EFFECT OF FEEDING ALBINO RATS WITH IRRADIATED WHEAT GRAINS ON BODY WEIGHT AND SOME HEMATOLOGICAL PARAMETERS

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Abstract. It has been proved that irradiating wheat grains with definite doses of fast neutrons increased wheat yield and also its quality, while being safe for eating. This study was conducted to investigate the effect of feeding albino rats with wheat grains (Sakha, 92) irradiated with three various neutron fluencies 10^5, 10^6, 10^7 n/cm^2, respectively, from a ^{252}Cf source, through measuring the changes in the whole body weight and some hematological parameters. Forty albino rats were divided into two groups; the first group (30 rats) was fed with first generation grains, after irradiation with the three neutron fluencies respectively (10 rats for each) and plantation. The second group (ten rats) was fed with unirradiated wheat grains and used as control. The feeding was overtaken for 12 weeks. The whole body weight was measured for all the rats before and after the feeding period. Also, some hematological parameters such as RBCs counts, HB content, PCV, MCV, MCH, MCHC and WBCs, PLT counts were investigated for the two groups In experimental diet rats there were no significant changes at p <0.05 in the whole body weight relative to the control; slight changes were noticed in all the investigated hematological parameters.

Key words: wheat grains, fast neutrons, rats, hematological parameters.

INTRODUCTION

Food irradiation is an important application of nuclear energy for the benefit of mankind [15]. The modern applications and important aims to use ionizing radiation such as γ-rays and fast neutrons in agriculture are to produce a new variety with good mutation and consequently good yield [7, 9].

The effect of fast neutrons upon wheat grains produces new and superior wheat cultivars [1, 5, 18]. Studies on some morphological properties and physiological parameters of wheat grains irradiated with fast neutrons were carried out by Hanafy [11]. The results showed that irradiation of wheat grains with the

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neutron fluence of 2.0×10^6 n/cm^2 stimulated the plant growth leading to a quantity and quality mutant and produced a good yield.

The goal of this study was to investigate the biological effects of feeding albino rats with irradiated wheat grains to ensure that it is safe for humans to eat the crop resulted from irradiated wheat grains (first generation).

In the same idea, Shin and Cho [22] observed little difference in organ weights among rat groups treated with irradiated food ($p < 0.05$). E. Kim *et al*. [17] reported that the gamma-irradiated fat feeding did not affect the plasma lipid concentrations. M.J. Kim and J.H. Kim [16] found no significant effect on the food of pork by gamma irradiation. Roongrotchinda *et al*. [20] found that irradiation of all of food types had no statistical significance at $p < 0.01$ on the reproductive parameters and food consumption in Sprague-Dawley rats. Kalyani *et al.* [14] concluded that there was a significant difference at $p = 0.01$ level in the food consumption pattern and weight gain of albino rats fed with control and experimental soya mix, but no difference was observed between the groups fed with the irradiated and non-irradiated diets.

Irawati and Sani [13] used different foods irradiated with gamma rays at the dose of 45 kGy. The results demonstrated that such foods did not give any adverse effect on the reduction of body weight, the toxicological impact, nor anatomy-pathology examinations of the rats.

In the present work, wheat grains Sakha 92 were chosen because they are the major food crops not only in Egypt, but also globally. Unfortunately, the demand for them exceeds by far the supply and in a previous work [11] we proved that a definite dose of fast neutrons having the fluency of 2×10^6 n/cm^2 increased the grain yield. Hence we aimed in this work to study the biological effects of feeding albino rats with wheat grains irradiated with various fast neutrons fluencies in the range $10^5 - 10^7$ n/cm^2 to ensure that eating the yield of irradiated wheat grains is safe for humans. The study performed through measuring the whole body weight of the examined rats and also through studying the changes in some hematological parameters of the rats, such as erythrocyte counts (RBCs), hemoglobin content (HB), packed cell volume (PCV), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), leucocytes counts (WBCs), and platelet counts (PLT). The study was achieved for two groups, one group fed with first generation grains (after irradiation and plantation) in addition to control rats, fed with unirradiated grains. The feeding was overtaken for 12 weeks.

MATERIALS AND METHODS

The analytical work was carried out in the Biophysics Laboratory of the Physics Department of the Faculty of Science of Zagazig University, Egypt.

PLANT MATERIAL

Wheat grains (*Triticum aestivum* L.), Sakha 92 variety, were obtained from the Agriculture Research Center in Cairo, Egypt. The grains were divided into four groups (A, B, C and D). All the grains were soaked for 24 hours and group A was kept unirradiated, while the other groups were irradiated with three various neutron fluencies, respectively. After irradiation process, the groups A, B, C, and D of grains were planted in the wheat green house at the Faculty of Agriculture of Zagazig University and regularly watered until complete germination, to produce first generation grains and the yield was used.

IRRADIATION PROCESS

The irradiation was performed at the Biophysics Department of the Faculty of Science of Cairo University, Egypt. A ^{252}Cf point source (E = 2.8 MeV) manufactured by Radiochemical Center, Amersham, England was used. Mature soaked wheat grains of groups B, C and D were irradiated with 4.0×10^5, 2.0×10^6 and 1.0×10^7 n/cm^2 of fast neutrons, respectively. The distances between the source and the groups of grains were equal, but the time of irradiation was different: 8 minutes for 4×10^5 n/cm^2, one hour for 2×10^6 n/cm^2, and 3.5 hours for 10^7 n/cm^2.

EXPERIMENTAL ANIMALS

Forty albino male rats in the weight range of 80±5 g were divided into four groups A1, B1, C1 and D1, 10 for each, and were fed with grains of groups A, B, C and D, respectively.

The animals were fed equally with grains of about 400 g daily in addition to some vegetables. Food and water were provided *ad libitum* and the rats were kept on constant environmental conditions and temperature about 26 °C. The feeding period was of 12 weeks.

WEIGHT FACTOR

After each experiment the weight of each rat of each group was measured for 5 times to obtain the mean, and then mean weights of the rats of each group were carried out to calculate the standard deviation for each group. The Mann-Whitney U-test was used to determine the significant differences at $p < 0.05$.

HEMATOLOGICAL PARAMETERS

Blood samples were obtained after the sacrification of the rats by cervical dislocation at the end of the experiment .The samples were collected either on 0.2% EDTA anticoagulant for evaluation of erythrocytes (RBCs count, Hb concentration, PCV, MCV, MCH and MCHC) and leukocytes (total leukocyte count, WBCs), or on 1% ammonium oxalate as anticoagulant for platelet counts (PLT), using standard techniques according to Feldman *et al.* [6].

After each experiment the average reading of each hematological parameter was carried out for each rat in each group, and then the hematological parameters value of the rats in each group was carried out to calculate the standard deviation. The Mann-Whitney U test was used to determine the significant differences at $p < 0.05$.

RESULTS

Because of the good results of irradiation of wheat grains with neutron fluency of 2.0×10^6 n/cm^2 in our previous work [11], which stimulated the plant growth and led to a quantity and quality mutant and produced a good yield, it was necessary to ensure that eating the yield of irradiated wheat grains is safe for humans. The biological effects of feeding albino rats with wheat grains irradiated with various fast neutrons fluencies were carried out.

BODY WEIGHT MEASUREMENTS

Figure 1 presents the changes in whole body weight of all groups. It is clear that the two groups fed with first generation grains B, C, and D resulted in a slight decrease at $p < 0.05$ in the whole body weight relative to the control group.

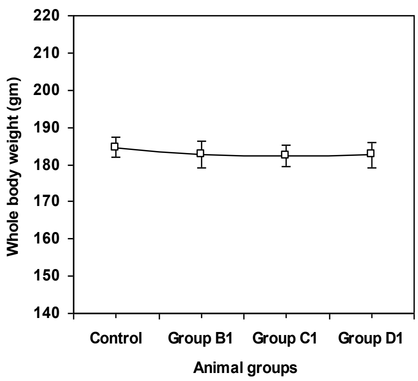

Fig. 1. The changes in whole body weight of all groups.

HEMATOLOGICAL PARAMETERS MEASUREMENTS

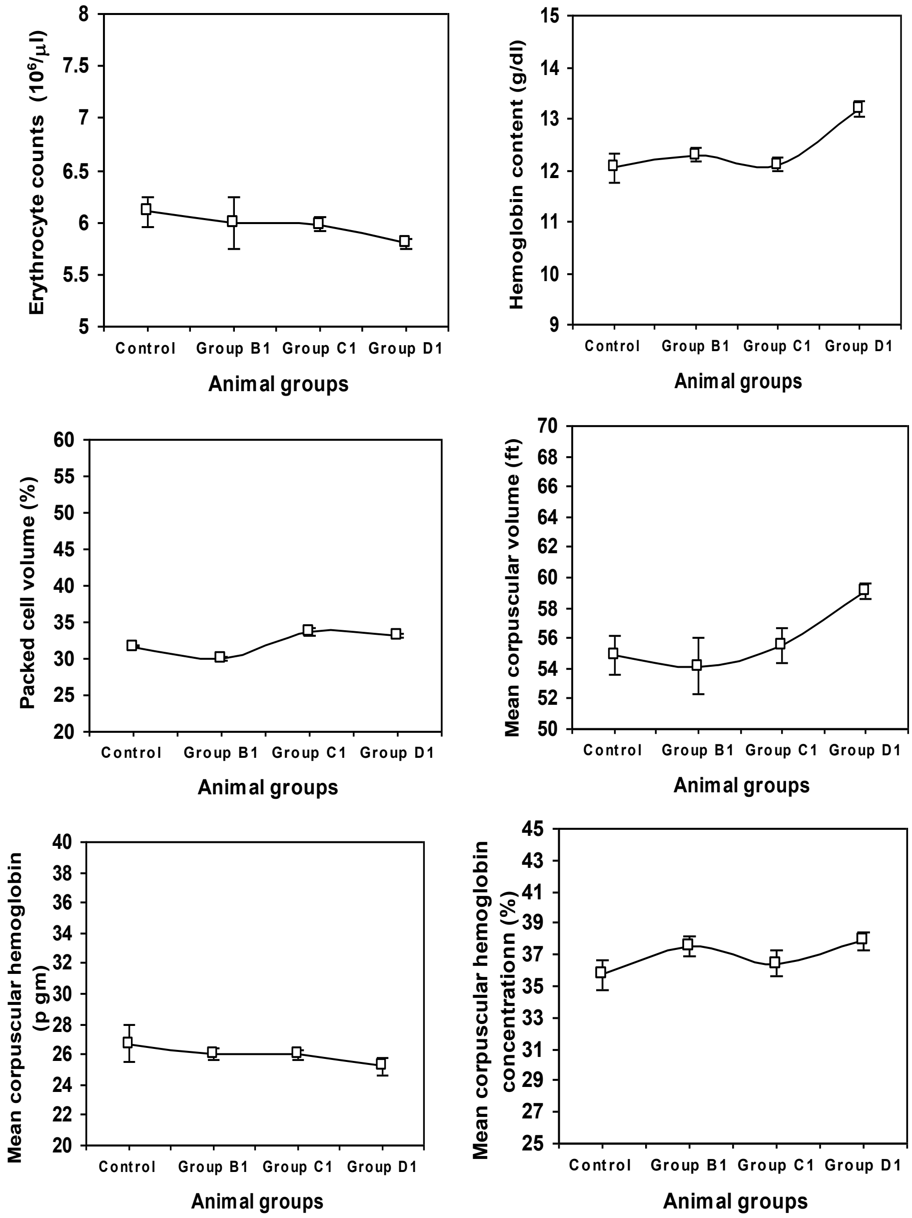

Fig. 2. The changes of erythrocytes parameters of control rats and rats fed with irradiated wheat grains irradiated with three neutrons fluencies for group one and group two.

Figure 2 presents the erythrocytes parameters of groups A1, B1, C1 and D1. It is clear that there is no significant change for the parameters, except the count of RBCs for the rats feeding with grains irradiated with 10^7 n/cm^2, where RBCs decrease and hemoglobin content increased. For the other two neutron fluencies (2×10^6 and 4×10^5 n/cm^2) there is no change relative to the control rats. It is clear that feeding the rats with grains irradiated with 2×10^6 n/cm^2 gives a good result and the hematological parameters of the experimental rats are approximately like those of the control.

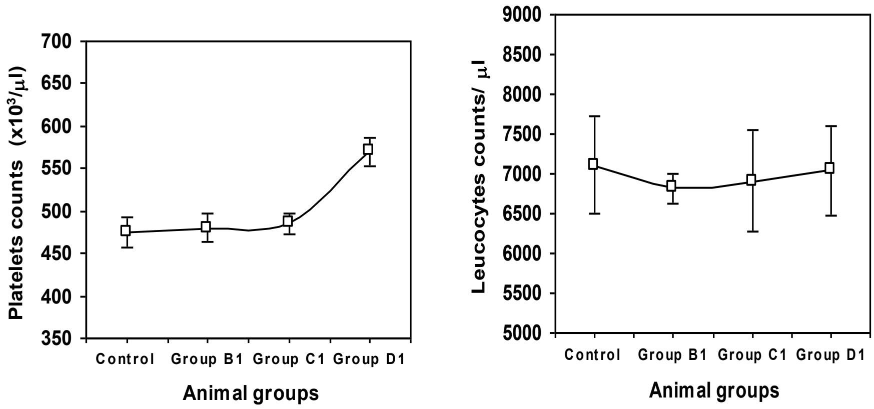

Fig. 3. The changes of leukocytes and platelets counts of control rats and rats feeding with wheat grains irradiated with three neutrons fluencies for group one and group two.

Figure 3 presents the leukocytes and platelets counts of groups A1, B1, C1 and D1. It is clear that there is no significant change for groups A1, B1, C1, but platelets counts for group D1 (rats who were fed with grains irradiated with 10^7 n/cm^2) increased relative to the other. For the leukocytes there is no significant change for groups C1 and D1 relative to the control rats, but for group B1 it is smaller than the others. It is clear that irradiation of the grains with neutron fluency 2×10^6 n/cm^2 give a good result and is not harmful for the rat health.

DISCUSSION

It may be presumed that the interaction of fast neutrons with biological materials may result in the generation of highly active nuclei recoils, resulting in highly active protons, carbon, oxygen and nitrogen. These highly active nuclear species migrate in the structure network of the biological material, lose their kinetic energies through further recoil processes with macromolecules leading to deficient regions (not completely occupied energetic levels) and highly energetic radicals. These free radicals may recombine again at random leading to new molecular forms [10, 12]. For example, Hanafy [8] used fast neutrons to change the molecular structure of snake venom to be safe and for medical uses.

Since fast neutrons have the maximum logarithmic energy decrement per collision and large scattering cross section with hydrogen nuclei, the interaction of fast neutrons with hydrogenous material will lead to high moderation of fast neutrons in this medium, and high energy will be transferred to the hydrogen nuclei forming the main structure of the biological macromolecules. Based on these hypotheses, one can imagine how fast neutrons interacted with the wheat grains. Then, the changes in molecular structure of the irradiated biological macromolecules can be either better or worse, according to the types of radiation and according to the dose, since the irradiation processes were externally.

This phenomenon was supported by irradiating rice seeds with different neutrons fluencies and a good yield was produced [7].

Our results have shown that there is no significant increase ($p < 0.05$) in the whole body weight relative to the control rats, especially for the irradiated grains with the dose of 2.0×10^6 n/cm^2. These results are in good agreement with studies of Irawati and Sani [13], who used different foods such as steamed gold fish, spicy curry beef and soy sauces beef irradiated with gamma rays at the dose of 45 kGy. The results demonstrated that such foods did not give any adverse effect on the reduction of body weight, the toxicological impact, or anatomy-pathology examinations of the rats. Also, feeding of albino rats with Soya mix subjected to radiation processing at 0.75 kGy was studied for the effect of radiation processing on food consumption patterns and weight gains by Kalyani *et al.* [14]. The study concluded that there was a significant difference at 1% level in the food consumption pattern and weight gain of albino rats fed with control and experimental soya mix, while no great difference was observed between the groups fed with the irradiated and non-irradiated diets. Shin and Cho [22] observed that, after 8 weeks, rats given diets irradiated with 5 kGy presented little difference in organ weights among groups $p < 0.05$).

In addition to increasing the yield of the wheat grains irradiated with 2.0×10^6 n/cm^2, a higher concentration of some ions, such as Zn^{2+}, Na^+, Mg^{2+}, Fe^{3+}, K^+ and also crude protein in the irradiated wheat grains were observed [11]. The blood serum parameters of the rats fed with the irradiated grains may change considerably, due to the importance of those elements in the body.

Dani and Dhawan [3] reported that zinc supplementation in ^{131}I treated rats attenuated the adverse effects caused by ^{131}I on the levels of antioxidative enzymes. Also Malhotra and Dhawan [19] found that zinc supplementation to lithium-treated rats effectively raised the reduced glutathione levels and also normalized lipid peroxidation and activities of antioxidative enzymes. Chen *et al.* [2] explained that zinc transferrin stimulates red blood cell formation in the head kidney of common crab.

In addition to the fact that the presence of sodium ions is beneficial for transportation of ions through the cell membrane, also magnesium is known to be an important trace element in bone and teeth, it plays a key role in bone metabolism and its depletion cases bone fragility and bone loss [21]. Potassium depletion in RBC could contribute to the development of future hypertension [4].

Also our results are supported by Kim *et al*. [17], who reported that the gamma-irradiated fat feeding did not affect the plasma lipid concentrations; in addition, M.J. Kim and J.H. Kim [16] found no significant effect on the pork food by gamma irradiation.

Roongrotchinda *et al*. [20] studied the effect of pasteurized, irradiated, and autoclaved food on reproductive performance as percentage of fertilization (% *F*), percentage of wean (% *W*), percentage of production (% *P*) and litter size of the outbreed Sprague-Dawley rats and found that all of food types had no statistical significance at $p < 0.01$ on reproductive parameters and food consumption.

All these results are supported by Shin and Cho [22]: Packed cell volume, plasma protein, plasma albumin and plasma glucose were not affected by irradiated diets in the used rats.

CONCLUSION

We concluded here clearly that feeding rats with irradiated wheat grains is not harmful for their health and this can be extrapolated to human being. This study showed that the irradiated wheat grains can be used in the production and supply process that does not affect the health.

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