Effect of Gamma Ray on Reactive Oxygen Species at Experimental Animals

Zakaria KM*

Nuclear and Radiological Regulatory Authority, Egypt

Abstract

The present study was designed to investigate the oxidative stress, which is due to the effect of low doses of gamma irradiation. Animals were divided into 6 groups, where the first group kept as control group, while 2nd, 3rd, 4th, 5th and 6th groups were exposed to gamma ray at 1.5 Gy, 2 Gy, 2.5 Gy, 3 Gy and 3.5 Gy once weekly for one month respectively. Rats were subjected to gamma radiation and nitric oxides (NO), superoxide dismutase (SOD), malondialdehyde, alanine aminotransferase (ALT), aspartate aminotransferase (AST) and white blood cells (WBCs) were measured. SOD recorded highly significant decrease with percent change -22.7%, -25.01%, -55.01% -55.4% and -56.38% respectively in groups which were exposed to 1.5, 2, 2.5, 3 and 3.5 Gy. MDA serum level have a significant increase in groups which were exposed to successive doses of 1.5 Gy, 2 Gy, 2.5 Gy, 3 Gy and 3.5 Gy respectively with percent change 25.7% , 41.8% 59.1% 65.6% 75.8% consequently as compared to control group. Nitric oxide serum level is markedly showed highly significant increase in rats exposed to successive dose of 1.5, Gy, 2 Gy, 2.5 Gy, 3 Gy and 3.5 Gy respectively with percent change 59.69%, 74.17%, 87.1%, 120.1% and 130.6% consequently as compared to control group. ALT and AST recorded highly significant increase in rats exposure to successive doses of 1.5, Gy, 2 Gy, 2.5 Gy, 3 Gy and 3.5 Gy respectively. On the other hand WBCs recorded highly significant decreased in rats exposed to successive dose of 1.5, Gy, 2 Gy, 2.5 Gy, 3 Gy and 3.5 Gy respectively. WBCs recorded percent change -26.11%, -32.3%, -47.8%, -50.1% and -53.6% respectively as compared to control group.

***Corresponding author:** Khaled Zakaria, Nuclear and Radiological Regulatory Authority, Nasr City 11762, P. O. Box: 7551, Cairo, Egypt, E-mail: drkhaledzakaria@gmail.com

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cytoplasm of the cells removes H_2O_2 by coupling its reduction to H_2O with oxidation of GSH. Glutathione reductase regenerates GSH from oxidized glutathione in the presence of NADPH. GSH is a tripeptide and a powerful antioxidant present within the cytosol of cells and is the major intracellular non protein thiolcompound [21].

e data presented in Table 2 show that MDA serum level have a signi cant increase in groups of rats exposed to successive dose of 1.5 Gy, 2 Gy, 2.5 Gy, 3 Gy and 3.5 Gy respectively showed percent change 25.7%, 41.8%, 59.1%, 65.6%, 75.8% consequently as compared to control group. MDA elevation take place as a result of histopathological changes in the liver included dilatation of blood vessels congestion in the lobules, enlargement of portal areas, and in ltration of mixed in ammatory cells around the necrotic hepatocytes and the portal area. ese results was found to be in agreement with that observed by Burlakova [22] who reported that exposure to γ-irradiation induced liver lesion was associated with massive elevation in liver MDA level. Also the MDA elevation has been well accepted as a reliable marker of lipid peroxidation. Exposure to γ-irradiation decreased the activities of these antioxidant enzymes in the tissues, indicative of oxidative stress in the liver. e decline in these enzymes in the present study could be explained by the fact that excess superoxide radicals may inactivate H_2O_2 scavengers, thus resulting in inactivation of superoxide dismutase [23]. From the previous reports of Tyurina et al. [24] **t**he increase in MDA could be explained on the basis that ionizing radiation induces lipid peroxidation through the radiolysis of water in the aqueous media of the cells which leads to production of hydroxyl radicals (•OH). Hydroxyl radicals interact with the polyunsaturated fatty acids in the lipid portion of biological membranes initiating the lipid peroxidation and nally damage the cell membranes [25]. Also, the exposure to γ-radiation produces a decrease of membrane uidity of the erythrocytes**,** membranes which was suggested to be resulted from lipid peroxidation of polyunsaturated fatty acids in such membranes induced by g-irradiation [26]. Some studies have reported that irradiation increases MDA formation as an end product of lipid peroxidation.

e data presented in Table 3 show that nitric oxide serum level is markedly highly signi cant increase in rats exposure to successive dose of 1.5 Gy, 2 Gy, 2.5 Gy, 3 Gy and 3.5 Gy respectively with percent change 59.69%, 74.17%, 87.1%, 120.1% and 130.6% consequently as compared to control group . In the present study, irradiation of rats induced lipid peroxidation signi cantly and protein oxidation and increased NO levels and reduced antioxidant defense indicating increased oxidative stress. e increased levels of TBARS (an index of lipid peroxidation) in NO of gamma- irradiated rats, may be due to the attack of free radical on cell membrane phospholipids and circulating lipids and, thus, TBARS acts as a sensitive biomarker for oxidative stress that occurs as part of the pathogenesis of various diseases [27,28].

ese results are in agreement with Ou et al. [29], which postulated that free radicals caused lipid peroxidation in the irradiated tissue Moreover, Ibuki et al. [30] examined a wide variety e ects for ionizing radiation at doses 3 Gy and 4 Gy in nitric oxide , which indicated an increased in NO in blood level at dose 3Gy and 4Gy. Radiation induced injury on peripheraide and circr for ye 1sis o3ur22t ectAl5thats6hpared

percent change 87.9%, 111.1%, 131.2%, 150.5% and 158.3% respectively as compared to control group. On the other hand AST recorded 27.1%, 44.68%, 65.6%, 75.5%, 75.5% and 90.1% in groups which exposed to whole body gamma irradiation at dose level of 1.5 Gy, 2 Gy, 2.5 Gy, 3 Gy and 3.5 Gy respectively as compared to control group. e oxidative stress due to free radical formation was greatly augmented during ionizing radiation exposure [34]. It was likely that animal particular antioxidants generally decrease the level of oxidation in such systems by transferring hydrogen atoms to the free radical structure [35]. Gamma irradiation showed an increase in the level of serum AST, ALT and ALP activities indicative to the toxicity induced by radiation exposure (Table 4). ese results are in agreement with those previously reported

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