The Efficacy of Coffee and Green Tea in Ameliorating Histological and Biochemical Changes Induced By γ-Irradiation in Albino Rats.

R. G. Rezk and M. M. Darwish.

Health Radiation Research Department, Radiation Biology Department, National Center for Radiation Research and Technology, Radiation Atomic Energy Authority, Egypt.

ABSTRACT

Exposure to ionizing radiation results in oxidative damage, organ dysfunction and metabolic disturbances. The aim of the present study was to investigate the efficacy of coffee, green tea, or coffee + green tea consumption on radiation-induced damage in liver and heart tissues of rats. Rats received/day, by gavages, the water extract of 0.3g green tea and/or 0.2g coffee, for a period of 7 days. The last dose was given 60min before irradiation with a dose of 6.5 Gy. Histological examination through light microscope of sections in the liver and heart tissues on the 3rd day post-irradiation revealed that all treatments had attenuated radiation-induced oxidative damage. Necrosis, apoptosis, cell death and rupture of cell membrane in both tissues were less severe and were associated with significant decrease of serum malondialdehyde (MDA) content and significant increase in superoxide dismutase (SOD) and catalase (Cat) activities, and glutathione (GSH) content, compared to their corresponding value in non irradiated rats. The results were substantiated by significant amelioration in the activity of serum lactate dehydrogenase (LDH), aspartate amino transferase (AST), alanine amino transferase (ALT), gamma glutamyl transferase (GGT), and alkaline phosphatase (ALP) and the content of triglycerides (TG) and total cholesterol (TC), markers of liver and heart functions.

No significant changes were recorded between the 3 treatments. However, coffee + green tea provoked better results with respect to radiation-induced lipid peroxidation, which might be attributed to their synergistic effect as free radical scavengers. It could be concluded that drinking coffee associated with green tea is healthier than drinking coffee or green tea alone to protect liver and heart tissues from oxidative stress.
INTRODUCTION

Evidences have shown that the over production of reactive oxygen species (ROS) in both intra- and extra-cellular spaces upon exposure of cells or individuals to certain chemicals, radiation or local tissue inflammation results in oxidative stress defined as the imbalance between pro-oxidants and anti-oxidants\(^{(1)}\). Once this imbalance takes place cellular molecules such as nucleic acids, proteins, structural carbohydrates, and lipids may be damaged by oxidative modifications\(^{(2)}\).

Lipid peroxidation is one of the major outcomes of free radical-mediated injury to tissue because the formation of lipid peroxidation products leads to spread of free radical reactions. The membrane lipids, mainly phospholipids, containing polyunsaturated fatty acids are predominantly susceptible to peroxidation. The initial reaction of \(*OH\) with polyunsaturated fatty acids produces lipid hydroperoxide that can break down to reactive aldehyde products, including malondialdehyde (MDA), 4-hydroxy-2-nonenal (HNE), 4-hydroxy-2-hexenal (4-HHE) and acrolein\(^{(3)}\). Compared to free radicals, these aldehydes are which relatively stable, can diffuse from the cell and attack targets far from the site of the original event. These aldehydes exhibit great reactivity with biomolecules, for instance, malondialdehyde reacts with deoxyadenosine and deoxyguanosine in DNA, forming DNA adducts to them\(^{(4)}\).

Peroxidation of lipids can disturb the assembly of the membrane, causing changes in fluidity and permeability, alterations of ion transport and inhibition of metabolic processes\(^{(5)}\). Living organisms have evolved different molecules that speed up termination by catching free radicals and therefore protect the cell membrane. One of the important antioxidant is vitamin E. Other anti-oxidants made within the body include the enzymes superoxide dismutase, catalase, and peroxidase. Exposure to ionizing radiation generates an excess of free radicals in the body that exceed the activity of endogenous antioxidants\(^{(6)}\). Consequently, antioxidant supplementation might provide protection against oxidative damage.

Food and beverages rich in polyphenols with antioxidant activity are highlighted as the potential factors for reduction of oxidative damage. Coffee and tea are the widely consumed beverages rich in polyphenols. Coffee can be
obtained from several Coffea species, with *Coffea Arabica* representing most of the world’s coffee production. All tea derives from the plant *Camellia sinensis*. Tea can be processed into a variety of types, although the two main types are black and green. Promoting the enzymatic oxidation of polyphenols produces black teas, whereas enzymes involved in polyphenol oxidation are inactivated in the production of green tea. Coffee can also be processed and prepared for drinking in a range of ways. Processing and differing methods of preparation of coffee or tea can lead to substantial differences in chemical composition. However, the final beverages contain consistently high concentrations of polyphenols, including chlorogenic acid (coffee) and gallic acid (tea)\(^7\).

Results of several investigations suggest that coffee might represent a potential contributor to dietary antioxidant intake\(^8\). An inverse relation has been reported between coffee consumption and risks of Parkinson's disease\(^9\), diabetes mellitus type 2\(^{10}\), cirrhosis of the liver\(^{11}\), liver cancer\(^{12}\) and endometrial cancer\(^{13}\). The moderate consumption of coffee was shown to produce an increase in the metabolic activity and/or numbers of the gut microbiota reputed for beneficial effects\(^{14}\). Furthermore, it was demonstrated that habitual coffee consumption is not associated with increased risk of cardiovascular diseases or premature mortality among diabetic women\(^{15}\).

Tea remains the most consumed drink in the world after water, well ahead of coffee, beer, wine and carbonated soft drinks. An accumulated number of population studies suggest that consumption of green and black tea beverages may bring positive health effects. One hypothesis explaining such effects is that the high levels of flavonoids in tea can protect cells and tissues from oxidative damage by scavenging oxygen-free radicals\(^{16}\). Tea consumption has been inversely related to the risk of cardiovascular disease by reducing the inflammatory process underlying cardiovascular disease\(^{17}\). Interest in green tea is growing rapidly following publications demonstrating its anticancer\(^{18}\) and antioxidant properties\(^{19}\).

The present study was designed to determine the possible modulator effect of coffee, green tea, and coffee combined with green tea on gamma radiation-induced histological damage in liver and heart tissues and alteration in antioxidant status and metabolic disturbances in the serum.

**MATERIAL AND METHODS**

All animal experimental procedures were performed in accordance with
the Ethics Committee of the National Research Centre and in accordance with the Recommendations for the Proper Care and Use of Laboratory Animals \(^{20}\).

**Animals**

Male albino rats, weighing 140-150g were used in this study. The animals were obtained from the animal farm of Egyptian Organization for Vaccine and Biological preparations at Helwan, Cairo. The animals were housed in cages and maintained under standard condition of ventilation, temperature and humidity. Standard diet and water were allowed adlibitum.

**Gamma Radiation**

Irradiation was performed through the use of a Canadian Gamma Cell-40 \(^{\text{137}}\text{Cs}\) at the National Center for Radiation Research and Technology (NCRRT), Cairo, Egypt, at a dose rate 1Gy/1.5min. Rats were whole body exposed to gamma irradiation and received a dose of 6.5 Gy (acute dose).

**Treatments**

Coffee: Coffee was purchased from the local market. Based on 10 g coffee per cup, a value of 100-200 mg polyphenols has been reported\(^{21}\). Coffee infusion was prepared freshly each day by adding 100 ml boiling water to 20 g coffee, brewing for 5 min then filtrated and centrifuged. One ml contains the extract of 0.2 g coffee for each rat, which is equivalent to the extract of 10 g coffee for human according to Paget and Barnes\(^{22}\).

Green Tea: Lipton Green tea was purchased from the local market. Much of the research documenting the health benefits of green tea is based on the amount of green tea typically consumed in Asian countries, about 3 cups (5g/cup i.e. water extract of 15 g green tea) per day providing 240–320 mg of polyphenols\(^{23}\). In the present study, green tea infusion was prepared freshly each day by adding 100ml boiling water to 30g green tea, brewing for 5 min then filtrated and centrifuged. One ml contains the extract of 0.3 g green tea for each rat, which is equivalent to the extract of 15g green tea for human according to Paget and Barnes\(^{22}\).

The water extract of green tea and/or coffee was administered to rats, by gavages, during 7 days and the last dose was given 60 min before irradiation of rats.
Animal Groups

A total of forty eight rats were divided into four equal groups. (1) Control: rats received tap water, (2) Coffee: rats received coffee, (3) Green tea: rats received green tea, (4) Coffee + Green tea: rats received coffee + green tea, (5) Irradiated: rats received a whole body gamma irradiation dose of 6.5Gy. (6) Coffee + Irradiation: rats received coffee before irradiation. (7) Green tea + Irradiation: rats received green tea before irradiation. (8) Coffee + Green tea + Irradiation: rats received coffee + green tea before irradiation.

Rats were sacrificed on the 3rd day post-irradiation. Blood samples collected by heart puncture and serum separated by centrifugation at 3000 rpm for 15 min.

Histological Preparations

Liver and heart were immediately excised, fixed in buffered formol, processed routinely for paraffin embedding then sectioned at 6 micrometer. Sections were stained with hematoxylin and eosin (HE) and mounted with Canada Balsam. Sections were examined by Olympus light microscope to detect the histological changes induced by any of the above mentioned treatments.

Biochemical Analysis:

Spectrophotometric determination of SOD and catalase activities was carried out according to Minami and Yoshikawa\(^{(24)}\) and Aebi\(^{(25)}\), respectively. Glutathione content (GSH) was determined by the method of Beutler, et al\(^{(26)}\). The lipid peroxidation products of polyunsaturated fatty acids were estimated as thiobarbituric acid reactive substances, (TBARS) according to Yoshioka, et al\(^{(27)}\). Serum transaminases (AST and ALT) and alkaline phosphatase activities were determined according to Reitman and Frankel\(^{(28)}\) and Burtis and Ashwood\(^{(29)}\); respectively. The content of triacylglycerols (Tr), and total cholesterol (Tc), were assayed according to the methods of Fossati and Principe\(^{(30)}\) and Allain, et al\(^{(31)}\), respectively.

Statistical Analysis

Data are presented as mean ± S.E. (n=6). Student’s t-test was applied for the statistical analysis of results\(^{(32)}\). Differences between means were considered significant at P ≤0.05.
RESULTS

The results obtained in the present study showed that administration of rats with the water extracts of coffee, green tea and coffee + green tea, during a period of 7 days, induced un pronounced histological changes in liver and heart tissues. Liver tissue sections showed normal structure of hepatic trabeculae, normal sinusoids and normal hepatic portal area (portal vein, lymph and bile duct) (Fig. 1 b, c, d). Cardiac muscles sections exhibited normal structure of cardiac muscle fiber branches which anastomized with other fibers to form a network. Each cardiac muscle cell has its own nucleus located centrally as well as normal endomysium capillaries (Fig. 2 b, c, d).

Furthermore, serum biochemical analysis showed that the activity of SOD and Cat, the content of GSH and TBARS were within normal ranges. The results obtained demonstrated also that administration of the water extracts of coffee, green tea and coffee + green tea, to rats during a period of 7 days, was of insignificant effect on liver and heart functions. The activity of LDH, AST, ALT, GGT and ALP and the content of triglycerides and total cholesterol showed normal values (Table 1).

Table 1: Effect of coffee, green tea, and coffee with green tea consumption on serum biochemical parameters in rats.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Animal groups</th>
<th>Control</th>
<th>Coffee</th>
<th>Green Tea</th>
<th>Coffee+Green Tea</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSH (mg/dl)</td>
<td></td>
<td>69.4±2.10</td>
<td>67.3±2.40</td>
<td>68.1±2.90</td>
<td>68.5±3.10</td>
</tr>
<tr>
<td>SOD (U/ml)</td>
<td></td>
<td>7.5±1.100</td>
<td>7.2±1.07</td>
<td>7.4±0.80</td>
<td>7.3±1.50</td>
</tr>
<tr>
<td>Cat (U/g)</td>
<td></td>
<td>20.9±2.40</td>
<td>19.3±2.90</td>
<td>21.0±3.10</td>
<td>19.9±3.10</td>
</tr>
<tr>
<td>MDA(μ mol/ml)</td>
<td></td>
<td>55.15±1.50</td>
<td>58.90±1.10</td>
<td>54.3±1.80</td>
<td>56.9±1.90</td>
</tr>
<tr>
<td>AST (U/ml)</td>
<td></td>
<td>137.1±2.10</td>
<td>135.1±1.57</td>
<td>136.8±1.89</td>
<td>137.4±2.30</td>
</tr>
<tr>
<td>ALT (U/ml)</td>
<td></td>
<td>35.6±0.79</td>
<td>36.8±1.80</td>
<td>35.9±1.90</td>
<td>35.7±0.93</td>
</tr>
<tr>
<td>GGT (U/dl)</td>
<td></td>
<td>4.50±1.91</td>
<td>4.69±2.01</td>
<td>4.60±1.11</td>
<td>4.30±1.09</td>
</tr>
<tr>
<td>LDH (U/dl)</td>
<td></td>
<td>15.4±2.40</td>
<td>17.9±2.90</td>
<td>15.9±2.60</td>
<td>16.7±2.80</td>
</tr>
<tr>
<td>ALP (U/dl)</td>
<td></td>
<td>5.9±0.90</td>
<td>6.1±1.30</td>
<td>5.8±1.20</td>
<td>6.9±1.10</td>
</tr>
<tr>
<td>TGs</td>
<td></td>
<td>189±1.70</td>
<td>190±2.10</td>
<td>188±2.00</td>
<td>188±2.90</td>
</tr>
<tr>
<td>TC</td>
<td></td>
<td>98±3.30</td>
<td>101±2.30</td>
<td>99±2.50</td>
<td>99±2.30</td>
</tr>
</tbody>
</table>

Values are means ± S.E. (n=6). T–test.
Fig. 1: Photomicrographs of sections in the liver of a) control rats b) coffee-treated rats, c) Green tea-treated rats and d) Coffee+Green tea-treated rats showing normal architecture of hepatic trabeculae, normal sinusoids, and normal hepatic portal area. (H&E) (x200).
Fig. 2: Photomicrographs of sections in cardiac muscles of a) control rats b) coffee-treated rats, c) Green tea-treated rats and d) Coffee+Green tea-treated rats showing normal architecture of myofibrils (mf) and anastomosing normal central nuclei (n), normal capillary in endomysium (c). (H&E) (x400)
Liver sections of rats exposed to whole body gamma irradiation at a dose of 6.5 Gy showed dilated and widened portal vein, degenerated and ruptured hepatocytes, necrotic, pyknotic hepatic, and karyolitic hepatic nuclei and vacuolated cytoplasm (Fig. 3a). Also, Cardiac muscles of irradiated rats showed ill-defined shape of fibers, necrotic and karyolitic nuclei, and severe dilated widened and inflamed capillaries in endomysium (Fig. 4a).

Data obtained in the present study showed that whole body gamma irradiation of rats at a dose of 6.5 Gy induced oxidative stress notified by an increase in the level of serum MDA associated with a decrease in SOD and Cat activities, GSH content, compared to control values (Table 2). Furthermore, significant increases was recorded in serum ALT, AST, ALP, GGT, LDH activities triglycerides and total cholesterol contents, compared to control values (Table 3).

Administration of water extracts of coffee, green tea, coffee + green tea to rats during 7 days and the last dose given 60 min before irradiation has caused a significant amelioration in radiation induced histological changes in liver and heart tissues.

The significant amelioration in radiation-induced biochemical changes in the treated rats was associated with a significant improvement in the histological changes recorded in liver and heart tissues. Restoration of hepatic trabeculae, hepatic portal area and sinusoids were observed (Fig .3b, c, d). Cardiac muscle structure showed regenerated nuclei and ameliorating features of capillaries in endomysium (Fig .4b, c, d).

Administration of the water extracts of coffee, green tea, coffee + green tea to rats during 7 days and that given 60 min before irradiation improved significantly the serum antioxidant status, compared to irradiated rats (Table 2). Serum enzyme activities, triglycerides and total cholesterol content showed also a significant improvement, compared to those of irradiated rats (Table 3).
Fig. 3: Photomicrographs of sections in the liver of
(a): Irradiated rats showing vacuolated cytoplasm, severe rupture and shrinkage hepatocytes, necrotic (n), pyknotic (p) karyolitic (k) nuclei, severe dilating and widening control vein (C.V), haemorrhage and red blood cells filled the hepatic cells (H & E) (X 400).
(b): Coffee + Irradiated rats showing regenerated hepatic cells with improved cells membrane, regenerated nuclei, improved hepatic portal area (pa) (H & E) (X 400).
(c): Green tea + Irradiated rats showing nearly normal hepatic architecture, normal central vein (C.V), regenerated nuclei (n) and improved cells membrane (H & E) (X 400).
(d): Coffee + Green tea + Irradiated rats showing hepatic architecture, normal hepatic nuclei (n), normal central vein (C.V) and regenerated cells membrane (H & E) (X 400).
Fig. 4: Photomicrographs of sections in Cardiac muscles of  
(a): Irradiated rats showing rupture, sticky and ill-defined shape of cardiac muscle branch (cm) and necrotic nuclei (n). (H & E) (X 400).  
(b): Coffee + Irradiated rats showing ameliorating structure of cardiac muscle fibers, improved central nuclei (n) and ameliorated capillaries in endomysium (H & E) (X 400).  
(c): Green tea + Irradiated rats showing improved structure of cardiac muscle fibers, improved central nuclei (n) and ameliorated capillaries in endomysium (H & E) (X 400).  
(d): Coffee + green tea + Irradiated rats showing ameliorated central nuclei (n), regenerated cardiac muscle fibers, improved capillaries in endomysium (H & E) X 400).
Table 2: Effect of coffee, green tea, and coffee with green tea consumption during a period of 7 days on radiation-induced changes of serum antioxidant status of rats

<table>
<thead>
<tr>
<th>Animal groups</th>
<th>Control</th>
<th>RAD</th>
<th>GT + RAD</th>
<th>Coffee + RAD</th>
<th>Coffee + GT + RAD</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSH (mg/dl)</td>
<td>69.4±2.1</td>
<td>53.9±2.5</td>
<td>58.3±2.9</td>
<td>59.1±3.2</td>
<td>60.9±1.9</td>
</tr>
<tr>
<td>P value</td>
<td>≤0.001</td>
<td>≤0.05</td>
<td>≤0.05</td>
<td>≤0.05</td>
<td>≤0.05</td>
</tr>
<tr>
<td>SOD (U/ml)</td>
<td>7.5±1.1</td>
<td>5.1±0.5</td>
<td>5.7±1.3</td>
<td>5.9±0.8</td>
<td>6.1±1.3</td>
</tr>
<tr>
<td>P value</td>
<td>≤0.01</td>
<td>≤0.05</td>
<td>≤0.05</td>
<td>≤0.05</td>
<td>≤0.05</td>
</tr>
<tr>
<td>Cat (U/g)</td>
<td>20.9±2.4</td>
<td>15.8±1.7</td>
<td>17.7±3.0</td>
<td>18.1±2.7</td>
<td>17.1±2.5</td>
</tr>
<tr>
<td>P value</td>
<td>≤0.01</td>
<td>≤0.05</td>
<td>≤0.05</td>
<td>≤0.05</td>
<td>≤0.05</td>
</tr>
<tr>
<td>MDA(μmol/ml)</td>
<td>55.15±1.5</td>
<td>93.72±1.3</td>
<td>70.31±1.7</td>
<td>74.10±1.2</td>
<td>62.90±1.2</td>
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<tr>
<td>P value</td>
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<td>≤0.05</td>
<td>≤0.05</td>
<td>≤0.05</td>
<td>≤0.05</td>
</tr>
</tbody>
</table>

Values are means ± S.E. (n=6). P values > 0.05: Nonsignificant. P values ≤0.05: significant. P values ≤0.01: Highly significant. P values ≤0.001: very highly significant.

Table 3: Effect of coffee, green tea, and coffee with green tea consumption during a period of 7 days on radiation-induced changes in serum enzyme activities and lipids content in rats.

<table>
<thead>
<tr>
<th>Animal groups</th>
<th>Control</th>
<th>RAD</th>
<th>GT + RAD</th>
<th>Coffee + RAD</th>
<th>Coffee + GT + RAD</th>
</tr>
</thead>
<tbody>
<tr>
<td>AST (U/dl)</td>
<td>137.1±2.10</td>
<td>154.3±1.70</td>
<td>145.3±2.00</td>
<td>146.7±1.95</td>
<td>143.1±1.90</td>
</tr>
<tr>
<td>P value</td>
<td>≤0.001</td>
<td>≤0.05</td>
<td>≤0.05</td>
<td>≤0.05</td>
<td>≤0.05</td>
</tr>
<tr>
<td>ALT (U/dl)</td>
<td>35.6±0.79</td>
<td>44.6±1.70</td>
<td>39.3±2.10</td>
<td>40.1±1.90</td>
<td>38.9±1.25</td>
</tr>
<tr>
<td>P value</td>
<td>≤0.001</td>
<td>≤0.05</td>
<td>≤0.05</td>
<td>≤0.05</td>
<td>≤0.05</td>
</tr>
<tr>
<td>GGT (U/L)</td>
<td>4.50±1.91</td>
<td>8.80±1.40</td>
<td>6.93±1.50</td>
<td>7.20±1.10</td>
<td>6.90±0.89</td>
</tr>
<tr>
<td>P value</td>
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<td>≤0.05</td>
<td>≤0.05</td>
<td>≤0.05</td>
<td>≤0.05</td>
</tr>
<tr>
<td>LDH (U/dl)</td>
<td>15.4±2.4</td>
<td>33.7±3.1</td>
<td>25.1±2.1</td>
<td>26.3±2.9</td>
<td>24.3±2.5</td>
</tr>
<tr>
<td>P value</td>
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<td>≤0.05</td>
<td>≤0.01</td>
<td>≤0.01</td>
<td>≤0.01</td>
</tr>
<tr>
<td>ALP (U/dl)</td>
<td>5.9±0.9</td>
<td>7.7±1.5</td>
<td>6.9±1.3</td>
<td>6.8±1.9</td>
<td>6.9±1.1</td>
</tr>
<tr>
<td>P value</td>
<td>≤0.05</td>
<td>≤0.05</td>
<td>≤0.05</td>
<td>≤0.05</td>
<td>≤0.05</td>
</tr>
<tr>
<td>TGs (mg/dl)</td>
<td>189±1.7</td>
<td>230±1.9</td>
<td>204±2.5</td>
<td>203±2.8</td>
<td>201±1.8</td>
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<tr>
<td>P value</td>
<td>≤0.001</td>
<td>≤0.05</td>
<td>≤0.01</td>
<td>≤0.05</td>
<td>≤0.05</td>
</tr>
<tr>
<td>TC (mg/dl)</td>
<td>98±3.3</td>
<td>151±2.9</td>
<td>112±3.5</td>
<td>115±3.1</td>
<td>110±3.0</td>
</tr>
<tr>
<td>P value</td>
<td>≤0.001</td>
<td>≤0.05</td>
<td>≤0.01</td>
<td>≤0.05</td>
<td>≤0.05</td>
</tr>
</tbody>
</table>

Values are means ± S.E. (n=6). P values > 0.05: Non significant. P values ≤0.05: significant. P values ≤0.01: Highly significant. P values ≤0.001: very highly significant.
Radiation damage is, to a large extent, caused by the overproduction of ROS, including superoxide anion (O$_2^-$), hydroxyl radical (·OH) and hydrogen peroxide (H$_2$O$_2$), that overwhelm the levels of antioxidants, resulting in oxidative stress and cellular damage. ROS cause damage by reacting with cellular macromolecules such as nucleotides in nucleic acids, polyunsaturated fatty acids found in cellular membranes and sulfhydryl bonds in proteins. If this damage is irreparable, then injury, mutagenesis, carcinogenesis, accelerated senescence and cell death can occur (33). Efficient defense and repair mechanisms exist in living cells to protect against oxidant species. SOD catalyses the reduction of O$_2^-$ to H$_2$O$_2$. The majority of which is broken down to oxygen and water by Cat. In addition to Cat, glutathione peroxidase in presence of adequate amount of glutathione (GSH) can also break down H$_2$O$_2$ and also any peroxides that form on lipids within the body(34).

In the present study, rats received a whole body gamma irradiation dose of 6.5 Gy showed drastic changes in the configuration and architecture of liver and heart tissues. These histological damages might be attributed to the interaction of ·OH with the polyunsaturated fatty acids in the phospholipids portion of cell membranes initiating the lipid peroxidation chain reaction(33). In the present study, a significant increase was recorded in serum MDA level. In addition, a decrease in the antioxidant status notified by a significant decrease in SOD and Cat activities and GSH content contribute to oxidative damage. The decrease of SOD and Cat activities might result from oxidation of the enzyme molecule by the excess of ·OH(35). The decrease of GSH might had resulted from the inhibition of GSH synthetase and glutathione reductase enzymes(36). In the present study tissue damage was associated with a significant increase in the activity of serum LDH, AST, ALT, GGT and ALP and the content of serum triglycerides and cholesterol.

Damaging effects of ROS include oxidative attack on vital cell constituents. Several soluble enzymes of blood serum have been considered as indicators of the tissue damage. Alanine aminotransferase (ALT) and aspartate aminotransferase (AST) are important and considered as critical enzymes in the biological processes; their activities are related with the maintenance of amino acid homeostasis. ALT and AST are two of the most reliable markers of hepatocellular injury or necrosis. If the liver is injured, the liver cells spill the enzymes into blood, raising their levels in the blood and signaling the liver
damage. In the present study, the increase in the activity of ALT and AST in the serum might be due to their release from injured liver cells. Furthermore, GGT is a membrane bound enzyme and its elevated activity in the serum pointes to the destruction of cell membrane. Aspartate amino transferase (AST) and lactate dehydrogenase (LDH) have been found to increase in the plasma due to apoptosis and were considered common characteristics of cardiotoxicity after irradiation. In the present study, their significant increase in the serum might therefore results from alterations in dynamic permeability of cardiac cell membranes due to peroxidation. The hypercholesterolemia and hypertriglyceridemia might be attributed to an increase in the activity of 3-hydroxymethylglutaryl CoA, as an early reaction necessary for the restoration of biomembranes.

In the present study, rats receiving the water extracts of coffee, green tea, coffee + green tea before exposure to gamma radiation showed a significant amelioration in the configuration and architecture of liver and cardiac tissues. Improvement of tissues structure was substantiated by a significant restoration in the activity of serum LDH, AST, ALT, GGT, ALP and the content of triglycerides and cholesterol. This might be explained on the basis that coffee and green tea possesses antioxidant potential against peroxyl radical. Recent studies demonstrated that coffee and green tea, are large sources of antioxidant polyphenols. Polyphenols have a range of activities that might have a positive impact on health.

Coffee contains phenolic compounds identified as chlorogenic acids, a family of esters formed between quinic acid and several cinnamic acids such as caffeic, ferulic and p-coumaric acid, caffeoylquinic acid being by far the most abundant. Coffee is also rich in caffeine. Beans of Coffea arabica plants contain 12 milligrams of caffeine per gram of dry mass. Caffeine has been shown to increase the antioxidant capacity of blood plasma and modify acute radiation syndrome. Moreover, caffeine was shown to scavenge \( \cdot OH \) and prevent lipid peroxidation.

In the present study, the beneficial effect obtained by drinking coffee is consistent with the findings of Tanaka, et al. who found that coffee consumption protect against oxidative liver cell damage induced by alcohol and decrease serum GGT, AST and ALT activities. Furthermore, Ruhi and Everhart showed that coffee and caffeine consumption reduce the risk of elevated serum alanine aminotransferase activity. The mechanism by which
coffee protects tissues may be attributed to the role of the coffee components kahweol and cafestol that induce gamma-glutamylcysteine synthetase, the rate limiting enzyme of glutathione synthesis, in several organs of the rat\(^{(47)}\).

A substantial number of studies with green tea demonstrated a significant increase in plasma antioxidant capacity approximately 1 h after consumption of moderate amounts of tea (1-6 cups/d)\(^{(46)}\). Furthermore, green tea has been shown to lower cholesterol level through an increase in fecal lipid excretion\(^{(48)}\). Consumption of green tea has been shown to decrease lipid peroxidation in irradiated mice\(^{(49)}\). This could be explained on the basis that green tea is rich in the polyphenols: epicatechin, epigallocatechin, epicatechin-3-gallate and epigallocatechin-3-gallate that play an important role in quenching active oxygen radicals\(^{(50)}\) and attenuating oxidative stress\(^{(51)}\).

According to the results obtained in the present study, consumption of coffee, green tea or both provide a significant protection against radiation-induced structural changes in liver and heart tissues and serum metabolic disturbances. There was no significant difference between the 3 beverages. However, the level of MDA was lower in case of coffee+green tea consumption, which may be attributed to their synergistic effect as free radical scavengers. It could be concluded that drinking coffee associated with green tea is better than drinking coffee or green tea alone to protect liver and heart tissues from oxidative stress.

REFERENCES


كفاءة القهوة والشاي الأخضر في تحسين التغيرات الهستولوجية والبيوكيميائية المتصلة بالإشعاع الجسمي في الجرذان البيضاء.

1. رقيق جورج و. رحالة محمد درويش.

2. قسم البيولوجيا الإشعاعية، قسم البحوث الصحية الإشعاعية، المركز القومي لبحوث وتقنية الإشعاع، هيئة الطاقة الذرية، مدينة نصر، القاهرة، مصر.

إن التعرض للإشعاع المؤين ينتج عنه أكاسدة التدمير وإختلاط وواحد الأعضاء، وتشتيت في عملية الأيض، والهدف من هذه الدراسة هو معرفة كفاءة شرب القهوة والشاي الأخضر أو كلاهما معا ضد التدمير المسبب من الإشعاع لأنسجة الكبد والقلب في الجرذان البيضاء.

لقد تجريت الفحوص بيوما بالغ المستخلص المائي من 0.2 جم قهوة و/ أو 0.3 جم من الشاي الأخضر لمدة 7 أيام. وأخر جرعة أعطيت 60 دقيقة قبل التشعیب بجرعة 6 جرعة.

أوضح الفحوص الهستولوجي من خلال الميكروسكوب الضوئي والغذاء لأنسجة الكبد والقلب في اليوم الثالث بعد التشعیب أن كل من المعالجات الثلاثة (القهوة، الشاي الأخضر، القهوة + الشاي الأخضر) قد أضرع بتأثير الإشعاع المؤيد المدمج لضوء النور وإيقاعها وموت الخلية. كلها ونكه الغشاء الخلوي في كلا المرضى. وكان هذا مرئيا بانتشار في محتوى الأموال المحيط الدهناء. الموجود في السيرم. وزيادة متطرفة لسوي كسيد ديميتريز والكابتشينات والجلوتانين. وهذا يعني أن القهوة والشاي الأخضر زادوا من كفاءة عمل مضادات الأكسدة الموجودة في سيرم الجرذان البيضاء.

كما قلت الدعوم المؤيدة بالمتحور بالفعل المنصوص عليها من المجموعة المعرضة للتشعیب فقط.

أوضحت النتائج أيضا تحسن ملحوظ في نشاط إنزيمات ديهدروجيناز والأسبارتات أميتراسفريز والأميتريتراسفريز والجاماجاميزتراسفريز والألكالين وفاسفوت ومحترد الدهون الثلاثية والكولسترول الكلي. وهو مؤشر هام لطول الأساس والقلب.

لم تسجل النتائج أي اختلافات ملموسة بين الثلاثة معاملات (القهوة، الشاي الأخضر، القهوة والشاي الأخضر معا) بالنسبة للقياسات التي أجريت. ولكن النتائج شرب القهوة + الشاي الأخضر معا كان أفضل في تقليل تأثير التعرض للإشعاع المؤين السبب لأكسدة هذا يرجع إلى التأثير المدمج والشريك للقهوة والشاي الأخضر كطاردين للذرات الحرة الناتجة من التعرض للإشعاع المؤين. والقدرة على تخفيف تأثيرهم الضار على جسم الحيوانات.

ولهذا يمكن الاستنتاج بأن تناول القهوة والشاي الأخضر خلال اليوم أفضل من تناول مشروب واحد فقط لحماية أنسجة الكبد والقلب من الإجهاد الناتجة من التعرض للإشعاع المؤين.