

A Study on Hepatoprotective Role of Virgin Coconut Oil on Liver Toxicity Induced by Cadmium Chloride in Rats

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Abstract

Cadmium is a toxic carcinogenic metal, abundant in our surrounding since industrial age. Injury occurring due to direct toxic effect of cadmium metal poses a variety of disruption of the hepatocytes. Virgin coconut oil (VCO) has been consumed worldwide for various health-related reasons and some of its benefits like the antioxidant property have been scientifically evaluated. Hence present study was designed to gauge the protective role of virgin coconut oil in attenuating cadmium induced liver damage. Animals were divided into the following groups with 6 rats in each group; Group 1: Control Group (rats were injected with single dose of 0.9% NaCl intraperitoneally) and sacrificed after 15 days, Group 2: (Virgin Coconut Oil treated group), Group 3: (Cadmium treated Group), Group 4: (Virgin coconut oil+ cadmium treated group) Rats were pretreated with virgin coconut oil (2ml/kg bw) for 30 days and then were injected with single dose of 1mg/kg bodyweight cadmium. Rats were sacrificed 15 days after cadmium administration. Liver was removed and stored for histopathological parameters after injecting appropriate anesthesia. Results of the present study showed that there was significant increase in the level of SGPT and SGOT in cadmium treated group compared to normal control. Pre-treatment with virgin coconut oil showed a decrease in the level of SGPT and SGOT compared to cadmium treated rats. Histological results were supported the biochemical results. Hence, Virgin coconut oil showed protective role in attuning cadmium induced liver and testicular damage.

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Introduction

One of major threat to the environmental pollution is the contamination of atmosphere by various heavy metals. Cadmium is a heavy metal of considerable environmental and occupational concern. Cadmium compounds are classified as human carcinogens by several regulatory agencies. Cadmium exposure has also been linked to human prostate and renal cancer, although this linkage is weaker than for lung cancer. Other target sites of

cadmium carcinogenesis in humans, such as liver, pancreas and stomach, are considered equivocal. It has been well established that cadmium having a long biological half-life of approximately 20-40 years, accumulates in the human body and causes toxicity². The main contributors of cadmium to the atmosphere are industrial and agricultural sources, cigarette smoke, lead smelting, nickel cadmium battery manufacturing and so on³. Humans get exposed to cadmium either through industry or through diet⁴. The injurious effect of cadmium is related with diverse clinical manifestations like renal and hepatic dysfunctions, bone diseases, anemia, pulmonary edema, testicular damage and immune toxic effects along with the alterations of the lipid profile⁵. Acute Cd exposure results in hepatocellular damage, while chronic Cd intoxication results mainly in renal diseases. When ingested, the intestine absorbed Cd reaches the liver through portal circulation and is subsequently taken up from

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the sinusoidal capillaries to the hepatocytes. Injury occurring due to direct toxic effect of the metal poses a variety of disruption of the hepatocytes⁶.

Virgin coconut oil (VCO) has been consumed worldwide for various health-related reasons and some of its benefits have been scientifically evaluated. Virgin coconut oil (VCO) is the finest and purest grade of coconut oil available. VCO is increasingly getting the reputation of being the most versatile and healthiest oil in the world. Virgin coconut oil when consumed, turns to monolaurin, a chemical compound which is believed to increase immunity against viruses, bacteria, fungus, parasites and other pathogens⁷. There are few studies which have shown the beneficial property of virgin oil such as anti-inflammatory, antiviral, antidiabetic and antioxidant property⁸. Arunima et al in their study found that the beneficial role of virgin coconut oil in improving antioxidant status, prevented lipid and protein oxidation⁹. Antioxidants protect the tissue from oxidative stress. Several studies are aimed at antioxidant therapy to prevent cadmium induced liver damage¹⁰. There are not much studies on role of virgin coconut oil on cadmium induced hepatic toxicity. Moreover, it is also seen that increasing environmental exposure to cadmium, currently existing occupational exposure and the prevalence of tobacco smoking, has resulted in increase in the risk of cadmium induced toxicity. Hence, present study is aimed to study whether pretreatment with virgin coconut oil will be helpful in reducing cadmium induced liver damage.

AIMS & OBJECTIVES:

1. To study the effects of cadmium toxicity on liver in rats.
2. To study the effects of pre-treatment with virgin coconut oil on cadmium induced liver damage in rats.

Materials and methods

Institutional ethics committee clearance was obtained before beginning the experiments. Healthy adult Albino rats of Wistar strain, approximately 150-200 gm body weight(bw), aged 2-3 months were ordered from the central animal house of our institution. They were housed in the central animals' house at the laboratory under controlled conditions of

temperature and light, with normal rat feed and drinking water.

Animals were divided into the following groups with 6 rats in each group;

Group 1: Control Group (rats were injected with single dose of 0.9% NaCl intraperitoneally) and sacrificed after 15 days.

Group 2: (Virgin Coconut Oil treated group) Rats were orally treated with VCO (of 2-ml/kg body weight) every day for 30 days and then sacrificed.

Group 3: (Cadmium treated Group) Rats were injected with single dose of 1mg/kg bodyweight cadmium chloride intraperitoneally and were sacrificed after 15 days

Group 4: (Virgin coconut oil+ cadmium treated group) Rats were pretreated with virgin coconut oil (2ml/kg bw) for 30 days and then were injected with single dose of 1mg/kg bodyweight cadmium. Rats were sacrificed 15 days after cadmium administration

After desired protocol, animals were anesthetized by giving suitable anesthesia (ketamine) according to the body weight. Liver was removed and stored for histopathological parameters.

Blood sample was collected by cardiac puncture for biochemical estimation like serum SGPT and SGOT.

Preparation of Virgin Coconut oil.

Virgin coconut oil (VCO) was separated from the coconut as follows: The fresh coconut meat was shredded and then cold-pressed to make coconut milk. The coconut milk was fermented for 48 hours, whereupon the oil naturally separated out from the milk, producing crystal clear oil. This unique process means that the pure oil will not have a coconut taste or odour. The virgin coconut oil was filtered and kept in a refrigerator.

Statistical Analysis

The data was expressed as mean + SD from 6 animals per group. Analysis was done by using the students unpaired t- test and the Mann-Whitney U test. Statistical package SPSS version 17.0 was used to do the analysis. Significance of the test was set at $p < 0.05$.

Results

Effects of virgin coconut oil pre-treatment on liver damage induced by cadmium

Groups	SGPT (U/L)	SGOT(U/L)
Group I	43.6±2.87	120.3333±6.80
Group II	44.5±4.18	123.6667± 6.62
Group III	81.5±10.83***	194.16± 3.48***
Group IV	72.6± 8.82 ^{NS}	157± 2.25*

Table 1. Effect of virgin coconut oil treatment on liver damage induced by cadmium chloride. Mean ± SD, n=6 in each group. ***p<0.001 Gr.III compared to Gr.I & Gr.II. NS= not significant, Gr.IV compared to Gr.III.

Results of the present study showed that there was significant (P<0.001) increase in the level of SGPT and SGOT in cadmium treated group (Gr.III) compared to Gr.I and Gr.II. Pre-treatment with virgin coconut oil (Gr.IV) showed a decrease in the level of SGPT compared to cadmium treated rats but it was not statistically significant. The level of SGOT was significantly (p<0.05) lower in Virgin pre-treated rats prior to cadmium administration (Gr.IV), compared to cadmium administered rats (Gr.III) (Table: 1)

Histological results of the liver:

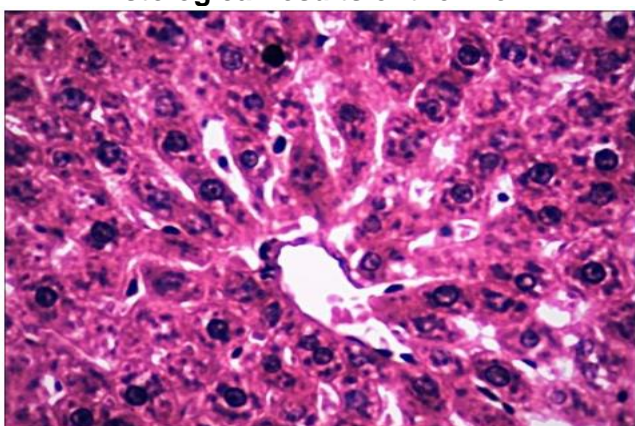


Figure:1. Photomicrograph of liver of control animal showing single cell thick liver cells, normal sinusoids, and portal triad (PT)(Gr.I). (Hematoxylin & Eosin. 40X).

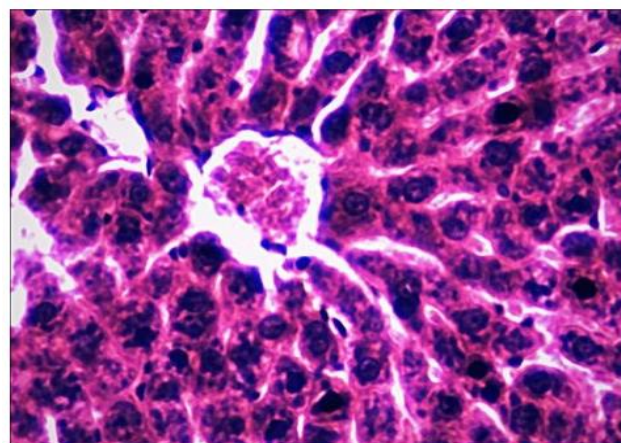


Figure 2. Photomicrograph of liver of VCO treated animal showing single cell thick liver cells, normal sinusoids, and portal triad (PT) (Gr .II). (Hematoxylin &Eosin. 40X).

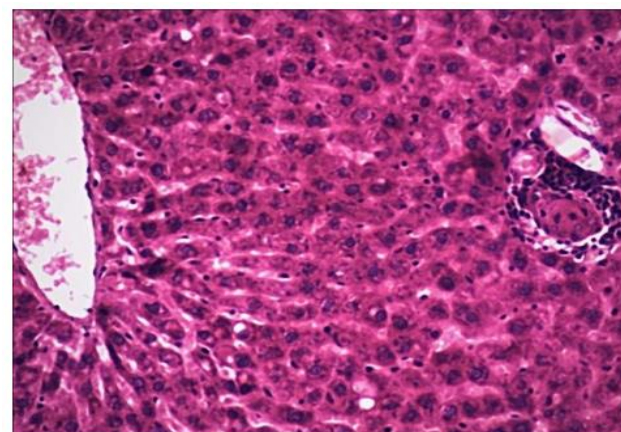


Figure 3. Photomicrograph of liver of treated with cadmium showing disrupting liver cell plate with infiltration and inflammation (Gr.III). (Hematoxylin &Eosin. 20X).

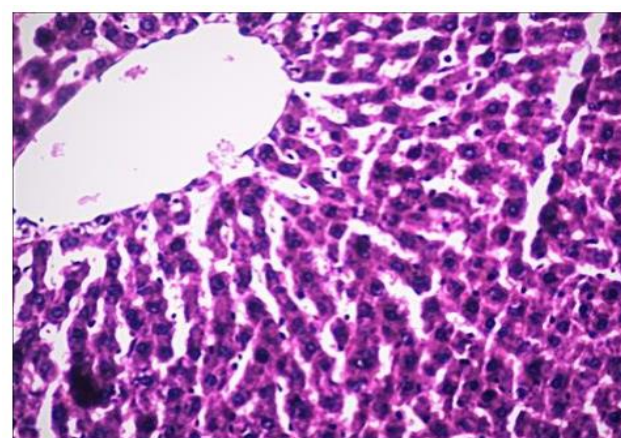


Figure 4. Photomicrograph of liver of pre-treated VCO prior to cadmium administration, showing normal liver cell plate with minimal infiltration (Gr.IV). (Hematoxylin &Eosin. 40X).

Liver section in normal control rats (Gr.I) and virgin treated rats showed normal hepatocytes, sinusoids and portal triads (Figure: 1 & 2). But, in cadmium treated rats (Gr.III) the liver histology showed crowded hepatocytes with inflammation and infiltration (Figure: 3). The photomicrograph of the liver section of rats pre-treated with virgin coconut oil (Gr.IV) showed normal liver cells with minimal infiltration (Figure: 4).

Discussion

Cadmium (Cd), as known, is a heavy metal and a major environmental toxicant. According to Toxic Substances and Disease Registry, Cd is ranked the 7th toxic metal. It has been well established that cadmium having a long biological half-life of approximately 20-40 years, accumulates in the human body and causes toxicity, giving way to impairment of the reproductive organs of adults, liver, kidney etc^{2,20}

SGPT and SGOT are the liver specific enzyme. Acute liver injury is known to cause high levels of SGPT and SGOT^{11,12}. Serum SGPT and SGOT are the most sensitive markers of liver damage because they are cytoplasmic in location and are released into the circulation after hepatocellular damage^{13,14}. In accordance previous studies, results of our study also showed a significant increase in the SGPT and SGOT in cadmium treated rats showing the damaging effects of cadmium on the rat liver. In the present study, biochemical results were supported by histological results where hepatocytes showed inflammation and infiltration due to damage caused by cadmium administration. These findings are very similar to findings observed by Sharma RK in his study¹³.

The evolutionary survival process has provided aerobic organisms with protective systems to neutralize the oxidative effect of oxygen and its reactive metabolites. These self-sustained protective components are called as "antioxidant protective systems"^{15,16}. Antioxidants do their function either by quenching of electron mobility, scavenging free radicals or by breaking free radical chain reaction. Some recent studies have shown that virgin coconut oil (VCO) has varied degree of beneficial properties such as antiviral, antibacterial, anti-fungal, anti-inflammatory, antidiabetic, anti-obesity, anti-

ulcerogenic, analgesic and antipyretic, and antioxidant properties^{7,8}. Arunima et al in their study found that the beneficial role of virgin coconut oil in improving antioxidant status, prevented lipid and protein oxidation⁹. A study conducted by Arunskaran et al reported that virgin coconut oil can be used as a nutraceutical against hepatosteatosis¹⁷. Previous studies have also presented that polyphenols isolated from VCO prevent Cd-induced lipid abnormalities and cardiovascular risk ratios by improving antioxidant defense systems^{18,19}. In the present study, pre-treatment with virgin coconut oil prior to cadmium administration was helpful in attenuating liver damage induced by cadmium chloride.

Conclusions

Biochemical and histological results of the present study proved that cadmium administration lead to damaging effect on the liver, while Virgin coconut oil showed protective role in attuning cadmium induced liver damage.

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Declaration of Interest

The authors report no conflict of interest.

References

1. Jarup L, Akesson A. Current status of cadmium as an environmental health problem. *Toxicology and Applied Pharmacology*. 2009;238(3):201-208.
2. Siu E, Mruk D, Porto C, Cheng C. Cadmium-induced testicular injury. *Toxicology and Applied Pharmacology*. 2009;238(3):240-249
3. Adams RG. Manufacturing process, resultant risk profiles and their control in the production of nickel-cadmium(alkaline) batteries. *Occup Med*.1992;42:101-106
4. Ellis KJ, Cohn SH, Smith TJ. Cadmium inhalation exposure estimates their significance with respect to kidney and liver cadmium burden. *J Toxicol Environmental Health*. 1985;15:173-181
5. Arowojolu A, Akinloye O, Shittu O, Anetor JI. Cadmium toxicity:A possible cause of male infertility in Nigeria. *Reproductive biology*. 2006;6(1):17-30.
6. Arroyo V, Flores K, Ortiz L, Gómez-Quiroz L, Gutiérrez-Ruiz M. Liver and Cadmium Toxicity. *Journal of Drug Metabolism & Toxicology*. 2012;03(06):2-7.
7. Intahphuak S, Khonsung P, Panthong A. Anti-inflammatory, analgesic, and antipyretic activities of virgin coconut oil. *Pharmaceutical Biology*. 2009;48(2):151-157.

8. Zakaria Z, Somchit M, Mat Jais A, Teh L, Salleh M, Long K. In vivo Antinociceptive and Anti-inflammatory Activities of Dried and Fermented Processed Virgin Coconut Oil. *Medical Principles and Practice*. 2011;20(3):231-236.
9. Arunima S, Rajamohan T. Effect of virgin coconut oil enriched diet on the antioxidant status and paraoxonase 1 activity in ameliorating the oxidative stress in rats – a comparative study. *Food & Function*. 2013;4(9):1402-1409.
10. Patra RC, Swarup D, Senapati SK. Effects of cadmium on lipid peroxides and superoxide dismutase in hepatic, renal and testicular tissue in rats. *Veterinary and Human Toxicology*. 1999;41(2):65-7.
11. Assessment of liver damage in male albino rats after repetitive heat stress of moderate level Assessment of liver damage in male albino rats after repetitive heat stress of moderate level. *National journal of Physiology, Pharmacy and Pharmacology*.2013;3(2):147-152
12. Edoardo G, Giannanni Roberto Testa and Vincenjo Savarino. Liver enzyme alteration: a guide for clinicians. *Canadian Medical Association Journal*,.2005 ; 172(3): 367–379.
13. Sharma RK. Morphological & morphometric studies on liver in rats subjected to repetitive heat stress. *Indian J Med Res*. 1997;106:20–6.
14. Pari L., Amali D.R. Protective role of tetrahydrocurcumin (THC) an active principle of turmeric on chloroquine induced hepatotoxicity in rats. *J Pharm Pharmaceut Sci*. 2005;8:115–123.
15. Davies K. Intracellular proteolytic systems may function as secondary antioxidant defenses: An hypothesis. *Journal of Free Radicals in Biology & Medicine*. 1986;2(3):155-173.
16. Heffner J, Repine J. Pulmonary Strategies of Antioxidant Defense. *American Review of Respiratory Disease*. 1989;140(2):531-554.
17. Arunaksahran Narayanakutty ,Devika Mukundan Palliyil, Kezia Kuruvilla, Achuthan C Raghavamenon. Virgin coconut oil reverses hepatic steatosis by restoring redox homeostasis and lipid metabolism in male Wistar rats. *Journal Science Food Agriculture*.2018;98(5):1757-1764
18. Ademola Clement Famureva and Fidelis Ebele Ejezie. Polyphenols isolated from virgin coconut oil attenuate cadmium-induced dyslipidemia and oxidative stress due to their antioxidant properties and potential benefits on cardiovascular risk ratios in rats. *Avicenna J Phytomed*.2018;8(1):73-84
19. Ademola C Famurewa, Chioma S Ugwu-Ejezie , Eghosa E lyare et al Hepatoprotective effect of polyphenols isolated from virgin coconut oil against sub-chronic cadmium hepatotoxicity in rats is associated with improvement in antioxidant defense system. *Drug chem Toxicology*.2019;25:1-9.
20. Kavita Rana, Yeshvandra Verma and S.V.S.Rana. Possible Mechanisms of Liver Injury Induced by Cadmium Sulfide Nanoparticles in Rat. *Biological Trace Element Resaerch*.2021;199:216-226.