كليـة العلـوم

STUDY A CORRELATION BETWEEN THE EFFECT OF DIFFERENT DOSE RATES ON ORGANS, TISSUES AND THE REGIONAL DISTRIBUTION OF THE CONCENTRATION OF TRACE ELEMENTS IN MAMMALS

THESIS

Submitted for the degree of doctor of philosophy in physics

TO

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بسم الله الرحمن الرحيم

قَالُوا سُبْحَانَكَ لَا عِلْمَ لَنَا إِلَّا مَا عَلَّمْتَنَا إِنَّكَ أَنْتَ الْعَلِيمُ الْحَكِيمُ .

صدق الله العظيم

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SYNOPSIS

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SUMMARY

For studying the effect of different doses of γ-rays on some of tissues and organs of albino rats, as well as its effect on the regional distribution of trace elements in these tissues and organs, we divide this thesis to five chapters.

CHAPTER ONE.

It is considered as an introduction for this study, where we review from the published papers the early and late responses of living tissues to γ-ray doses. A historical review for the effect of fractionating the irradiation dose to several doses of equal or different values at close and equal intervals of time. The isoeffect models as the linear quadratic model, incomplete repair and continues irradiation models.

CHAPTER TWO.

The effect of the irradiation doses from zero to five Greys, on the muscles force had been studied up to fifty days after irradiation. For measuring the muscles force the **Load Cell 20** apparatus (for measuring tension and maximum limit for elongation) was modulated by adding part for transferring the rats muscles force to the motion and measuring parts of the apparatus. By measuring the apparatus efficiency after this addition, the accuracy was 97% with sensitivity of 10^{-3} Newton.

By inspection of the obtained results, an empirical formula was deduced for characterizing the different probable phases for the muscles up to total recovery. This formula includes the effect of

irradiation dose and time after irradiation on the muscles force. It was found that, the muscles force of the irradiated rats from 1 to 5 Gy. passes through three phases.

- The first : started after irradiation up to 4 days.
- The second: from 4 days up to 17 days.
- The third : from 17 days till 50 days.

In the first phase, the muscles force increases as an exponential function with respect to time after irradiation. In the second and third phases, the function was linear (for every dose). In case of control rats (0 Gy), the muscles force passes into two phases the first from beginning of the experiment up to 25 days (males) and 31.5 days (females). The second phase started from the end of the first up to the end of the experiment. In these two phases, the increase in the muscles force was linear with respect to the time, but the difference was in the rate of this increase.

By comparing the daily increase in the muscles force for treated and control rats, it was found that, the first is larger by a factor of 3.26 (males), 2.03 (females) for the first phase, then decreases in the second phase to 1.08 times (males) and 0.94 (females).

On the other hand, the study of the dose effect on the half recovery period for muscles and comparing this by the dose effect on the percentage loss of the muscles force for both sexes has been carried out. It was found that, the half recovery period increases with a little rate for doses up to 3 Gy, then the increase is large for higher doses in males and females. The values of females were in the range of $\frac{1}{2}$ to $\frac{2}{3}$ the corresponding intervals of males of the same dose

In case of the dose effect on the percentage loss, the variation between males and females was clear. For the dose of 1 Gy, the difference is ≈ 4% (the increment was for males). This gap increases to 11.5% (2 Gy), 13.8% (3 Gy) then decreases again to 4.32% (4 Gy) and nearly vanishes 0.54% (5 Gy), so it is expected that, the percentage loss for females will be larger for doses above 5 Gy.

By data extrapolation, the total percentage loss (100%) was at 7.6 Gy (males) and 6.4 Gy (females) i.e. the dose of 5 Gy is considered as the limit of the irradiation effect on males and females.

CHAPTER THREE.

For calculating the full energy peak efficiency of a cylindrical (extended range) high purity germanium detector for sources with different geometrical shapes (point, disk, cylinder) placed coaxially with the detector at different positions, a simple treatment is outlined including the principle of calculation method, a phenomenological discussion about the probable interactions of γ-ray with the detector material and (in some details) the used mathematical model, taking into account the geometrical dimensions of the detector as well as the used sources and the correction factors (the attenuation process of the γ-ray along its path, as well as the probability of a γ-ray impinging on the active zone of the detector to interact with the detector material before leaving it and the probable discarded paths). There were attention by:

1- Sources with diameters larger than the detector radius.

2- Percentile error due to unaccurate values of the used parameters (the geometrical dimensions of the detector, sources and the linear attenuation coefficient μ_G of γ-rays).

From this study, we concluded that:

1) The detector peak efficiency can be carried out (using the geometrical parameters of the detector and point sources instead of using sources with corresponding dimensions with that of the tested samples) by calculating the effective solid angle at reference position, at the desired distance from the detector (measuring position) and the total peak efficiency for point sources at the reference position.

2) For increasing the accuracy in the peak efficiency calculation such that the percentage errors are ± 2% (for small sources) and ± 3% (for large sources), then the maximum permissible error in the used parameters values are:

* ± 0.1 mm	detector radius,
* ± 0.3 mm	source radius,
* ± 3%	n-layer, μ_G,
* ± 5%	the rest parameters.

CHAPTER FOUR.

A study of the late effects of radiation on the blood clearance in some organs of ^{131}I-Cholografin and using this method for testing the physiological organs efficiency after 60 days of irradiation with 5 Gy, was carried out.

As an introduction to this study, we outlined some concepts about haemopoietic function, reservoir function, the phagocytic and reticoloendothelial activity, ^{131}I-Cholografin characteristics, basic principles of tracer techniques, isotope dilution principle, biological and physical half lives and K-factor with its calculation methods.

From the obtained results of blood, brain, muscles, heart, lung, liver, kidney, spleen and the thyroid gland, an empirical formula was deduced, showing the ^{131}I-Cholografin concentration as a function of clearance factor and time after injection. According to this formula, the concentration ratio passes into two phases (one is fast and the other is slow) for both filter organs and the others.

A brilliant observation in this study is that: the concentration of ^{131}I-Cholografin in blood, brain, muscles, lung, and the thyroid gland tend to increase at the same time with increasing the irradiation dose, but decreases in heart, spleen, liver and kidney. This may be lead to the conclusion that ^{131}I-Cholografin causes immediate chelation of blood calcium and this makes micro-colloidal substance which is ingroup by the reticuloendothelial system.

Since the uptake ratio of ^{131}I-Cholografin in the thyroid gland increases at the same time with increasing the irradiation dose, this lead to that, the thyroid gland becomes more active by irradiation.

CHAPTER FIVE.

The effect of radiation doses and sex on the regional distribution of the concentration of some elements as **P, S, Cℓ, K, Ca, Fe, Ni, Zn and Se** in some tissues and organs of the albino rats as hair, bone, muscles, heart, lung, brain, liver, spleen, kidney and testes have been studied by using X-ray fluorescence.

As an introduction to this study, we outlined (in some details) the factors: affect on the trace elements concentration in the body, which are the type of tissue or organ, normality or abnormality of the tissue, diet, job and the individual habits, age and sex, geographical environment, racial factor as well as disease and drug treatment before analysis. Also we review the relation between trace elements and disease, interrelation between these elements as well as the different techniques used in trace elements analysis, then we pay more attention to X-ray fluorescence technique which we used in this study.

From this study we find that:

1) The maximum concentration of **P** and **Cℓ** were found in hair, while that of **Ca** in bone, **P** in brain and **Fe** in spleen for males and females. The testes have maximum concentration of **K** and **Zn** while hair of females has maximum concentration of **Zn** and **Se**. This degree of maximum content does not affect by irradiation although changing the concentration.

2) The effect of irradiation on the elements concentration in most organs is different either by increasing or decreasing where the variation range was large. Generally, the number of increasing or decreasing cases (case represent the concentration of any element in any organ) in males were 52:38, but for females were 28:52. The distribution of increasing to decreasing cases for each organ was:
   a) For males, **Ca 9:1, P 7:3, Se 7:3, K 6:4, Ni 6:4, Zn 6:4, Fe 4:6, Cℓ 4:6, S 3:7.**
   b) For females, **K 7:2, Cℓ 5:4, Zn 5:4, P 3:6,** each of **S, Ca, Fe** and **Se 1:8,** the **Zn** in liver remain without changing.

3) There were some elements in some organs can be considered as radio-resistant where the variation range in their concentration were ± 6%. There were also other elements can be considered as radiosensitive where their variation range was ≥ 20% to 266% and from -20% to -99%.

LIST OF FIGURES