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Therapeutic effect of pectin on octylphenol induced kidney dysfunction, oxidative stress and apoptosis in rats

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ABSTRACT

Octylphenol (OP) is one of ubiquitous pollutants in the environment. It belongs to endocrine-disrupting chemicals (EDC). It is used in many industrial and agricultural products. Pectin is a family of complex polysaccharides that function as a hydrating agent and cementing material for the cellulose network. The aim of this study was to evaluate the therapeutic effect of pectin in kidney dysfunction, oxidative stress and apoptosis induced by OP exposure. Thirty-two male albino rats were divided into four equal groups; group 1 control was injected intraperitoneally (i.p) with saline [1 ml/kg body weight (bwt)], groups 2, 3 & 4 were injected i.p with OP (50 mg/kg bwt) three days/week over two weeks period where groups 3 & 4 were injected i.p with pectin (25 or 50 mg/kg bwt) three days/week over three weeks period. The results of the present study revealed that OP significantly decreased glutathione-S-transferase (GST), glutathione peroxidase (GPx), catalase (CAT), reduced glutathione (GSH), glutathione reductase (GR) and superoxide dismutase (SOD) levels while increased significantly lipid peroxidation (MDA), nitric oxide (NO) and protein carbonyls (PC) levels in the kidney tissues. On the other hand, OP increased serum urea and creatinine. Furthermore, OP increased significantly serum uric acid but decreased significantly the kidney weight. Moreover, OP decreased *p*53 expression while increased bcl-2 expression in the kidney tissue. The treatment with either dose of pectin to OP-exposed rats restores all the above parameters to approach the normal values where pectin at higher dose was more effective than lower one. These results were supported by histopathological investigations. In conclusion, pectin has antioxidant and anti-apoptotic activities in kidney toxicity induced by OP and the effect was dose-dependent.

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1. Introduction

Octylphenol (OP) is one of ubiquitous pollutants in the environment. It belongs to the endocrine-disrupting chemicals (EDC). Due to its widespread uses in many industrial and agricultural products, it is believed that high amounts of OP have been discharged to aquatic ecosystems (Ying et al., 2002). OP is a final degradation product derived from alkylphenol polethoxylates that are extensively used as a surfactant in detergent, herbicides, paints, cleaners, dispersants, emulsifiers, pesticides, food packaging, cosmetics, pulp, paper and for other domestic and industrial products. In the environment, OP is mainly present in the sediment and various water supplies, such as surface, waste and drinking waters. Moreover, it can be accumulated within the internal organs of fish and birds as well as vegetables and fruits, reaching a concentration up to 10–100 times higher than that found in the environment based on its high stability and lipid solubility. This compound is a generating and considerable concern within the public and scientific community because EDC can be easily pass to the humans through the food chains and mimic the actions of natural hormones in the body. Recent studies reported that the levels of OP present in the environment may be sufficient to disrupt the endocrine system (Ying et al., 2002; Quirós et al., 2005; Kim et al., 2006; Othman et al., 2012).

Many environmental contaminants have been reported to disrupt the pro-oxidant/antioxidant balance of cells, thereby inducing oxidative stress (Ho et al., 1998). Reactive oxygen metabolites such as hydroxyl radicals, peroxide anions, peroxyl radicals and hydrogen peroxide are cyto-toxic agents. They caused significant oxidative damage by attacking biomolecules such as membrane lipids, DNA and proteins in the cells (Kabuto et al., 2003). OP caused tissue injury in the kidneys, liver, brain, testes and other organs by forming oxidative stress (Chitra et al., 2002; Kabuto et al., 2004; Karageorgos et al., 2006). Moreover Aydoğan et al. (2008) found that malondialdehyde concentration has been increased in rats exposed to OP and also decreased GSH concentration in the brain. All evidences reported in the recent years have emphasized the need for more effective and reliable methods for the risk assessment of this substance and to find out a possible control to hamper its toxicity.

Pectin is a family of complex polysaccharides that function as a hydrating agent and cementing material for the cellulose network (Thakur et al., 1997). Although pectin occurs in a majority of plant cell walls, it is most abundant in citrus (lime, lemon, grapefruit and orange) fruits. Pectin was found to protect the liposomes against aggregation during drug storage so pectin was used for stabilizing liposomal drug delivery systems (Smistad et al., 2012). Pectin was also found to be a suitable alternative of semi-synthetic polymers, which can be further employed in an industrial scale as an efficient release retardant in the formulation of microspheres (Banerjee et al., 2012). There was a marked beneficial effect while using pectin containing drug in the postoperative treatment of intestinal insufficiency, as was confirmed by evaluation of biopsy specimens of gastric mucosa, jejunum and sigmoid colon (Demidov et al., 2012). Moreover, pectin reduced neutrophil migration into the oral cavity during exercise because of hyper-stimulation of their functional activity (Paderin and Nikitina, 2012). Furthermore, pectin combined with liquid nutrient is effective in preventing acidic gastro-esophageal reflux and the gastro-esophageal reflux reaching the upper portion of the esophagus in elderly patients undergoing percutaneous endoscopic gastrostomy feeding (Adachi et al., 2012). There was a link between administration of pectin and decreased metastasis of prostate tumors in rats (Pienta et al., 1995). Prostate cancer dramatically reduced by 22.8%, and the age of onset drastically increased, if the population at risk consumed high proportion of pectin in foods, beginning early in life (Atawodi, 2011). A diet supplemented with 20% pectin significantly decreased the number and incidence of colon tumors in rats, and reduced prostaglandin E2 (PGE2) levels in distal colonic mucosa and blood of the portal vein. The ability of pectin to decrease PGE2 was dose dependent, and these results suggested the anti-inflammatory effect of pectin. Pectin oligosaccharides showed a lower incidence of hepatic metastasis with antioxidant activity and portal scavenging function (Tazawa et al., 1999). The diets contain pectin and fish oil protect against colon cancer by up-regulating apoptosis and suppressing proliferation during the tumorigenic process (Cho et al., 2011). Pectin demonstrates dual advantages as drug carrier and therapeutic for use in treatment of colon cancer where pectin is suitable for use as colon-specific drug delivery vehicle; it is selectively digested by colonic microflora to release drug with minimal degradation in upper gastrointestinal tract (Wong et al., 2011).

The purpose of the present study was to evaluate the therapeutic effect of pectin to reduce kidney dysfunction, oxidative stress and apoptosis induced by OP administration. To accomplish this, we measured several oxidative stress, kidney function and apoptotic parameters to determine if OP can induce oxidative stress in the kidney organ and if this stress could be treated by the use of pectin.

2. Materials and methods

2.1. Materials

Citrus pectin (its percentage = 2.5%), 4-tert-Octylphenol (OP) and all chemicals used in this study were purchased from Sigma–Aldrich, St. Louis, MO, USA. All kits reagents used were of analytical grade and were obtained from Biomerieux Company, France through local supplier.

2.2. Animals

Thirty-two adult male albino rats of Sprague–Dawley strain weighing 120–130 g were obtained from the animal house colony of National Research Centre, Egypt. They were kept under the hygienic conditions and well balanced diet and water. The experiments were carried out according to the national regulations on animal welfare and institutional animal ethical committee (IAEC).