THE EFFECT OF CORN COB ON LIPID PROFILE OF NICKEL INDUCED HEART TOXICITY IN WISTAR RATS

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ABSTRACT

Background: Exposure to nickel produced physiological and biochemical disturbances in human and animals. Polysaccharides from corn cobs showed immunogenic, mitogenic, antioxidant and anti proliferative activities.

Aim: The aim of this study was to determine the effect of Corn Cob on lipid profile of nickel induced heart toxicity in wistar rats.

Methodology: Eighteen wistar rats were divided into six groups of three wistar rats each. The controls group were given 0.2mls of distilled water and rat diet and water *adlibitum*, rats in group 2 were administered with 0.5mg/kg Nickel, while rats in groups 3, 4 and 5 were administered with 0.5mg/kg Nickel with 300mg/kg, 450mg/kg and 600mg/kg of corn cob extracts respectively by oral intubation for 28 days. The Cholesterol, Triglycerides, High density lipoprotein (HDL), Low density lipoprotein (LDL) and Very Low density lipoprotein (VLDL) concentrations were estimated using standard methods. The data were analyzed using statistical package for social science (SPSS) version 25.

Results: There was significant difference ($P<0.05$) in LDL (Mmol/L) concentrations of 2.22 ± 0.29, 3.32 ± 0.19, 4.16 ± 0.25, 2.09 ± 0.27, 2.16 ± 0.27 and 3.43 ± 0.39 in control, Nickel treated, 300mg/kg, 450mg/kg, 600mg/kg and 450mg/kg Corn cob Ash respectively. There were significant difference ($P<0.5$) in Cholesterol concentration of Nickel and Nickel + 300mg/kg corn cob ash treated compared with the control. There were no significant difference ($P>0.5$) in HDL, Triglycerides and VLDL concentrations at different treatments compared with their respective controls.

Conclusion: The study showed that Nickel caused significant increase in Cholesterol and LDL. The administration of ash corn cob at 450mg/kg and 600mg/kg reversed the increased Cholesterol and LDL concentrations caused by Nickel.

Keywords: corn cob, Nickel, lipid profile

INTRODUCTION

Corn cobs are wastes from dried corn shells which are now becoming increasingly in demand by farmers to be used as feed with abundant availability as well as the proportion of waste products by 20% from corn (Tsado *et al.*, 2019). It is estimated that maize cob accounts for 40–50 percent of total corn production. Corn cob is considered an agriculture waste (by-product of sweet corn) (Islam *et al.*, 2023). However, the utilization of corn cobs is still of low quality with high crude fibre content and low protein content that requires a touch of technology such as fermentation in order to improve its quality and can be used as a more optimal feed (Arwinsyah, and Yunilas 2019). Corn cobs are used for the development of value-added bakery product products, and this product is safe for gluten allergy persons (Islam *et al.*, 2023). Corncobs are by-products of maize processing industries and households. They can constitute environmental menace not only on the farms but on the streets and in homes if not properly disposed.

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Corncob contains hemicelluloses that produce appreciable quantities of xylose and arabinose, with lesser quantities of glucose and galactose fermentable sugars. These are webbed up in mass of lignin and other polysaccharides, which gives it characteristic hardness and insolubility in water (Warren, 1996)

Stainless steel manufactured implants are widely used biomedically, especially for the replacement or support of broken bones with plates or screws, the replacement of joints at the hip or knee, and the fixation of hard tissues in dentistry. These metallic implants contain 4–17% nickel (Ni) (Cigada *et al*., 1994) Also nickel–chromium dental casting alloys (which contain 61–77% nickel) (Bumgardner and Lucas 1994) have been used in dentistry since the early 1930s. Ni gets into human and animals mainly through inhalation, drinking water and food, and food is the most important among these pathways (Haber *et al.*, 2000). The previous studies have shown that long-term exposure to Ni can also be toxic to the upper respiratory tract, skin, kidney, immune system, embryo, and breeding system (Kasperzak *et al*., 2000, Haley *et al.*, 1987). During last few decades, trace metal toxicity-related health problems outshined the mere understanding of occupational health issues of professionally exposed individuals. A report indicated that nickel is a potential immunomodulatory and immunotoxic agent aside from its action as an allergen in humans (Das and Buchner 2007, Das *et al*., 2010). However, the exposure of human beings mainly concerns oral ingestion through water and food as nickel may be a contaminant in drinking water and/or food (Sinicropi *et al.,* 2012). Cardiovascular disease (CVD) is the number one cause of death and a leading contributor to mortality and morbidity worldwide (Roth *et al*. 2020). Between 1990 and 2019, prevalent cases of total CVD nearly doubled from 271 to 523 million globally, with the number of CVD deaths reaching 18.6 million in 2019 (Roth *et al*. 2020). Dyslipidemia is a significant factor in cardiovascular and other diseases (Bhatia and Wilkinson 2022). Patients with dyslipidemia are twice as likely to experience cardiovascular disease as normal lipids (Joint committee for guideline revision in the management of dyslipidemia in adults 2018). More than a third of cardiovascular disease and stroke deaths are due to elevated LDL-C. Ischemic Heart Disease (IHD) affects as many as 8.54 million people globally, of which 3.78 million are associated with high levels of LDL-C. In the same year, it was also known that there were 2.73 million deaths due to ischemic stroke, and 0.61 million were also associated with high LDL-C levels (Metrics IfH, 2019). Dyslipidemia also increase the risk of atherosclerosis, myocardial infarction, stroke, and death from cardiovascular disorders in people with diabetes mellitus or pre-diabetes (Joint committee for guideline revision in the management of dyslipidemia in adults 2018; Patel *et al.,* 2021). Any adverse effects caused by dyslipidemia require attention, and these conditions must be controlled. Das, *et al*. (2006) reported that nickel sulfate, a toxic heavy metal, adversely affects the serum lipid profile. Simultaneous treatment with L-ascorbic acid partially improved nickel-induced serum lipid profiles.

The aim of this study is to determine the effect of Corn Cob on lipid profile of nickel induced heart toxicity in wistar rats using the Cholesterol, Triglycerides, HDL, LDL and VLDL concentrations as indicators.

MATERIALS AND METHODS

Animals

A total of 18 male albino rats weighing 140 – 200 g purchased from the animal unit of University of Port Harcourt, were used for the study. They were kept in the animal house of Madonna University, Elele campus, and were housed in aluminum cages at room temperature and under light/darkness cycles.

The albino rats were supplied with clean drinking water and fed *ad libitum* with standard commercial pelleted starter feed (vital feed) and were acclimatized for two weeks before administration. They were maintained in accordance with their commendations of the guide for the care and use of laboratory animals and experimental protocol was approved by the institution.

Corn Cob Preparation

Corn cob was purchased from Elele Market in Elele. The cobs were dried under room temperature, and were stored until needed for extraction. The dry corn cob were incinerated to ashes (Controlled burning). Ninety (90) grams of corn cob ash was mixed in 300ml of distilled water. The mixture was vortex-mixed for 48hours for proper texture and triple filtered using whatman filter paper to get clear extract.

Nickel and other Chemicals

All the chemicals used in this work were of analytical grade obtained from Merck, Germany; BDH chemicals Ltd, England; May and Baker Ltd, England; Riedel-De-Haen Hannover, Germany and Hopkins and Williams Essex, England. Analytical grade Nickel produced by BDH chemicals Ltd, England was obtained from University of Benin.

Reagents

Commercially prepared Cholesterol, Triglycerides, HDL and LDL produced by Randox Limited UK were used

Experimental Protocol

Eighteen albino rats divided into six groups of three rats each were used for the study. The control group was given 0.2mls of distilled water and rat diet and water *ad-libitum*. The rats in group 2 was administered with 0.5mg/kg Nickel, while rats in groups 3,4 and 5 was administered with 0.5mg/kg Nickel with 300mg/kg, 450mg/kg and 600mg/kg of corn cob extracts respectively by oral intubation. The rats in group 6 were fed 450mg/kg corn cob extract. The treatments were done daily for 28 days. At 28th day, the rats were sacrificed. Blood was collected into plain tubes for Lipid profile analysis.

Biochemical analysis

The cholesterol was determined after enzymatic hydrolysis and oxidation. The indicator quinoneimine is formed from hydrogen peroxide and 4-aminoantipyrine in the presence of phenol and peroxides (Allain *et al*., 1974). Ten microlitre (10ul) of sample, Control, standard and distilled water was pipetted into respective test tubes then 1000ul of cholesterol working reagent was added. It was mixed and incubated for 5 minutes at 37^{0}C. The absorbance of the sample was measured against the reagent blank at 520nm. The cholesterol concentration of sample was calculated using the absorbance of sample against absorbance of standard multiplied by concentration of standard.

The triglycerides are determined after enzymatic hydrolysis with lipases. The indicator is a quinoneimine formed from hydrogen peroxide, 4-aminophenazone and 4-chlorophenol under the catalytic influence of peroxidase (Buccolo and David, 1973).

Ten microlitre (10ul) of sample, Control, standard and distilled water was pipetted into respective test tubes then, 1000ul of triglyceride reagent was added. It was mixed and incubated for 5 minutes at 37^{0}C. The absorbance of the sample was measured against the reagent blank at 520nm. The TG concentration of sample was calculated using the absorbance of sample against absorbance of standard multiplied by concentration of standard.

Low density lipoproteins (LDL and VLDL) and chylomicron fractions were precipitated quantitatively by the addition of phosphotungstic in the presence of Magnesium ions. After centrifugation, the cholesterol concentration in the HDL (high density lipoprotein) fraction, which remains in the supernatant, was determined.

Five hundred microlitre (500ul) of sample, Control standard and distilled water was added into respective test tubes, 1000ul of precipitant was added into all the tubes. It was mixed and allowed to stand for 10 minutes at room temperature. It was centrifuged for 2 minutes at 12,000 rpm. Then 10ul of supernatant from Control, standard and distilled water was added into their respective test tubes and cholesterol concentration of supernatant was determined as shown above by the methods of Allain *et al* .(1974).

LDL-cholesterol and VLDL Cholesterol (Mmol/L) was determined using the formula of Friedwald *et al* . (1972): LDL-cholesterol (Mmol/L) =Total cholesterol (Mmol/L)-HDL (Mmol/L) – TG(Mmol/L) /2.22. The VLDL Cholesterol (Mmol/L) was determined by dividing triglyceride concentration by 2.2.

Statistical Analysis:

Data obtained were subjected to statistical analysis using Statistical Package for Social Science version 25 using statistical tools such as t-test and analysis of variance (ANOVA). Results were expressed as Mean ± Standard Deviation (X±SD). The values of $P<0.05$ were considered significant.

RESULTS:

There was no significant difference ($P>0.05$) in Cholesterol (Mmol/L) concentrations of 3.13±0.40, 4.33±0.20, 5.03±0.24, 3.17±0.24, 3.57±10.71 and 4.30±0.32 and triglyceride (Mmol/L) concentrations of 1.49±0.17, 1.47±0.11, 1.67±0.17, 1.51±0.04, 1.61±0.05 and 1.73±0.09 in control, Nickel treated, Nickel + 300mg/kg Corn cob Ash, Nickel + 450mg/kg Corn cob Ash, Nickel + 600mg/kg Corn cob Ash and 450mg/kg Corn cob Ash respectively. There was no significant difference ($P>0.05$) in HDL (Mmol/L) concentration of 1.61±0.19, 1.66±0.07, 1.63±0.06, 1.76±0.02, 1.65±0.01 and 1.66±0.02 and VLDL (Mmol/L) concentrations of 0.68±0.07, 0.67±0.06, 0.75±0.08, 0.69±0.02, 0.73±0.02 and 0.78±0.04 in control, Nickel treated, Nickel + 300mg/kg Corn cob Ash, Nickel + 450mg/kg Corn cob Ash, Nickel + 600mg/kg Corn cob Ash and 450mg/kg Corn cob Ash respectively. There was significant difference ($P<0.05$) in LDL (Mmol/L) concentrations of 2.22±0.29, 3.32±0.19, 4.16±0.25, 2.09±0.27, 2.16±0.27 and 3.43±0.39 in control, Nickel treated, Nickel + 300mg/kg Corn cob Ash, Nickel + 450mg/kg Corn cob Ash, Nickel + 600mg/kg Corn cob Ash and 450mg/kg Corn cob Ash respectively (Table 1).

Table 1 Effect of Corn cob ash on Lipid Profile of Nickel induced Heart toxicity

Treatment	Cholesterol (Mmol/l)	Triglycerides (Mmol/l)	HDL (Mmol/l)	LDL (Mmol/l)	VLDL (Mmol/l)
Control	3.13±0.40	1.49±0.17	1.61±0.19	2.22±0.29	0.68±0.07
Nickel	4.33±0.20[a]	1.47±0.11	1.66±0.07	3.32±0.19[a]	0.67±0.06
Nickel + 300mg/kg Corn cob Ash	5.03±0.24[a,b]	1.67±0.17	1.63±0.06	4.16±0.25[a,b]	0.75±0.08
Nickel + 450mg/kg Corn cob Ash	3.17±0.24[b]	1.51±0.04	1.76±0.02	2.09±0.27[b]	0.69±0.02
Nickel + 600mg/kg Corn cob Ash	3.57±10.71[b]	1.61±0.05	1.65±0.01	2.16±0.27[b]	0.73±0.02
450mg/kg Corn cob Ash	4.30±0.32a	1.73±0.09	1.66±0.02	3.43±0.39[a]	0.78±0.04
F	0.823	0.759	0.355	9.022	0.695
P	0.556	0.596	0.869	0.001	0.637

a= significant when compared with Control

b= significant when compared with Nickel

DISCUSSION

The result showed that Nickel exposure caused significant increase ($P<0.05$) in Cholesterol and LDL with no significant changes ($P>0.05$) in triglycerides, HDL and VLDL concentrations compared with their respective controls. This is similar to report of Das *et al*., (2006) who reported that Nickel-treated rats showed a significant increase in serum low-density lipoprotein-cholesterol, total cholesterol, and a significant decrease in serum high-density lipoprotein-cholesterol. The increase observed in LDL could be due to changes in the gene expression of hepatic enzymes like HMG-CoA reductase (hydroxymethylglut-aryl-CoA reductase), which in turn depresses LDL receptor gene expression. Defects in the LDL-receptor interfere with cholesterol uptake from the blood stream, which in turn causes excess cholesterol synthesis in the liver and high levels of serum total cholesterol and LDL-cholesterol (Kantola *et al*., 1998). Heavy-metal-induced change in the gene expression of HMG-CoA reductase in rats has already been reported (Kojima *et al*., 2004). Dyslipidemia is a major risk factor for the development of atherosclerosis and other cardiovascular diseases (Soppert *et al*., 2020). Dyslipidemia is a disorder of lipid levels in the blood that occurs when there is a decrease in High-Density Lipoprotein-Cholesterol (HDL-C), an increase in Low-Density Lipoprotein-Cholesterol (LDL-C), and an increase in triglycerides. TG), and increased total cholesterol (TC) (Pawlak *et al.*, 2012). Therefore, a high level of LDL-cholesterol and a low level of HDL cholesterol is a high risk factor for heart disease (Lichtenstein and Deckelbaum 2001).

The result further showed that corn cob caused dose reduction in Cholesterol and LDL Cholesterol of rats treated with nickel. Xu *et al*. (2020) had reported that corn husks are effective in reducing TC, LDL-C, and TG. Previous studies showed that corn can reduce harmful lipids (cholesterol, LDL-C, triglycerides) and increase good lipids (HDL-C) in rats (Shariati *et al.*, 2011, Xu *et al*., 2020), using certain parts of the corn fruit, such as corn husks (Xu *et al*., 2020) and corn silk (Budiman and Puspasari 2016), as well as using processed corn products such as corn oil (Ostlund *et al*.,2002, Maki *et al*., 2015, Maki *et al.*, 2017, Maki *et al.*, 2018).

The study found no significant difference in the lipids panel except LDL cholesterol which were reduced by the ash corn cob. The LDL concentrations of Nickel treated and ash corn cob treated compared with the control showed significant difference ($P<0.05$) with no significant difference ($P>0.05$) in Cholesterol, triglycerides, HDL and VLDL concentrations of all the groups. Studies in ApoE knockout mice have shown that inhalation of nickel nanoparticles is associated with altered cardiac function and may induce oxidative stress and inflammation that ultimately contribute to the progression of atherosclerosis (Lippmann *et al.* 2006; Kang *et al.* 2011). Sumarni *et al*., (2023) reported that corn can reduce harmful lipids (cholesterol, LDL-C, triglycerides) and increase good lipids (HDL-C). Instant foods, high in fat and complex processing, increase the risk of dyslipidemia, in contrast to fruits and vegetables, which have the effect of lowering the bad fat profile (Huriyati *et al.*,2019).

Conclusion

The study showed that Nickel caused significant increase in Cholesterol and LDL. The administration of ash corn cob, an agricultural waste at 450mg/kg and 600mg/kg reversed the increased Cholesterol and LDL concentrations caused by Nickel.

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