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Changes in the Concentration of Super Oxide Dismutase and Catalase in the Skin of Male Albino Rat after Acute and Sub-acute UVB Radiation

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Abstract

The present investigation highlights the concentration of skin super oxide dismutase and skin catalase in male albino rat after acute (1 day) and subacute (5 days) artificial UVB radiation. Twenty healthy male albino rats of 100 – 140 gm were selected for this investigation. Proper hygiene was maintained throughout the experiment. Albino rats were grouped into four sets and each set contained 5 male rats. Set A_1 (Control) and set A_2 (Control) were not exposed to artificial UVB radiation while set B_1 was exposed to 0.44 J/cm^2 of artificial UVB radiation continuously for 10 hours for 1 day and set B_2 was exposed to 0.088 J/cm^2 of artificial UVB radiation continuously for 2 hours for 5 days. Results represent a significant decrease in skin super oxide dismutase and catalase concentration after acute (1 day) and subacute (5 days) of artificial UVB radiation. Study concluded that the UVB radiation causes damage to the antioxidant system leads to decrease in SOD and catalase concentration. The investigation also indicates decrease in SOD concentration in the skin of male albino rats of set B_1 was more than the Set B_2.

***Key words*:** Acute, Subacute, Artificial UVB radiation, Male albino rat, Skin, Super oxide dismutase, Catalase

The three main wavelength components of electromagnetic radiation are ultraviolet radiation (5%), visible radiation (45%), and infrared radiation (50%). The wavelengths in the UV-C, UV-B, and UV-A ranges of the ultraviolet sun spectrum are 100–280 nm, 315–400 nm, and 280–315 nm, respectively. On February 22, 1801, Johann Wilhelm Ritter discovered the UV radiation. Ultra implies beyond in the Latin language, the word "ultraviolet" means "beyond violet." The light that is visible beyond violet is known as ultraviolet light. The wavelength and unit of measurement for ultraviolet light are nanometers.

UV-B radiation, which only makes up a very small portion of UV light, is the most active component of sunlight. All UV-C radiation is absorbed by the ozone layer, as is the majority of UV-B radiation (95%), but UV-A radiation is not at all absorbed. Chlorofluorocarbons (CFCs), which are frequently found in air conditioners and refrigerators, deplete the ozone layer. UV-B and UV-A radiations reach the earth because of the depletion of the ozone layer and cause a variety of negative impacts. Skin (Skin cancer), eye (cataracts) and immune system (immunosuppression) have been found to be seriously damaged by UV radiations. Immune system disorders may lead to cancer. The most common type of cancer is skin cancer. UV radiations cause skin cancer, melanoma, non-melanoma, basal cell carcinoma (BCC) and squamous cell carcinoma (SCC). About 93% of skin cancers are caused by exposure to ultraviolet radiation [1]. UV radiation can also cause inflammation, including erythema, vascular changes, etc.

UV-B radiations don't directly harm macromolecules or antioxidants, but damage to the antioxidants can affect the ageing process in the keratinocytes of the epidermis and increase the production of reactive oxygen species, which can lead to oxidative stress. Antioxidants are found on the surface of the skin. Epidermis-specific antioxidants include vitamin E, glutathione peroxidases and super oxide dismutase (SOD) and catalase. Extracellular space-specific antioxidants include ascorbic acid, uric acid and glutathione [2].

Antioxidant helps to neutralize the free radicals; however, if it does not, it can lead to oxidative stress, which is one of the primary causes of dermatological disorders. SOD is an antioxidant that turns super oxide free radicals into Hydrogen peroxide (H_2O_2) and oxygen (O_2). Catalase and Peroxidases turn H_2O_2 into water, which is harmless. In this sequence, two toxic species, super oxide free radicals and H_2O_2, turn into harmless products. The present investigation reveals biochemical changes in the skin of male albino rat, Rattus norvegicus (Berkenhout) under the stress of acute and subacute artificial UV-B radiation. The biochemical changes have been assessed in terms of concentration of skin SOD and skin Catalase in male albino rats.

MATERIALS AND METHODS

Twenty healthy male albino rats weighing between 100 and 140 g were used in the study. Rats were acclimated for 30 days to a photoperiod of 12 hours each day at temperatures 25

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± 30 °C and relative humidity 55% ± 5 with good hygiene. Albino rats were housed in tidy polypropylene cages, fed a standard laboratory food, and water *ad libitum*.

Experimentation

The current study was conducted using a 90 × 45 × 30 cms rectangular UVB radiation chamber composed of 3 mm thickened glass. In the radiation chamber, a Philips F30T8 fluorescent tube light was installed 45 cm away. The hair remover was administered to the dorsal side of rat in order to precisely remove the hairs. The albino rats were exposed to artificial UVB radiation to different dose and different time duration vide infra. In the current study, there were four different treatment groups: Set A_1 was a control group without UVB exposure after 1 day; Set A_2 was a control group without UVB exposure after 5 days; Set B_1 was an exposure group exposed to 0.44 j/cm^2 of UVB radiation continuously for 10 hours for 1 day; and Set B_2 was an exposure group exposed to 0.088 j/cm^2 of UVB radiation continuously for 2 hours/day for 5 days. Probit analysis was used for UVB radiation dose fixation [3].

Biochemical and statistical methods

The skin SOD was estimated by Winterbourn *et al.* [4] and skin Catalase was estimated by Sinha *et al.* [5]. The biochemical data was put into statistical analysis using method of Fisher and Yates [6]. Mean and unpaired t-test of biochemical changes were assessed for different exposed and unexposed male rats.

RESULTS AND DISCUSSION

The skin protects the animal body from various environmental factors. The skin plays various roles for the body such as immunological response, thermoregulation, barrier response, protection against water loss, insulation, elimination and toxic secretion. The skin is a prime target for UVB radiation and is susceptible to the effects of UVB radiation. Additionally, UVB radiation is produced by artificial sources of light, such as UVB tube light, in addition to natural sunlight. In current study, biochemical changes in the concentration of SOD and Catalase have been observed after artificial exposure of UVB radiation to albino rats. This study showed that skin toxicity depends on the dose and duration of exposure to UVB; this is also supported by the observations obtained from the unpaired t-test. The results from this study also showed that acute and sub-acute exposure to UVB is less toxic than chronic exposure to UVB. Acute and sub-acute UVB exposure decreases the concentration of SOD and Catalase (Table 1-2).

Table 1 Skin SOD concentration (Units/mg) in control and exposed male rats

No. of exposure days	Control set (5) Range (Mean ± S.Em.)	Exposed set (5) Range (Mean ± S.Em.)
1	1.36-1.54 (1.40±0.035)	0.15-1.32 (0.40±0.230)***↓
5	1.35-1.53 (1.42±0.035)	1.17-1.30 (1.26±0.025)***↓

S. Em.- Standard error of mean ↓- Decrease (5) - No. of rats
***- Very highly significant (p<0.001)

Table 2 Skin Catalase concentration (mmoles/min./ml.) in control and exposed male rats

No. of exposure days	Control set (5) Range (Mean ± S.Em.)	Exposed set (5) Range (Mean ± S.Em.)
1	1.70-2.20 (1.80±0.100)	0.40-1.38 (0.70±0.198)***↓
5	1.70-2.28 (1.82±0.115)	1.55-1.65 (1.60±0.021)*↓

S. Em.- Standard error of mean ↓- Decrease ***- Very highly significant (p<0.001) (5) - No. of rats * – Significant (p<0.05)

This could be happened because skin toxicity to UVB radiation depends on the amount and duration of exposure, it is possible that this could be caused by the more radiant energy given to the rats for 10 continuous hours for 1 day. When time duration of UVB exposure decreased to 2 hours per day for 5 days, the decrease in super oxide dismutase (SOD) and Catalase exhibited increasing trend (Fig 1-2).

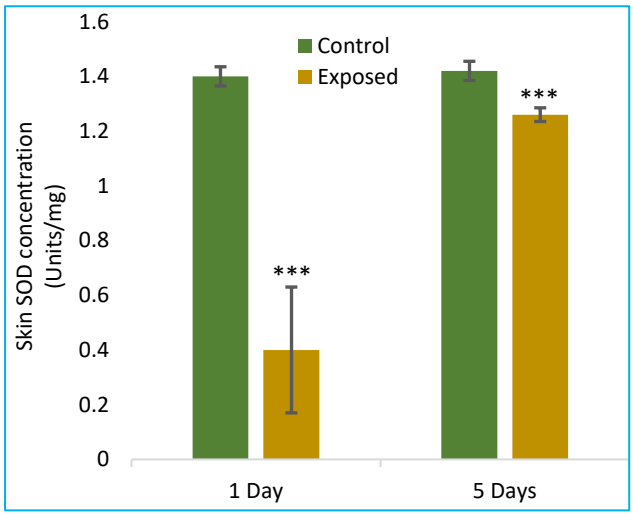

Fig 1 Skin SOD concentration (Units/mg) in control and exposed male rats

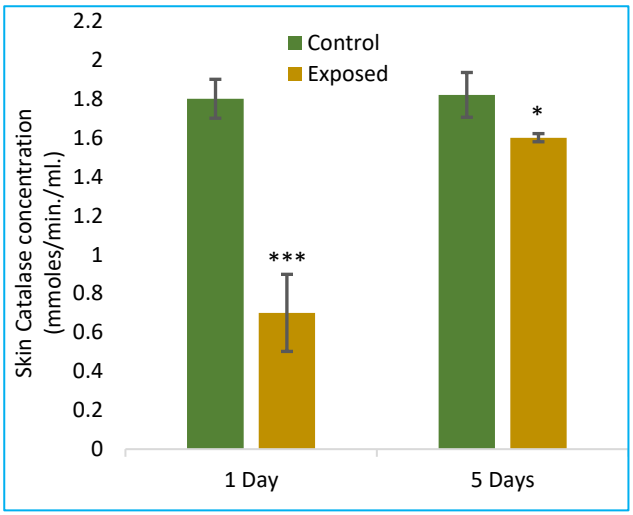

Fig 2 Skin catalase concentration (Units/mg) in control and exposed male rats

The formation of reactive oxygen species (ROS) is an initiator of acute UVB irradiation, which may result in cellular damage. Antioxidants, such as super oxide dismutase (SOD), can mitigate the damage caused by oxidative stress, however, in oxidative stressed conditions, the concentration of antioxidants is significantly decreased. Exposure to UVB

significantly reduces the activity of SOD [7-8]. Repeated UV exposure might cause skin ageing which may lead an increase in ROS as a result of antioxidant system failure. The level of SOD and Catalase was decreased after UVB radiation exposure [9-10]. Content of SOD and Catalase was decreased and lipid peroxide content was increased in hypercholesterolemic albino rats. Various studies proved that UVB radiation caused the hypercholesterolemia in albino rats [11-12]. Biochemical changes in the SOD are held by the strike of radiant energy on the skin and the radiant energy is produced by the excitation of electrons. It is thus obvious that UVB produce damages to the skin which is proved biochemically.

CONCLUSION

The albino rats were exposed to UVB radiation both acutely and sub acutely. After conducting a biochemical analysis on rat skin, it was shown that the concentration of the antioxidant enzyme super oxide dismutase (SOD) and Catalase was significantly disturbed. The concentration of super oxide dismutase (SOD) and Catalase was decreased in the skin of albino rats when compared to control rats after acute and subacute UVB exposure. It is demonstrated by the findings that were obtained after using the unpaired t-test, and the hypothesis was accepted with significant differences in the biochemical changes caused by UVB exposure for different durations. The current analysis uncovered the biochemical findings, which point to precancerous alterations in the skin. As a result, the current work can be crucial in developing preventive strategies for cancer.

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