14, 30 and 45. After waiting for 10 minutes at a room temperature, samples were centrifugated at 2500 rpm for 10 minutes. The plasma was separated and put into different tubes and analysis was performed. Erythrocyte, leukocyte, hemotocyrite, neutrophil, lymphocyte monocyte, eosinophil, basophile and hemoglobin values were measured with Contraves Digicel 3100-H.

Data were analyzed using the SPSS for Windows software, Version 18.00(SPSS Inc., Chicago, IL, USA). The differences between means of the control and experimental groups were evaluated by Wilcoxon Signed Ranks Test. "Two-Related Samples Tests" was applied for further analysis. At the end of the study, all rats were taken to the areas they had been caught.

The experiment was carried out in accordance with the Ankara University guidelines for the care of the experimental animals. Besides, guiding principles for experimental procedures presented in the World Medical Association's Declaration of Helsinki, regarding animal experimentation were followed in the study.

3. RESULTS

Blood parameters of the UVC exposed rats were presented in **Table 1**. Statistically significant changes in some blood parameters were documented after 45 days. Erythrocyte counts on day 14, 30 and 45, hemoglobin value on day 45, leukocyte counts on day 30 and 45, neutrophil values on day 7, 14 and 30, monocyte value on day 30 were found statistically significant ($p < 0.05$) compared to day 0 (control) values whereas hematocryte, lymphocyte, eosinophil and basophile values were found statistically insignificant ($p > 0.05$).

Table 1. The hematological findings from control and exposed animals (Mole rats) to UVC radiation according to exposure time (7, 14, 30 and 45 days).

Variables	Radiation Period (Days)				
	0 d (*n* = 10)	**7 (*n* = 10)**	**14 (*n* = 10)**	**30 (*n* = 10)**	**45 (*n* = 10)**
Erythrocyte (10^6/mm^3)	8.57 ± 0.95	8.76 ± 1.42	7.53 ± 1.00[a]	7.65 ± 1.40[a]	9.65 ± 0.89[b]
Hemoglobin (g/dl)	12.46 ± 1.27	11.58 ± 1.17	12.56 ± 1.30	13.22 ± 0.83	13.60 ± 0.81[b]
Hematocryte (%)	46.20 ± 4.54	44.50 ± 3.80	46.80 ± 4.70	48.20 ± 5.11	50.40 ± 4.92
Leukocyte (10^3/mm)	29.90 ± 13.85	36.50 ± 18.75	41.00 ± 19.14	45.40 ± 19.31[a]	54.40 ± 17.43[a]
Lymphocyte (%)	29.30 ± 6.42	33.80 ± 11.97	33.40 ± 17.66	29.50 ± 8.84	29.70 ± 10.12
Neutrophil (%)	66.90 ± 6.40	58.20 ± 4.56[a]	56.20 ± 2.97[a]	55.60 ± 4.06[a]	63.00 ± 2.78
Monocyte (%)	6.30 ± 2.49	5.20 ± 2.20	8.80 ± 4.54	13.80 ± 7.92[b]	6.40 ± 2.17
Eosinophil (%)	0.70 ± 1.05	1.90 ± 1.79[a]	1.10 ± 1.19	0.50 ± 0.84	0.40 ± 0.51
Basophiles (%)	1.50 ± 1.84	0.90 ± 1.52	0.50 ± 0.52	0.80 ± 0.63	1.70 ± 0.67

[a,b]Mean values with different superscripts in the column are significantly different ($p < 0.05$).

4. DISCUSSION

All living beings on the earth are exposed to UV radiation emitted from the sun. It is clear that previously absorbed UV radiation would affect the outcome of the studies carried out on these living beings. On the other hand, mole rats used in this study live in underground galleries and are not exposed to sun emitted radiation. It is too hard to observe the effect of UV radiation on viscera of the animals that are exposed to sunlight all through their life. Blood parameters play a very important role in body functions and they are also affected from sun light. For these reasons, we thought that mole rats would be a better model to evaluate the effect of UV radiation on hematological parameters.

Rats were exposed to UVC radiation and changes on their hematological parameters were compared to baseline (day 0) values. With UVC exposure, the erythrocyte counts on day 14, 30 and 45 were found statistically significant ($p < 0.05$). According to these data, a significant decrease in erythrocyte values (from 8.76 ± 1.42 to 7.65 ± 1.40) on the 14th, 30th days, but an increase (9.65 ± 0.89) was noted on the 45th day of UV exposure (**Figure 2**). Our findings correlate well with the data derived from human, fish, rats and mice [11,17-19].

There was no significant effects of UVC on hemoglobin value along the experiment ($p > 0.05$), however, sta-

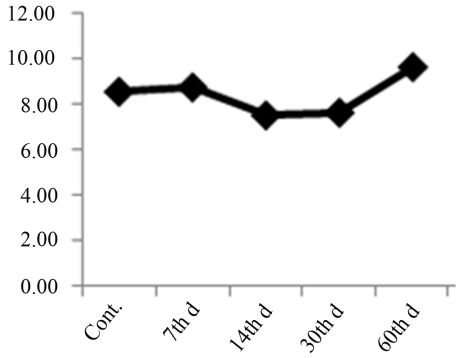

Figure 2. Erythrocyte values.

tistically significant increase was noted on day 45 (13.60 ± 0.81) ($p < 0.05$) (**Figure 3**). The increase is consistent with the studies performed on humans [19] and rats [11], but decrease in hemoglobin values were performed on mice, calves, sheep and fish [9,17,18,20].

In our study, there was no statistically significant effects on hemotocyrite values along the UVC radiation exposure ($p > 0.05$) (**Figure 4**). This finding was consistent with the studies on primate and fish [8] and inconsistent with the studies on rats and fish [11,13,17,18].

Leukocyte counts showed significant increase with UV radiation on day 30 and 45 (from 45.40 ± 19.31 to 54.40 ± 17.43) compared to the control group ($p < 0.05$) (**Figure 5**). This might be due to the protection of the organisms from the harmful effects of the sunlight. It has been reported that even strain differences are the cause of different immune responses to UV radiation [21]. The increase of leukocyte numbers during the experiment probably due to the secretion of IL-1 from melanocytes and keratinocytes of skin via effects of UV radiation. IL-1 activates bone marrow to release its leukocyte stores into circulation [22]. Our results were consistent with the studies on mice and rats [14,15], while no changes or decrease in some studies [8,11,13,23,24].

In the present study, there was a significant effects of UVC on lymphocyte percentage ($p > 0.05$) (**Figure 6**). Similar results have been shown in some studies done before [11,25,26].

In our study, with UV radiation a significant decrease in the neutrophil, values (from 58.20 ± 4.56 to 55.60 ± 4.06) were observed on day 7, 14 and 30 compared to the control group ($p < 0.05$) (**Figure 7**). These results were consistent with the studies done on dogs and human [27, 28], but inconsistent with some studies on calves, primates and humans [8,20,29].

In the present study, a significant increase in monocyte value (13.80 ± 7.92) was shown on day 30 ($p < 0.05$) (**Figure 8**), but there were no significant effects on eosinophil and basophile values during the UV experiment ($p > 0.05$) (**Figures 9** and **10**). Our findings were correlated with the studies carried out on primates, mice and rats

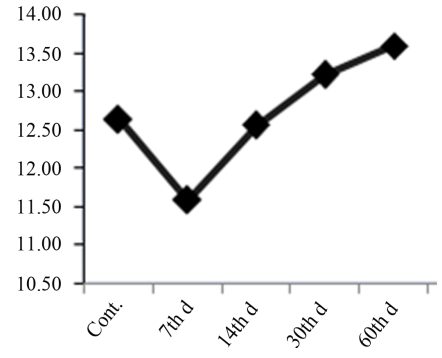

Figure 3. Hemoglobin values.

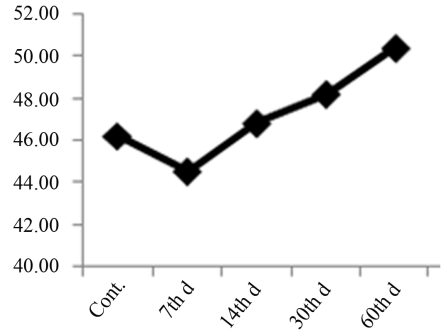

Figure 4. Hematocryte values.

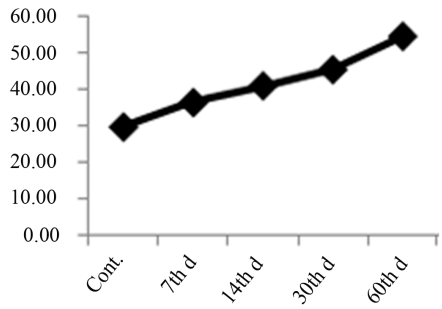

Figure 5. Leukocyte values.

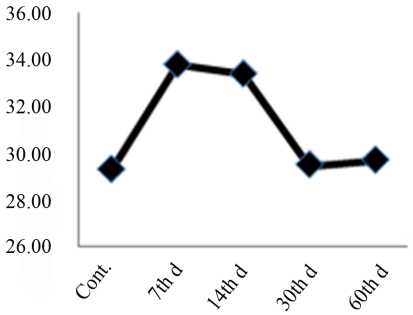

Figure 6. Lymphocyte values.

[8,10,15], but not correlated with the other studies in the literature [12,25].

These results stressed that UVC radiation is also effective on the hematological parameters, like other types of radiation. Animals exposed to radiation shows increased

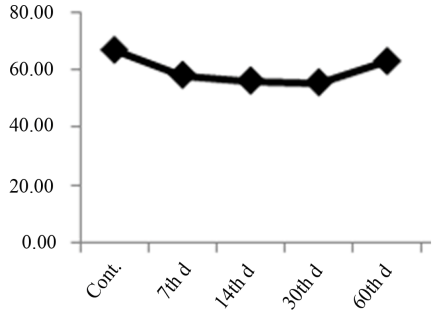

Figure 7. Neutrophil values.

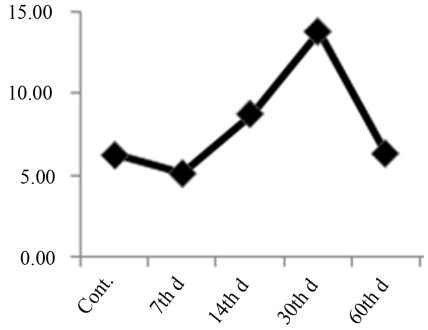

Figure 8. Monocyte values.

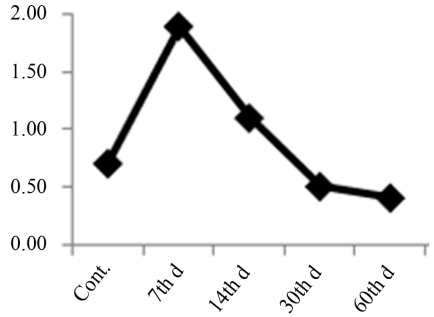

Figure 9. Eosinophil values.

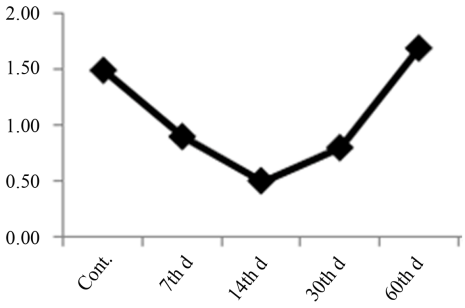

Figure 10. Basophiles values.

leukocyte counts and some granulocyte counts. This is an indicator of radiation provoked immune system damage [15]. Increased erythrocyte and hemoglobin values in mole rats, just like the Ostrichs, may be enlightened by the ability of fast running and high oxygen consumption and transport rates [30,31].

"Far ultraviolet radiation" with a wavelength of 100 - 1700 A˚ has enough energy for ionization. This is the type of ultraviolet radiation that is effective on the living beings. The longer exposure time of UV radiation shows more harmful effects on living beings. Loss in ozone layer will result with increased UVC exposure that will cause skin cancer, cataract and immune deficiency and impairs blood parameters [1,7].

Hematological and biochemical blood parameters are fundamental for the diagnosis of various diseases-both metabolic and infectious [32]. Higher leukocyte values indicate infectious disease. Heterophyl and eosinophil increase point out microbial and parasitical infections respectively and basophile domination indicates a parasitic disease [32,33].

5. CONCLUSION

In conclusion, according to UV radiation exposure in mole, rats were documented to cause some hematological values along the experiment. There was a significant increase in leukocyte counts, hemoglobin and monocyte value and a decrease in erythrocyte number and neutrophil values during the experiment. Statistically significant changes in hematocryte, eosinophil and basophile values could not be documented. These results indicate that the smaller wave UVC radiation has greater effects on some blood parameters than the others.

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