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Research Article

Evaluation of Lipid Profile Levels in Albino Rats Fed with Insecticide (Chlorpyrifos)

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Abstract

The evaluation of lipid profile in albino rats fed with insecticide (chlorpyrifos) was investigated. The study was aimed at examining the effect of chlorpyrifos on the lipid profile levels in albino rats fed with insecticides. A total of 41 albino rats were used and sixteen (16) rats were used for the plot phase which was done to ascertain the lethal dose of the insecticide of interest while the remaining twenty-five was used for the main study. The rats were divided into five groups. The control group (A) was given rat diet and water while rats in group B, C, D and E were administered with freshly prepared chlorpyrifos concentrate base on the lethal dose respectively through oral means. After twenty-eight days, blood sample were collected and Serum obtained was determined as follows total cholesterol, triglyceride, low density lipoprotein (LDL) and high-density lipoprotein (HDL) by enzymatic method. The data generated were determined and statistically analyzed using IBM SPSS version 27 and findings were considered significant at $P<0.05$. There was significant increase in serum low density lipoprotein (LDL) (mmol/l) of A(control) 103.80±5.54 162.80±14.10 (0.02ml/kg), 154.40±3.56 (0.01ml/kg), 154.40±7.83 (0.005ml/kg), and 143.60±4.83(0.003ml/kg) in control, and significant decrease in serum high density lipoprotein (HDL) (mmol/l) of A(control)=49.00±4.95, 34.60±2.70(0.02ml/kg), 29.40±5.08 (0.01ml/kg), 26.20±1.30 (0.005ml/kg) and 28.40±2.41 (0.003ml/kg), cholesterol 154.80±7.79 200.0±32.21, 196.0±3.94, 192.4±5.03, 180.0±3.67, triglyceride 59.60±3.65, 63.20±4.55.20±3.11, 52.40±3.78, 52.10±0.08, VLDL: 12.24±0.78, 12.64±0.91, 11.04±0.62, 10.08±0.23, 10.44±0.17 in the albino rats fed with insecticide (chlorpyrifos) compared to the control. In conclusion, the increase and decrease of low-density lipoprotein level and high-density lipoprotein levels respectively observed in albino rats fed with chlorpyrifos, is a result of pesticides exposure which is harmful, so it is advisable that the use of pesticides (insecticides) in our homes should stop and workers who handle them should use protective measures to avoid those risk hazard.

Keywords: lipid profile; albino rats; insecticide

Introduction

Pesticides are chemical or biological agents designed to incapacitate or kill pests. They are substances or mixtures that plays a crucial role in protecting crops from insects, weeds and diseases thereby enhancing food production and ensuring food security. Pesticides are deemed hazardous to both the environment and human life when used. The extensive use of pesticides for crops, fruits and vegetables causes serious problem on non-target organisms leading to a number of pathological and disordered biochemical processes [1]. Pesticides are classified into insecticides, herbicides, fungicides, and rodenticides.

Agriculture is a vital sector in Africa, employing about 60% of the continent's workforce and contributing significantly to the gross domestic product (GDP) of many countries [2]. However, pest infestations and diseases pose significant threats to crop yields, leading to the widespread use of insecticides like chlorpyrifos [3]. Insecticides are the most commonly used pesticides that are designed to target or kill insect [4], and this include carbamates (Baygon Fly Bait), organophosphates (Malathion, parathion, diazinon, fenthion, chlorpyrifos, ethion) organochlorine (Aldrin) and Pyrethroids (Baygon mosquito coli). Chlorpyrifos, an organophosphorus insecticide, has been widely used in agricultural and residential settings since its introduction in the 1960s [5]

Its extensive use has raised concerns about its potential impact on human health, particularly in relation to cardiovascular disease (CVD) [6]. CVD is a leading cause of morbidity and mortality worldwide, with ‘dyslipidemia’ being a significant risk factor [7].

Research has shown that exposure to chlorpyrifos can lead to changes in lipid metabolism, including alterations in high-density lipoprotein (HDL) and low-density lipoprotein (LDL) levels [8]. HDL and LDL are essential components of the lipid profile, with HDL considered "good" cholesterol” and LDL considered "bad" cholesterol” [9]. Elevated LDL levels and

reduced HDL levels are associated with increased CVD risk [10]. Studies have investigated the effects of chlorpyrifos on lipid profiles in humans and animal models. For example, a cross-sectional study of 155 adults in the United States found a significant positive correlation between urinary chlorpyrifos metabolites and LDL levels [11]. In a rat model, exposure to chlorpyrifos resulted in decreased HDL and increased LDL levels [12]. The exact mechanisms by which chlorpyrifos affects lipid metabolism are not fully understood, but several studies suggest that it may influence the activity of enzymes involved in lipid synthesis and metabolism [13]. For example, chlorpyrifos has been shown to inhibit the activity of paraoxonase1 (PON1), an enzyme that plays a crucial role in lipid metabolism and antioxidant defenses [14]. Albino rats, a commonly used animal model in toxicological studies, have been used to investigate the effects of chlorpyrifos on lipid metabolism. Albino rats are a commonly used animal model in toxicological studies due to their genetic homogeneity and rapid breeding capabilities. Understanding the impact of chlorpyrifos on lipid profiles in this model can provide valuable insights into its potential cardiovascular effects [15]. These changes can increase the risk of cardiovascular disease (CVD), which is a growing health concern in Africa. CVD is a leading cause of morbidity and mortality in Africa, with hypertension and other CVD risk factors increasing rapidly. In addition, the use of insecticides like chlorpyrifos has been associated with increased oxidative stress and inflammation, which can further exacerbate CVD risk. Despite these concerns, there is a lack of research on the specific effects of chlorpyrifos on lipid profiles in African populations. Most studies have focused on European and American populations, with limited generalizability to African populations [16]

Nigeria, the most populous country in Africa, faces significant challenges in ensuring food security for its growing population. Chlorpyrifos is an organophosphorus insecticide commonly used in Nigeria to control pests in crops like maize, cotton, and soybeans [17]. Chlorpyrifos, a widely used organophosphorus insecticide, has been linked to various health problems. Exposure to chlorpyrifos has been associated with neurological, reproductive, and respiratory issues (EPA, 2020). The insecticide has also been shown to affect lipid metabolism, leading to changes in total cholesterol and triglyceride levels. Studies have revealed that chlorpyrifos exposure can lead to hypercholesterolemia and hypertriglyceridemia [18]. This is a concern, as elevated cholesterol and triglyceride levels are risk factors for cardiovascular disease. Chlorpyrifos has been detected in water and food sources, increasing the risk of human exposure. The insecticide has also been found in high concentrations in agricultural workers, further highlighting the need for research [19]**.** Research has shown that chlorpyrifos exposure can lead to changes in lipid profiles, but the specific effects on total cholesterol and triglyceride levels are not well understood. This study aims to investigate the effects of chlorpyrifos on total cholesterol triglyceride levels in albino rats. Previous studies have focused on the acute effects of chlorpyrifos exposure, but the long-term effects are not well understood [20]. The chemical is still widely used in many countries, highlighting the need for research into its health effects. The use of chlorpyrifos has been linked to environmental contamination and even human handler also. Studying the effects of chlorpyrifos on lipid profiles is crucial due to the widespread use of this insecticide. Chlorpyrifos exposure has been linked to various health problems, including neurological, reproductive, and respiratory issues.

The insecticide has also been shown to affect lipid metabolism, leading to changes in total cholesterol and triglyceride levels. Elevated cholesterol and triglyceride levels are risk factors for cardiovascular disease, which is a leading cause of death worldwide.

The effects of chlorpyrifos on lipid profiles are not well understood, highlighting the need for further research [20], Chlorpyrifos has been detected in water and food sources, increasing the risk of human exposure. Agricultural workers are at high risk of chlorpyrifos exposure, which can lead to changes in lipid profiles [21], Investigating the effects of chlorpyrifos on lipid profiles can inform strategies for reducing cardiovascular disease risk. Chlorpyrifos exposure has been linked to changes in high-density lipoprotein (HDL) and low-density lipoprotein (LDL) cholesterol levels. HDL cholesterol is responsible for removing excess cholesterol from the bloodstream, while LDL cholesterol can build up in the arteries and increase the risk of cardiovascular disease [22]. Chlorpyrifos exposure has also been associated with changes in triglyceride levels, which can increase the risk of cardiovascular disease. Triglycerides are an important component of lipid profiles and can affect the risk of cardiovascular disease [23]. The effects of chlorpyrifos on lipid profiles can inform public health policies and pest management strategies . Reducing the use of chlorpyrifos could help mitigate the risk of cardiovascular disease. The effects of chlorpyrifos on lipid profiles may be long-lasting, highlighting the need for chronic exposure studies [24]. Chlorpyrifos exposure has been linked to changes in lipid profiles in both humans and animals. The mechanisms underlying the effects of chlorpyrifos on lipid profiles are not well understood, highlighting the need for further research. Studying the effects of chlorpyrifos on lipid profiles can inform the development of biomarkers for exposure [25]. The effects of chlorpyrifos on lipid profiles are essential for understanding the health effects of this insecticide. The effect of chlopyrifos on lipid profiles are not well understood, highlighting the need for further research.

Chlorpyrifos has been detected in water and food sources, increasing the risk of human exposure. Agricultural workers are at high risk of chlorpyrifos exposure, which can lead to changes in lipid profiles [26]

Investigating the effects of chlorpyrifos on lipid profiles can inform strategies for reducing cardiovascular disease risk. Chlorpyrifos exposure has been linked to changes in high-density lipoprotein (HDL) and low-density lipoprotein (LDL) cholesterol levels. HDL cholesterol is responsible for removing excess cholesterol from the bloodstream, while LDL cholesterol can build up in the arteries and increase the risk of cardiovascular disease.

Materials And Method

Study Area

This research was carried out in Madonna University (MU), Elele, River state, Nigeria. It is located in the south Eastern part of Nigeria in Ikwerre Local Government Area of River State, Nigeria. The climate of the area is tropical with the mean daily temperature of 29ºc for most of the year. The annual rainfall in this region is between 217 and 240cm. there are others towns and villages that surround Elele town, they include Isiokpo town, Omagwa, Ahoda, Omoku, Owerri town and others. People in this area are predominately farmers with few others into trading.

Ethical Approval

This study was conducted according to the rules and regulations of Madonna university Nigeria, Elele Campus Ethical committee on the use of Experimental Animals.

Experimental Animal

A total of forty-one (41) albino rats of six weeks old weighing between 130-150 g was purchased from the livestock breeding unit of animal friend farm, Royce Road Owerri, were used as the experimental animals for the study. The rats were weighed and kept in cages for two weeks at the Animal House, Madonna University Elele and allowed to acclimatize with their new environment. Within these periods the animal whose life span is 2.5-3.5years were feed with vital grower food and water. They were maintained in accordance with the recommendation of the guide for the care and use of laboratory animals and the protocol were in line with the

guideline of the National Institute of Health (NIH) . for laboratory animal's care and use.

Experimental Design

The first stage is the pilot stage, which was done to a certain lethal dose of the insecticides of interest. On this work, sixteen (16) albino rats were used for this study. The rat was randomly selected into four groups of four rats each and were given (100,150,200,250) ml/kg body weight respectively of

the insecticides orally. The rats were observed for the changes in physical appearance, gross behavioral changes and death in the next ninety-six (96) hours. With observed death, the LD50 was then calculated.

Reasearch Design

The rest of the rats numbering twenty-five in number were randomly assigned into five groups of five rats each:

Group A: Control (strictly feed and water)

Group B: Received feed, water and 0.02ml/kg dose of LD50 which is the highest admissible dose.

Group C: Received feed, water and 0.01ml/kg dose of LD50

Group D: Received feed, water and 0,005ml/kg dose of LD50

Group E: Received feed, water and 0.003ml/kg dose of LD50 and this is the list dosage.

Prior to the time of administration of the insecticides, the animals were weighed to a certain equal volume of dosage are given.

The rats were weighed after one-week interval and at the end of the experiment, blood samples were collected by cardiac puncture and were dispensed into a plain container which were allowed to coagulate at room temperature and centrifuged at 3000rpm for 10minutes to separate the sera. The sera were stored frozen at -20ºc and analyzed within 7 days.

Laboratory procedure

Method for high density lipoprotein cholesterol, randox kit grove 2024 catlog no. 269477

Principle:

It states that high density lipoprotein is precipitated by the addition of phosphotungstic acid in the presence of magnesium ions. The HDL-cholesterol fraction remains in the supernatant and was determined through enzymatic hydrolysis and oxidation. The indicator quinoneimine is formed from hydrogen peroxide and 4-amino antipyrine in the presence of phenol catalyzed by peroxidase, producing a blue color which is measured at 500nm wavelength.

HDL – Cholesterol ester cholesterol → HDL – Cholesterol + fatty acids

$$\text{HDL – Cholesterol} + O_2 \xrightarrow[\text{Cholesterol oxidase}]{\text{Esterase}} \text{Cholesterol – 3 one} + H_2O_2$$

$$H_2O_2 + 4 - \xrightarrow[\text{Quinoneimine}]{\text{amino antipyrine}} + 4H_2O$$

Method: Enzymatic Assay Method

HDL-CHOLESTEROL

0.5ml of HDL-C reagent was added to each of the test-tube i.e., blank, standard and test. This was followed by the addition of 0.2ml of sample, cholesterol standard and distilled water into the appropriates test-tube. The whole content was properly mixed and incubated for 10minutes at room temperatures and this centrifuge at 4000rpm.

After this, 1ml of HDL-C reagents was then placed in a separate test-tubes labelled Blank, standard and test. This was followed by the addition of 0.1ml of distilled water, supernatant standard and supernatant test. The whole content was properly mixed and incubated for 5minutes at 37ºc, then the absorbance of the sample was measured against the reagent Blank within 60minutes at 500nm.

Calculation:

$$\text{HDL-Cholesterol Conc.} = \frac{\text{Absorbance of Test}}{\text{Absorbance of Standard}} \times \text{Conc.}$$

$$\frac{\text{Absorbance of Test}}{\text{Absorbance of Standard}} \times \frac{5.18}{1} \quad \text{mmol/l}$$

Determination of serum triglyceride randox kit grove 2024. Catalog no; 325799.

Principle

Triglycerides are splitted enzymatically by lipoprotein lipase to form glycerol and fatty acids. The glycerol produced is acted upon by glucokinase enzyme in the presence of ATP to form glycerol-3-phosphate, which is in turn oxidized by glycerol-3-phosphatase oxidase to form di-hydroxy acetone- phosphatase and hydrogen peroxide producing a brilliant purple color which is measured at 500nm. The hydrogen peroxide produced is reacted with 4-amino antipyrine, 4 chlorophenol to form quinonimine as shown below:

$$\text{Triglycerides} + H_2O \xrightarrow[\text{Lipase}]{\text{Lipoprotein}} \text{glycerides + fatty acids}$$

$$\text{Glycerol} + \text{ATP} \xrightarrow[\text{ADP}]{\text{Glycerolkinase}} \text{glycerol-3-phosphatase}$$

Glycerol-3-phosphatase + O2 dihydroxy acetone phosphates + H_2O

H_2O + 4-amino antipyrine + 4 chlorophenol peroxidase quinonimine + HCl + $4H_2O$

Procedure

1ml of reagent was added to each of the test tubes i.e. standard, test and blank.

This was followed by the addition of 0.01ml of standard, sample and distilled water into the respective test tubes. The whole content of each tube was properly mixed and incubated at 37°C for 5 minutes. Then the absorbance was measured against the reagent blank within 60 minutes at 500nm.

Calculation

$$\text{Triglyceride (mmol/l)} = \frac{\text{Absorbance of test}}{\text{Absorbance of Standard}} \times 2.29$$

Determination of serum cholesterol randox kit grove 2024.

Catalog No: 325799

Principle

Cholesterol is determined after enzymatic hydrolysis and oxidation. The indicator quinonimine is formed from hydrogen peroxide and 4-amino antipyrine in the presence of phenol and peroxidase which produces a red color and is measured at 500nm.

The reaction is shown below:

$$\text{Cholesterol} \xrightarrow[\text{Esterase}]{\text{Cholesterol}} \text{Fatty acid}$$

$$\text{Cholesterol} \xrightarrow[\text{Oxidase}]{\text{Cholesterol}} \text{3-one} + H_2O$$

H_2O + phenol + 4-amino antipyrine-peroxidase quinonimine + $4H_2O$

Method

1ml of reagent was added to each of the rest tubes i.e., blank, standard and test. This was followed by the addition of 0.01ml of standard, sample and distilled water was added into the appropriate test tubes. The content of each tube was properly mixed and incubated for 5 minutes at 37˚C

The absorbance of the sample was then measured against the reagent blank within 60 minutes at 500nm.

Calculation

$$\text{Cholesterol (mmol/L)} \frac{\text{Absorbance of test}}{\text{Absorbance of Standard}} \times 5.18$$

Determination Of Serum Low Density Lipoprotein-Cholesterol

Low density lipoprotein-cholesterol (LDL-C) is determined by calculating thus:

LDL-Cholesterol conc. = $\frac{\text{Total Cholesterol}-\text{HDL Cholesterol}-\text{Triglyceride}}{2.2}$ mmol/l

The indicator quinonine is formed from hydrogen peroxide and 4-amino antipyrine in the presence of phenol and peroxidase which produces a red color and is measured at 500nm.

Determination of serum very low-density lipoprotein

Calculation

VLDL (mmol/L) = $\frac{triglyceride}{2.2}$

Statistical analysis

Result

Parameter	A(Control)	B(0.02ml/kg)	C(0.01ml/kg)	D(0.005ml/kg)	E(0.003ml/kg)	F- value	P-value
HDL	49.00±4.95^{bcde}	34.60±2.70^{a}	29.40±5.08^{a}	26.20±1.30^{a}	28.40±2.41^{a}	32.409	0.000
CHOL	154.8±7.79^{bcde}	200.0±32.21^{a}	196.0±3.94^{a}	192.4±5.03^{a}	180.0±3.67^{a}	7.251	0.001
TRIG	59.60±3.65^{bcde}	63.20±4.55^{a}	55.20±3.11^{a}	52.40±3.78^{a}	52.20±0.084^{a}	9.471	0.000
LDL	103.80±5.54^{bcde}	162.80±14.10^{a}	154.80±3.56^{a}	154.40±7.83^{a}	143.60±4.83^{a}	41.980	0.000

Table 4.1: Analysis of variance (ANOVA) on the effect of insecticides (chlorpyrifos) on high density lipoprotein cholesterol (HDL-C) and low-density lipoprotein cholesterol (LDL-C) levels in albino rats.

KEY:

a) Significant difference when compared with control
b) Significant difference when compared with 0.02ml/kg
c) Significant difference when compared with 0.01ml/kg
d) Significant difference when compared with 0.005ml/kg
e) Significant difference when compared with 0.003ml/kg

From table 4.1: The significant values are displayed in the P-value column. Since the P-values for the parameters are less than 0.05 (P<0.05), it suggests that the tests are statistically significant at 5% level of significant effect of insecticides (chlorpyrifos) on high density lipoprotein (HDL-C) and low-density lipoprotein (LDL-C) levels in albino rats.

PARAMETER	A (control)	B(0.02ml/kg)	C (0.01ml/kg)	D(0.005ml/kg)	E(0.003ml/kg)	F value	P value
CHOL	154.8± 7.79	200.0±32.21	196.0±3.94	192.4±5.03	180.0±3.67	7.251	0.001
TRIG	59.60± 3.65	63.20±4.55	55.20±3.11	52.40±3.78	52.20±0.084	9.471	0.000
VLDL	12.24± 0.78	12.64±0.91	11.04±0.62	10.08±0.23	10.44±0.17	16.328	0.000

Table 4.2 is the analysis of variance (ANOVA) on the evaluation of the effects of insecticides (chlorpyrifos) on cholesterol, triglycerides and very low-density lipoprotein (VLDL) levels in albino rats.

KEY:

a) Significant difference when compared with control
b) Significant difference when compared with 0.02ml/kg
c) Significant difference when compared with 0.01ml/kg
d) Significant difference when compared with 0.005ml/kg
e) Significant difference when compared with 0.003ml/kg

From table 4.2: The significant values are displayed in the P-value column. Since the P-values for the parameters are less than 0.05 (P<0.05). It suggests that the tests are statistically significant at 5% level of significant effect of insecticides (chlorpyrifos) on very low-density lipoprotein (VLDL), cholesterol and triglyceride levels in albino rats.

Discussion

The results from table 4.1 indicates that there is decrease level in the high-density lipoprotein (HDL-C) and increase level in the low-density lipoprotein (LDL-C) compared to the control. From the displayed significant values at P-value column, which is less than 0.05. This increase in low density lipoprotein (LDL) and the decrease in high density lipoprotein could be attributed to the effect of insecticide in the albino rats and the increase in low density lipoprotein (LDL) could lead to hyperlipidemia and the decrease in high density lipoprotein (HDL) can lead to cardiovascular disease. This research is aligned with the work done by [27]. The elevated LDL levels are a major risk factor for cardiovascular disease, as they can lead to the accumulation of cholesterol in the arterial walls, causing atherosclerosis and increasing the risk of heart attacks and strokes. This finding is aligned with the work done by ([28] who said that the increase in LDL levels following the chlorpyrifos exposure may be attributed to the insecticide's ability to disrupt lipid metabolism. It may lead to the development of dyslipidemia, a condition characterized by abnormal lipid levels in the blood [29,30,31]

The results from table 4.2 indicates that there is an increase in triglyceride, cholesterol and very low-density lipoprotein levels when compared to the control.

The increase in triglyceride levels is due to the exposure of the albino rats to chlorpyrifos and can be attributed to the ability of chlorpyrifos to alter lipid metabolism. This increase can lead to the development of metabolic disorders such as dyslipidemia [32,33]

Abnormalities in lipid metabolism can also lead to development of certain neurological disorders such as Alzheimer's disease and Parkinson disease [34]

The increase in cholesterol levels due to chlorpyrifos can lead to an increased risk of cardiovascular disease and can also lead to an increase in oxidative stress.

Exposure to chlorpyrifos can also inhibit clearance of VLDL from the blood leading to its elevated levels in albino rats

Conclusion

Conclusively, the study showed that the exposure of chlorpyrifos (insecticide) significantly altered the lipid profile in albino rats, leading to increased low-density lipoprotein (LDL) levels and decreased high density lipoprotein (HDL) levels in serum. These changes may contribute to the development of dyslipidemia and increase the risk of cardiovascular disease.

Conclusively, the study showed that the exposure to insecticide (chlorpyrifos) significantly altered the lipid profile in albino rats, leading to an increase triglyceride level and also an increase in the cholesterol and very low-density lipoprotein levels. These changes may contribute to the development of dyslipidemia and risk of cardiovascular disease. The

findings of this study highlight the potential health risks associated with chlorpyrifos and it shows that there is no amount of chlorpyrifos that is safe.

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