Cinnamon (Cinnamomum zeylanicum N) attenuates hepatic and cardiac tissues injury induced by gamma radiation in male albino rats

Rezk R.G.
Health Radiation Research Department, National Center for Radiation Research and Technology

Accepted: 9/9/2012 Received: 8/11/2012

ABSTRACT

The purpose of this study was to investigate the protective role of cinnamon; a spice rich in eugenol, cinnamic acid and cinnamic aldehyde, against tissue injuries induced by gamma irradiation. Moreover, the effect of time of cinnamon aqueous extract (aq.extr).administration was evaluated. Cinnamon aq.extr. (200mg/Kg body weight) was administered to male albino rats via gavages during 15 successive days or 40 successive days before whole body exposure to gamma rays (3Gy). The animals were sacrificed the 3rd day post-irradiation.

The results obtained revealed that the administration of cinnamon aq.extr. during 15 successive days or 40 successive days before irradiation has significantly attenuated hepatic and cardiac tissue injuries. Necrosis, apoptosis, cell death and rupture of cell membrane in both tissues were less severe. However, the protection was better when cinnamon aq.extr.was administered for 40 successive days before irradiation. It could be concluded that taking adequate amount of cinnamon aq.extr. for a long time would protect hepatic and cardiac tissues from radiation-induced damage.

Key words: Cinnamon, Ionizing Radiation, Radioprotectors, Oxidative Stress.

INTRODUCTION

Free radicals in the form of reactive oxygen and nitrogen species are an integral part of normal physiology. Overproduction of these reactive species can occur, due to oxidative stress brought about by the imbalance of the bodily antioxidant defense system and free radical formation. These reactive species can react with biomolecules causing cellular injury and even death. They can lead to the development of chronic disease such as cancers and those involved in the cardio– and cerebro-vascular systems (1). The consumption of fruits and vegetables (2) containing antioxidants has been found to offer protection against these disease.

Antioxidants are often added to foods to prevent the radical chain reactions of oxidation, and they act by inhibiting the initiation and propagation step leading to termination of the reaction and delay the oxidation process (3). Natural products from dietary components such as Indian spices and medicinal plants are known to possess antioxidant activity (4).

Cinnamon; a popular flavoring ingredient widely used in food products, has been shown to possess beneficial properties to health (5). Cinnamon oil Cinnamomum zeylanicum Family: Lauracea has been reported to be rich in eugenol, cinnamic acid, and cinnamic aldehyde (6).

In an elegant study, Anderson et al. (2004) (7) reported that cinnamon is rich in polyphenols with insulin-like biological activity. In the same line, Khan et al. (2003) (8) reported that cinnamon improves glucose and lipids of people with type 2 diabetes. More over, Hlebowicz et al. (2007) (9) found that cinnamon exert a beneficial effect on postprandial blood glucose, gastric emptying, and satiety in
healthy subjects. Furthermore, cinnamon has been reported to exhibit antimicrobial (10&11) and antitumor activities (12) and to inhibit the proliferation of various cancer cell lines (13&14). The goal of the present study was to examine the hepatoprotective and cardioprotective effect of cinnamon against radiation injury.

MATERIALS & METHODS

All animal’s experimental procedures were performed in accordance with the Ethics Committee of the National Research Center and in accordance with the recommendation for the Proper Care and Use of laboratory Animals (National Institutes of Health (NIH) guideline (1985).

Forty eight male albino Wistar rats weighting (100-120 gm) were used in this study. Animals were obtained from the animal farm of the Egyptian organization for vaccine and biological products. The animals were housed in cages and maintained under standard conditions of ventilation, temperature, and humidity. Food and water were available ad-libitum.

Gamma Radiation

Irradiation was performed through the use of a Canadian Gamma cell- 40 (137Cs) at the National Center for Radiation Research and Technology (NCRRT) Cairo, Egypt, at a dose rate 1 Gy/1.5 min. Rats were whole body exposed to gamma radiation and received a dose of 3 Gy one shot.

Cinnamon treatment

Cinnamon powder was obtained from the local market. Cinnamon powder was extracted in boiling water and then filtered and dried (15). 200 mg of the powder extract was suspended in 1 ml sterilized distilled water /kg. b.w. was administered to rats by gavage for 15 days or 40 days before irradiation.

Animal groups

Animals were divided into 6 groups (n=6). Group 1 (Control): rats received by gavages distilled water. Group 2 (Cinnamon 15 days): rats received 200mg/kg body weight of cinnamon extract by gavages in the form of aqueous suspension once daily for 15 days. Group 3 (Radiation): rats received a whole body gamma-irradiation dose of 3 Gy one shot. Group 4 (Cinnamon + Radiation): rats received cinnamon for 15 days before irradiation. Group 5 (Cinnamon 40 days): rats received 200mg/kg body weight of cinnamon by gavages in the form of aqueous suspension once daily for 40 days. Group 6 (Cinnamon + Radiation): rats received cinnamon for 40 days before irradiation.

Histological preparation

Animals were sacrificed 3 days after irradiation. Liver and heart were immediately excised, fixed in buffered formol, processed routinely for paraffin embedding then sectioned at 6 micrometers. Sections were stained with haematoxylin and eosin (HE) and mounted with Canada balsam (16). Sections were examined by olympus light microscope to detect the histological changes induced by any of the above treatment.

RESULT

In the current study, liver sections of control rats and rats receiving cinnamon 200 mg/Kg body weight daily for 15 and 40 consecutive days showed normal hepatic architecture with normal portal area (hepatic vein, bile duct and lymph vessels), normal hepatic strands, normal central vein, normal blood sinusoids, well-defined cell membrane, normal nuclei (Fig 1 a & b & c).
Whole body gamma-irradiation at a dose level of 3 Gy resulted in certain histological disorders in the liver. These disorders were manifested as widened, dilated hepatic portal area, hemorrhage, inflammatory cells and fibroblasts surrounding the portal vein, vacuolated cytoplasm, hydropic degeneration, necrotic, pyknotic and karyolytic nuclei, ill defined cell membrane and the blood vessels clogged with lysing erythrocytes, ruptured and necrotic hepatic cells (Fig 1 d & e).

Treatment of rats with cinnamon aq.extr. (200mg /kg body weight) for 15 or 40 consecutive days pre-exposure to whole body gamma irradiation led to improved liver structure, improved blood vessels structure, increasing regeneration of parenchymal cells, well defined cell membrane, normal nuclei with one or two nucleoli, normal hepatic portal vein with complete layers, mitotic index increased in most hepatic cells (Fig.1 f & g).

Cardiac muscles sections of control rats and rats receiving cinnamon aq. Extr.200 mg/kg body weight/day for 15 and 40 consecutive days exhibited normal structure of cardiac muscle fiber branches, which anastomized with other fibers to form a network. Each cardiac muscle has its own vesicular and central nucleus as well as normal endomysium capillaries (Fig. 2 a’ & b’ & c’).

Cardiac muscles of irradiated rats at a dose of 3 Gy applied in one shot showed degenerated cardiac muscle, necrotic and karyolytic peripheral nuclei and severe dilated and widened and inflammed capillaries in endomysium (Fig. 2 d’ & e’).

Administration of cinnamon aq.extr.to rats daily for 15 or 40 consecutive days before irradiation resulted in significant regeneration of cardiac muscle, normal central vesicular nuclei and well-defined shape of capillaries and regenerated cardiac muscles (Fig. 2 f’ & g’).
Fig1: Photomicrographs of sections in liver of a) control, b) cinnamon 15 days, c) cinnamon 40 days showing normal hepatic architecture with normal portal area (pa), d) & e) irradiated rats showing severe dilated and widened hepatic portal vein, necrotic and pyknotic nuclei, ruptured endothelial membrane of portal vein and inflammatory cells surrounding the vein f) Cinnamon 15 days + Radiation & g) Cinnamon 40 days + Radiation showing: normal hepatocellular architecture and normal portal vein. (x200) (H&E).
DICUSSION

Cinnamon has been used as a spice and as traditional herbal medicine. The available in vitro and animal in vivo evidence suggests that cinnamon has anti inflammatory antimicrobial, antioxidant, antitumor, cardio vascular and cholesterol lowering effects (5). The bark yields an essential oil containing cinnamaldehyde and eugenol. Several biological activities as peripheral vasodilator, antitumor, antifungal, and antimutagenic have been attributed to cinnamaldehyde (17).

Antioxidants have been given attention because of their potential in maintenance of human health and their importance in biotransformation and detoxification of toxic compounds. They are also considered as protectors against chronic diseases particularly cancer and cardiac disease.

Exposure to radiation causes injury to blood vessels provoking anoxia of tissue with degeneration and necrosis of hepatic parenchyma and hepatic fibrosis (18). In addition, cytoplasmic changes including swelling, vacuolation and alteration in the various components of the plasma membrane are seen (19). Radiation damage is largely caused by the overproduction of reactive oxygen species that overwhelm the levels of antioxidants, resulting in oxidative stress. The most important consequences of
oxidative stress are lipid peroxidation, protein oxidation, and depletion of antioxidant elements. Lipid peroxidation has been shown to provoke hepatocellular damage and to enhance production of fibrotic tissue (20).

In the present study, sections of the liver tissue of irradiated rats showed hypotrophied hepatocytes and hydropic degeneration, ill-defined cell membrane and pyknotic degenerated nuclei. Blood vessels were dilated and clogged with erythrocytes, particularly the hepatic portal vein in which the endothelial lining was ruptured at some points. Cardiac muscle sections of irradiated rats showed degenerated cardiac myofibrils, necrotic and karyolytic and peripheral nuclei, severe dilated, widened and inflamed endomysium capillaries. The results are consistent with previous studies of (21) that radiation induced structural and oxidative damage in tissues of rats.

Administration of cinnamon during 15 days as well as during 40 days pre-exposure to radiation recovered the membrane damage in both tissues. This might be attributed to a decrease of radiation-induced lipid peroxidation and improvement of the antioxidant's status (22). The beneficial effect of cinnamon might result from the presence of cinnamaldehyde; an aromatic aldehyde and one of the main constituents of cinnamon, which has been reported to possess multiple potential therapeutic activities (23). It was shown to inhibit necrosis and reduce reactive oxygen species (24). Moreover, (25) reported that cinnamaldehyde possess antioxidant and anti-inflammatory properties and suppress the expression of vascular cell adhesion molecule and intercellular molecule by suppressing nuclear transcription factor activation. Lan et al., (2007) (26) stated that phenolic group in cinnamon scavenge free radicals and inhibit the chain reaction of lipid peroxidation.

In the current study, administration of cinnamon for 40 days before irradiation showed excellent regeneration of hepatic and cardiac tissues compared to those receiving cinnamon during 15 days. Moreover, administration of cinnamon for 40 days to control rats has not induced histological changes. The results are consistent with the findings of (8) that there were no problems associated with consumption <6 g of cinnamon per day. It could be concluded that cinnamon has a potent radioprotective activity against hepatic and cardiac tissue injuries that might be attributed to its free radical scavenging and antioxidant properties

REFERENCES

(20) Mansour HA, Nawairy ASA , Yousef MI and Sheweita SA.( 2002 ) : Toxicology ; 170 : 221 – 228