Biomedicine & Preventive Nutrition 4 (2014) 543–553

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Original article

Protective role of turmeric against deltamethrin induced renal oxidative damage in rats

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ARTICLE INFO

Article history:
Received 24 July 2014
Accepted 10 August 2014

Keywords:
Deltamethrin
Turmeric
Renal toxicity
FT–IR
Oxidative stress

ABSTRACT

The objective of this study was to investigate the antioxidant potential of turmeric (TMR) (1% turmeric-diet) against the renal toxicity induced by deltamethrin (DLM) (41 ppm) in rats. Male Wistar rats were randomly divided into four groups of sex each: a control group and three treated groups during 7 weeks with TMR alone and DLM administrated either alone in drinking water for DLM group or co-administred with TMR for DLM + TMR group. Results showed that DLM caused a significant reduction in body weight and kidney absolute and relative weight and decreased antioxidant enzyme activity accompanied by significant ($P < 0.001$) increased renal MDA, serum urea and creatinine levels compared to control. Histopathologically, DLM caused dilatation of proximal tubules, tubular cell desquamation, inflammatory cell infiltration, degeneration and necrosis. TMR co-administration significantly restored oxidative enzymes activity, serum biochemistry, MDA level and histological alterations caused by DLM. However, all these changes were monitored by Fourier transform–infrared spectroscopy (FT–IR) technique, reflecting the alteration in the biomolecules due to the oxidative stress caused by DLM intoxication. While, TMR co-administration brought them near to the control, it can be concluded that TMR has beneficial influences and could be able to antagonize DLM caused oxidative stress, changes in serum biochemistry and histopathological alterations in male Wister rats.

1. Introduction

Pyrethroids are the organic insecticides obtained from natural compound pyrethrins. These insecticides were chosen over organochlorine, organophosphorus and carbamate insecticides due to their high bioefficacy at low concentrations, enhanced photostability and relatively low mammalian and avian toxicity [1]. Deltamethrin (DLM) is a type II synthetic pyrethroid, used extensively in the agriculture and domestic applications to control the pests. Recently, López et al. [2] and Lozowicka et al. [3] have been found the residues of DLM on fruits, vegetable and edible grains. The major sources of animal and human exposure to DLM are polluted food and water and it has been readily absorbed through the oral route [4]. Acute toxicity of DLM was mediated through the inhibition of ion channels and cytochrome P450, which is an enzyme involved in the metabolism of drugs and toxic substances [5–8]. As a consequence, choreoathetosis, hyperexcitability and salivation were reported in DLM-exposed rats [9]. Renal toxicity followed by DLM exposure was shown to be exerted through oxidative stress by enhancing the production of reactive oxygen species (ROS), including superoxide radicals (O_2^-), hydrogen radicals (H_2O_2) and hydroxyl radicals (OH) in rats and mice [10,11].

Naturally, body have an established antioxidant mechanism to neutralise the produced ROS. Neutralisation can be achieved by the enzymes, including superoxide dismutase (SOD), catalase (CAT), glutathione reductase (GR) and glutathione peroxidase (GPx). SOD can catalyses the dismutation of O_2^- to H_2O_2 [12], than CAT converts H_2O_2 to water and oxygen and thus protects the cell from oxidative damage by H_2O_2 and OH. Addition to this, GPx plays a major role in the neutralization of H_2O_2 and OH to non-toxic products [13]. Several studies were demonstrated that ROS can directly attack and induce oxidative damage to various biomolecules, including proteins, lipids, mitochondria, lipoproteins and DNA [14–16].

Consequently, several efforts were done to identify dietary compounds, which are able to strengthen the cellular antioxidant defence so as to counteract the oxidative stress-related adverse effects. Therefore, special attention was paid on turmeric. The dried powdered rhizomes of *Curcuma longa* L. (Zingiberaceae) is commonly known as turmeric. It has been extensively used as a spice to give flour and yellow colour to curry in many countries of Asia and Africa [17–19]. Turmeric is well known for its medicinal property in

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http://dx.doi.org/10.1016/j.bionut.2014.08.007
2210-5239/

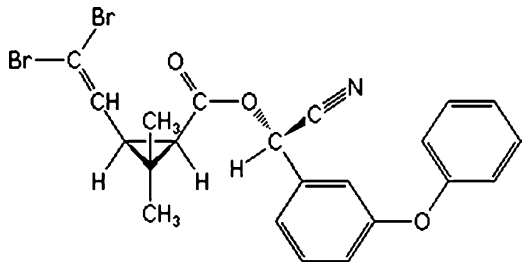

Fig. 1. Structure of the pyrethroid insecticide deltamethrin (DLM).

Ayurveda medicinal system and it has very good antioxidant capacity [20–22]. Thus, it has been traditionally used for the number of disorders, including allergy, asthma, cough, liver disease, anorexia, diabetic ulcers and sinusitis [23]. The curcumin, an active ingredient of turmeric, have been shown to exert antioxidant effects against different chemicals and pyrethroids [16,24,25]. In addition to this, curcumin, a phenolic compound, have been shown to act as an antioxidant through modulation of GSH levels and scavenging the oxygen free radicals [26–28]. Curcumin has also been reported as anti-carcinogenesis [19,29], anti-HIV [30], antioxidant [31] and anti-inflammatory [32]. Studies demonstrated that curcumin can be well bioavailable by the turmeric-diet and reported to prevent oxidative damage in mice [33,34]. Turmeric-diet also acts as anticancer by improving biochemical parameters and inhibiting cancer-causing genes in rat and mice [16,35].

In the present studyn in addition to biochemical and histological analysis, FT–IR spectroscopic technique have used to analysis the protective effect of turmeric against the DLM-induced oxidative damage in the renal tissue of rat. FT–IR is one of the vibrational spectroscopic techniques, which provide sensitive and precise measurement of biochemical alteration in cells and tissues [36]. The peaks, which arises in the spectra, were assessed for the different functional groups in the cells and tissue. Any changes in the frequency of these peaks monitor structural variations in the biomolecules. Several studies were demonstrated that such changes in the frequency were observed at the time of cellular damage caused by xenobiotics and in case of diabetics and cancer as well [36–39]. The signal intensity or more accurately the area under the bands gives information about the concentration of the related molecules [40,41]. Further, it will allow for detection, identification and quantification of changes in the macromolecular cellular components.

The present study describes the preventative effect of turmeric by evaluating serum biochemistry, renal oxidative metabolism, renal histology and alteration of biomolecules by using FT–IR spectroscopic technique in the kidney tissues in Albino rats.

2. Materials and methods

2.1. Test pyrethroid

Deltamethrin (DECIS 2.5 EC insecticide, BAYER) were purchased from commercial outlets (Fig. 1). All other chemicals were of analytical grade and commercially available.

2.2. Turmeric-diet

One percent (1%) turmeric-diet was prepared every week by mixing 1 g of turmeric with 99 g of rat diet. The 1% turmeric-diet used in our experiment and in other findings gave high protection against oxidative stress by enhancing the activities of antioxidant enzymes, improving the biochemical parameters, therefore, it can be considered as therapeutic dose [35,42].

2.3. Animals

Healthy adult male Albino rats weighted 150 ± 10 g were maintained at the animal house facility, Department of Zoology, Karnatak University, Dharwad, in plastic cages under controlled temperature (23 ± 2 °C), 12-h light/dark cycle and 60 ± 5% relative humidity. The rats were kept in the laboratory for one week before the experimental work and maintained on a standard diet (VLR, Mumbai) and water available *ad libitum*.

2.4. Experimental design

After two weeks of acclimatization, 24 male rats were equally divided into four groups each group containing six rats and treated as follows:

- group I: control, rats were fed with a standard laboratory diet and watered normal *ad libitum* water throughout experimental period;
- group II: TMR, rats were fed with turmeric-diet for 48 + 7 days;
- group III: DLM, rats feed with standard laboratory diet and received DLM through drinking water (41 ppm) for 48 days;
- group IV: DLM + TMR, rats feed with turmeric-diet for 48 + 7 days and received a DLM through drinking water (41 ppm) for 48 days.

The selected dose of DLM is equal to 1/12th of LD_{50} 40 mg/kg BW, which has been used previously by other researcher since, this dose was toxic but not lethal to rats [43]. DLM is given through the water because it can completely dissolve and rapidly absorbed in the gastrointestinal track [44]. In the present study, TMR and DLM + TMR group rats were fed with turmeric-diet 7 days before DLM exposure to acclimatise and daily thereafter throughout the study.

2.5. Measurement of body and organ weights

All rats were euthanized at the end of the experiment. After taking final body weight, the animals were dissected. The kidneys were removed, grossly examined and weighed. The kidney relative weight was calculated.

2.6. Sampling and biochemical assays

For estimations of different oxidative stress-related biochemical parameters in kidney, a 200 mg kidney tissue was minced into small pieces and homogenized in 2 mL of ice-cold phosphate buffer saline (PBS) (0.05 M, pH 7) to obtain 10% homogenate. Homogenates were centrifuged at 1500 *g* and supernatant was stored at −20 °C until assay. The kidney tissue were also immediately frozen and minced in liquid nitrogen and stored at −80 °C, then dried in a lyophilizer (VIRTIS 6 KBEL 85) for 12 h to remove the water and samples were used for the FT–IR analysis. Simultaneously kidney samples from different experimental groups were fixed in Bouin's fixative for 24 h for histopathological analysis.

2.7. Serum biochemistry

For serum biochemistry, blood was collected in clean centrifuge tube without anticoagulant and then it was allowed to stand for few minutes at room temperature to clot and centrifuged at 1500 *g* for 5 min at 4 °C. The serum was then collected into separate vial and subsequently subjected for the assessment of urea, uric acid, creatinine using specific Erba kits with automatic analyzer (Erba Chem-5, V_2).