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The effect of Curcumin extract (*Curcuma xanthorrhiza*) and gamma radiation exposure on the area of the free radical curve in the lungs of mice (*Mus musculus*)

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ABSTRACT

The interaction of radiation with cells will form free radicals. Free radicals can cause cell damage. The presence of free radicals contained in cells could be detected using Electron Spin Resonance. Antioxidant compounds could minimize free radicals. This study analyzed curcumin extract and gamma radiation exposure on the area of free radical curves in the lungs of mice. Eighty male mice were used in this study and were divisible into three groups, namely the negative control group, the non-extract radiation group, and the extract plus radiation group. Curcumin extract was given at a dose of 1,4 gr/kgBB; 2,0 gr/kgBB; 2,6 gr/kgBB; 3,2 gr/kgBB and 3,8 gr/kgBB. The mice were exposed to gamma radiation for 10, 20, 30, 40, and 50 minutes. The results showed that curcumin extract, which was given as prevention from gamma radiation, reduced the area of the free radical curve from 0,630 cm^2 to 0,004 cm^2.

Keywords: Curcumin extract, gamma radiation, lungs of mice

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INTRODUCTION

Currently, nuclear technology was used widely in the health sector for human welfare, one of which is therapy. Therapies used to emit radiation originating from radioactive sources, such as Co-60, Am-241, and Cs-137. These radioactive sources emit gamma radiation (Amilin, Zumani & Sunarya, 2015). Because gamma radiation has enormous penetrating power, it was used widely for cancer therapy.

When a person has lung cancer and is using treated gamma radiation, the right part of the lungs will also be exposed to radiation. This medium will cause damage to healthy lungs. Damage occurs due to the interaction of radiation with cells, resulting in free radicals (Ardiny, Supriyadi, & Subiyantoro, 2014).

Research shows that a radiation dose of 100 rad can cause damage (necrosis) in pancreatic β cells, which triggers cell death so that insulin secretion decreases (Zulkarnain, 2013). At a 250 rad dose, it causes 5.4% death of tubular cells in the kidney (Donuata, 2013). Giving high doses of gamma rays can reduce the percentage of plant growth. Plants become stunted due to physiological disorders or chromosomal damage caused by mutagens (Sutapa & Kasmawan, 2016). Reduction of mass in yam tubers irradiated at doses 80-180 Gy significantly reduced by about 5,13%-12,02%. This medium shows that the radiation can slow the mass decrease of cassava tubers during the storage period (Akrom, Hidayanto & Susilo, 2014).

One way to ward off free radicals that arise due to radiation is by administering antioxidants. Curcumin (*Curcuma xanthorrhiza*) Contains bioactive compounds such as curcumin, essential oils, flavonoids, sugars, and proteins. Giving curcumin 1% therapy as much as 2 ml can reduce MDA levels (Malondialdehyde) by 38% in the parotid glands of white mice that received LPS exposure (Lipopolisakarida) and repairing protein bands that have damaged the protein with a molecular weight of 44 kDa (Darwadi, Aulanni'am & Mahdi, 2013). Giving curcumin seven days in a row can reduce the value of SGOT (Serum Glutamic Oxaloacetic Transaminase) and SGPT (Serum Glutamic Pyruvic Transaminase) Paracetamol-induced chicken (Candra, 2013). The antioxidant properties of curcumin in curcumin can prevent liver cell damage (Syafitri, 2019). Curcumin can reduce SGPT levels from 153.91 U/L to 32.06 U/L due to gamma radiation (Sari, Widodo, & Juswono, 2015). Curcumin can reduce the area of the central liver veins of mice due to gamma radiation from 129424 μm^2 to 12941 μm2 (Sari, Widodo, & Juswono, 2018).

Therefore the interaction of radiation with cells produces free radicals, where free radicals can be detected using ESR (Electron Spin Resonance) (Limiansih, 2013). With a marked curve, the purpose of this study was to analyze the effect of gamma radiation exposure and administration of curcumin extract on the area of free radical curves in the lungs of mice.

RESEARCH METHODS

This study used 80 male mice with Balb/c strain, aged 6-8 weeks with an average body weight of 18-20 grams. The mice are grouped into 3 groups namely K- (without radiation and extract), R- (radiation without extract) and R+ (given extract then irradiated). Radiation exposure is given for 10 minutes with a large radiation dose is 379.45 x 10^{-5} rad, 20 minutes (758,90 x 10^{-5} rad), 30 minutes (1138,35 x 10^{-5} rad), 40 minutes (1517,80 x 10^{-5} rad) and 50 minutes (1897,24 x 10^{-5} rad), while curcumin extract was given with five dosage variations, namely 1.4 g/kgBW; 2.0 gr/kgBB; 2.6 gr/kgBB; 3.2 gr/kgBB and 3.8 gr/kgBB.

Provision of curcumin extract. Curcumin extract was given to mice in the form of a finished powder that has been packaged and sold on the market, taking into account the composition contained therein. One curcumin extract capsule contains 2500 mg of curcumin. The dose of curcumin extract given to mice is calculated based on the weight of each mouse. Curcumin extract is given once a day for 10 days before mice are irradiated by being fed into mice using gastric sonde.

Provision of radiation exposure. Radioactive sources used include Co-60, Am-241, Cs-137, Na-23 and Sr-90. The radioactive source is placing in a semicircular container. There is a hole to enter the radioactive source so that gamma radiation exposure can be precise about mice, as in Figure 1. In the vicinity of the radiation exposure area, 3 layers of lead are using for radiation protection.

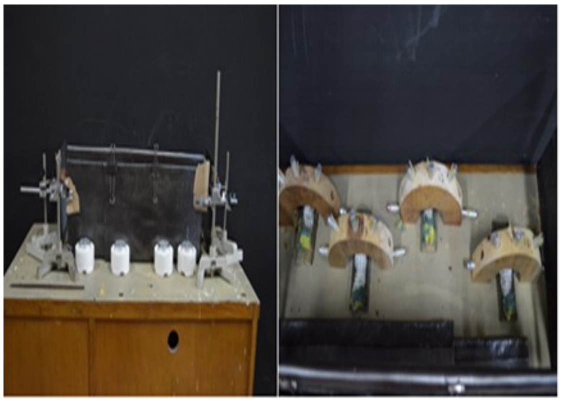

Figure 1. Gamma radiation exposure in mice

Free radical detection using ESR (Electron Spin Resonance). Before being used for measurements, the ESR device is calibrated first by using Diphenyl Pieryl Hidrazil (DPPH). After calibration, a lung sample is inserting and placed in the middle of the resonant coil. The input current is increased little by little along with the frequency so that a symmetrical resonance image is obtaining.

Free radical data retrieval selected resonant coil by the frequency range. There are 3 types of resonance coils, namely coils in the frequency range 13–30 MHz, 30–75 MHz dan 75 –130 MHz.

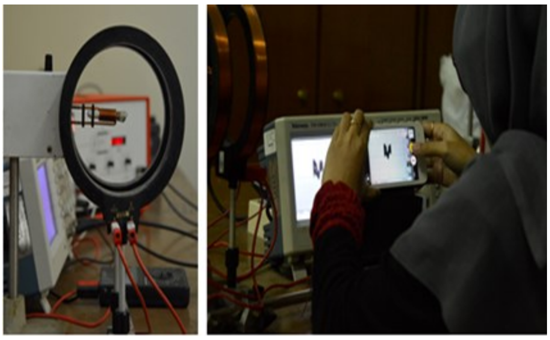

Figure 2. Retrieval of ESR Data

RESULTS AND DISCUSSION

The interaction of radiation with cells produces free radicals (Ardiny, Supriyadi & Subiyantoro, 2014). Previous research has shown that free radicals formed by the interaction of radiation with cells are tritons (Sari, 2016). In this study, data were obtaining in the form of broad free radical curves from each treatment group.

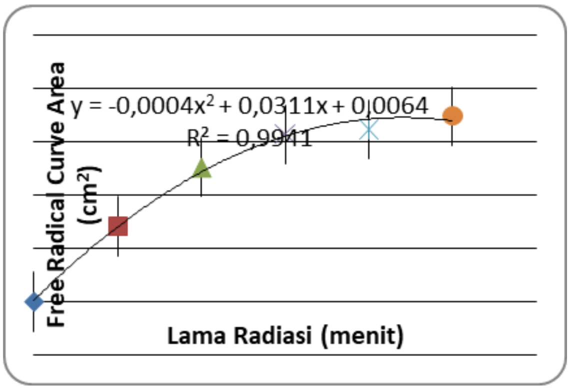

Figure 3. Relationship of the Length of Radiation Exposure to the Area of Free Radical Curves in the Lungs of Mice

The graph of the relationship between the duration of gamma radiation exposure to the area of the free radical curve is showing in Figure 3. Under normal circumstances, there is no identification of the curve's curve, as shown in Figure 4a.

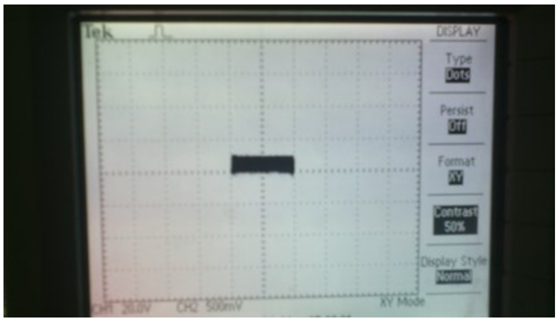

Figure 4a. Free Radical Curve in Control Treatment

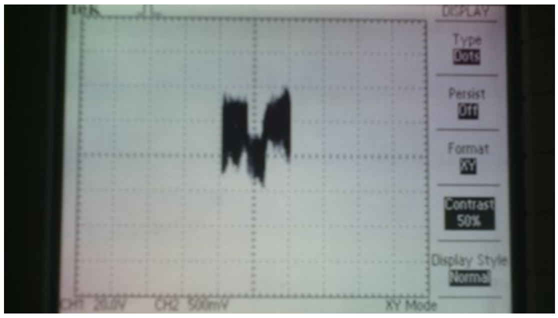

Figure 4b. Free Radical Curve in Radiation Treatment

After gamma radiation exposure, it shows that the longer the exposure, the wider the curve of the curve, as shown in Figure 4b. The wide of the curve indicates the presence of free radicals in the lungs of mice.

The Effect of Gamma Radiation on Area of Free Radical Curves. Free radicals forming are marked by the appearance of a hollow of the curve that appears on the ESR oscilloscope screen. The wider the curve of the curve, the more free radical concentrations in the samples of the mice's lungs.

The interaction of radiation with cells produces free radicals such as H*, OH*, and H_2O_2. Opportunities for the formation of free radicals found in the lungs of mice very much. However, only tritons were detecting in mice's lung samples. This is possible because the time taken by free radicals to damage cells is very short, and eventually will be lost, so it cannot be detected at ESR. Triton includes radioisotopes from H* (Radikal hydrogen). Triton is an unstable core, so it is very reactive. Triton can also enter the body through the skin due to injury (Sari, 2016).

The longer exposure to gamma radiation, the wider the free radical curve, which indicates the higher concentration of free radicals in the lungs of mice. Free extreme curves are formed based on the mapping of two waves, called the Lissajous curve. The wave amplitude is proportional to the square of the intensity of gamma radiation exposure. This medium causes more prolonged exposure to radiation, the more full the free radical curve.

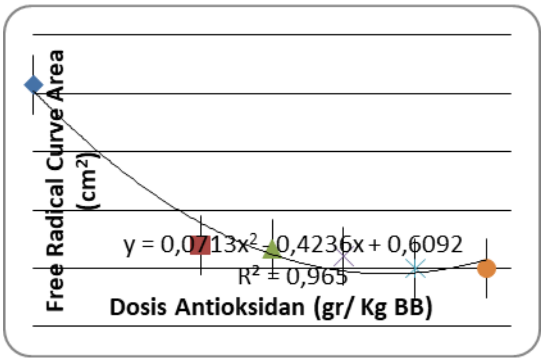

Figure 5. Relationship between Curcumin Extract Extract with Free Radical Curve Area in Mice Lung

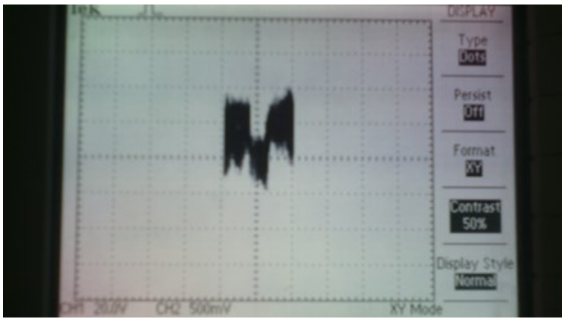

Figure 6a. Free Radical Curve in Radiation Treatment

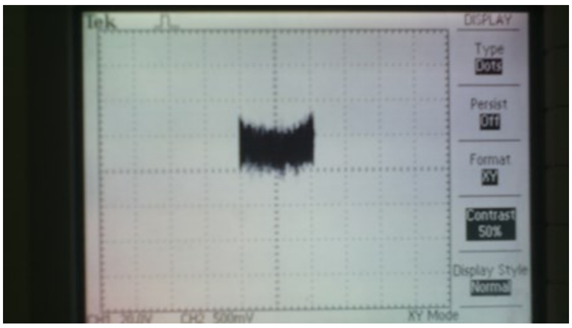

Figure 6b. Free Radical Curve in Curcumin Extract Treatment

Curcumin has given to mice also affects the area of the free radical curve. After being detected using ESR, there is a decrease in the curve area, shown in Figure 5. This medium is also clarifying in Figures 6a and 6b, where the area of the free radical curve will be reducing when curcumin extracts are giving.

The Effect of Curcumin Extract on Free Radical Curve Area. Curcumin can minimize the area of the free radical curve, which indicates the number of free radicals found in the lungs of mice, as well as reducing the level of damage to the lung cells of mice. Curcumin is the most compound in curcumin compared to other compounds, shown in Figure 7.

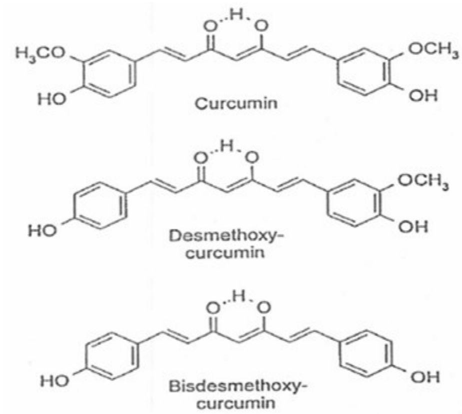

Figure 7. Chemical Structure of Curcuminoid Compounds

Curcumin contains many OH groups so that curcumin can capture free radicals, and free radicals were transforming into stable molecules. Cells damaged by free radicals can repair themselves (Sari, 2016).

When interacting with free radicals (R*), curcumin will donate its hydrogen atom (H) from the hydroxyl group (OH), as shown in Figure 8. The interaction will produce curcumin radicals that are more stable than free radicals. That is because the curcumin radical can experience a resonance structure change by redistributing unpaired electrons to the conjugated double bond structure in the aromatic ring. Then, the curcumin radical will react again to form a non-reactive compound. From this mechanism, curcumin can inhibit free radicals (Darwadi, Aulanni'am, & Mahdi, 2013).

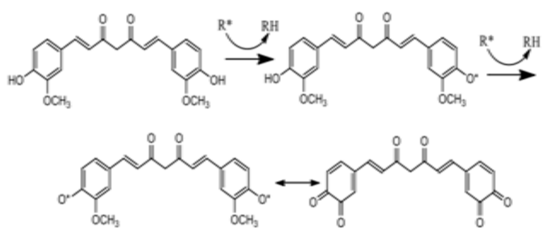

Figure 8. Free radical inhibition reaction by curcumin

Curcumin also helps cells defend against free radicals. This is because the curcumin contains SOD enzymes (Superoksida Dismutase dan Katalase), which catalyze the dismutation of hydrogen peroxide into water and alcohol, such as the reaction in Figure 9. The removal of glutathione residues is carried out by GSH S-transferase becomes reactive electrophilic metabolites of xenobiotic. Results using NADPH reduce the production of oxidized glutathione (GSSG), so that the radicals formed are quite stable, and the level of cell damage is reduced or decreased.

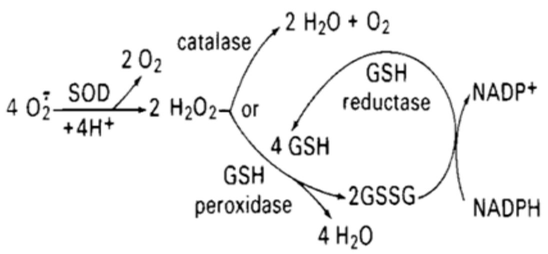

Figure 9. Cell Defense Against Free Radicals

Curcumin has functional groups such as the phenyl ring group, B-keto, and double carbon bonds that contain several hydroxyl and methoxyl substituents. Through this structure, curcumin can capture excessive ROS, which is the leading cause of oxidative stress (Nurtamin, 2014).

CONCLUSION

Curcumin extract, which is giving as prevention from the effects of gamma radiation, can reduce the area of the free radical curve from 0.630 cm^2 to 0.004 cm^2. The free radical curve area shows the concentration of free radicals found in the lungs of mice. The curcumin extract contains bioactive curcumin compounds that can inhibit the formation of free radicals due to gamma radiation in mice's lungs.

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