JJBS

Volume 8, Number 3, September .2015
ISSN 1995-6673
Pages 187 - 191

Jordan Journal of Biological Sciences

Ameliorative Effect of Different Concentrations of Mushroom (*Pleurotus tuberregium)* on Lipid Profile of Wistar Albino Rats Induced by Lead Nitrate

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Received: Fabruary 23, 2015 Revised: April 7, 2015 Accepted: April 12, 2015

Abstract

The cardiovascular effects of lead (Pb) are not only limited to increased blood pressure and hypertension, but they are also associated with an increased incidence of coronary heart disease, stroke, and peripheral arterial disease. The present study evaluates the effects of Pb poisoning in 90 Albino rats and its amelioration using different concentrations of mushroom/growers mash feed mixture. The results of the present work showed that mushrooms (*Pleurotus tuberregium*) were able to ameliorate the effect of lead toxicity by reducing total cholesterol, Low Density Lipoprotein/High Density Lipoprotein-cholesterol (LDL/HDL-ch) and Coronary Risk Index (CRI) (except in the group of rats fed with 90% feed+ 10% *P. tuberregium*) and to increase HDL-ch in the experimental rats (except in the group of rats fed with 90% feed+ 10% *P. tuberregium*) when compared to the control.

Keywords: Albino Rat, Lead Toxicity, *Pleurotus tuberregium*, Lipid Profile, Total Cholesterol.

1. Introduction

Heavy metals are chemical elements with a specific gravity that is at least five times the specific gravity of water (Babalola *et al.,* 2010). Examples of heavy metals commonly found in the environment include lead, cadmium, mercury, zinc, arsenic, bismuth, etc. These metals are particularly dangerous because they tend to bio-accumulate in the body tissues and organs (Babalola *et al.,* 2010). Lead is found in our food, water, air and soil. Lead emitted by power plants, smelters and boilers is frequently deposited in the soil, where it is taken up by crops (Lynda *et al.,* 2011). Lead exposure mainly occurs through the respiratory and gastrointestinal systems. Absorbed lead (whether inhaled or ingested) is stored in soft tissues (Anuradha, 2007). The toxicity of lead may largely be explained by its interference with different enzymes by binding to their protein or by displacing other essential metal ions. A wide range of biological effects of lead can cause a disruption of the biosynthesis of haemoglobin, a rise in blood pressure, a kidney damage, a brain damage, a miscarriage and subtle abortions, a disruption of the nervous system, declined fertility of men through a sperm damage, a behavioural disruption, a carcinogenic effect; it also causes an oxidative stress in the body, impairs learning, memory and audio-visual functions in children (ATSDR, 2007). Industrialized countries have made progress by phasing lead out of gasoline, banning lead in many consumer goods and replacing lead pipes with copper pipes.

Lead poisoning is presently becoming the most common disease of environmental origin and is increasing very rapidly in developing countries (Ademuyiwa *et al.,* 2002). Environmental toxicants, including lead and other metals, are potentially preventable exposures that may explain population variation in cardiovascular disease rates (Bhatnagar, 2006). The cardiovascular effects of lead, however, are not limited to increased blood pressure and hypertension, but it is also associated with an increased incidence of coronary heart disease, stroke, and peripheral arterial disease (Mark and Ellen, 2002). For a deeper insight into the lead exposure and its effects on lipid profiles, we investigated the ameliorative effect of

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different concentration of mushroom (*Pleurotus tuberregium*) on lipid profile of Wistar albino rats induced by lead nitrate.

2. Materials and Methods

2.1. Experimental Design

The 90 albino rats were subjected to acclimatization for 21 days pre-experimental stage. Thereafter, all the experimental groups were exposed to 0.1 g/l of lead daily for 21 days. At the end of the exposure period, lead salt was discontinued for 21 days and 42 days post-experimental stage. Samples were then collected and subsequently analyzed at every 21 day interval. Ninety (90) albino rats were divided into six groups with three replicates (with 5 rats per group) in this group order:

Group:

1. 90% of feed + 10% of *Pleurotus tuberregium*
2. 70% of feed + 30% *Pleurotus tuberregium*
3. 50% of feed + 50% *Pleurotus tuberregium*
4. 30% of feed + 70% *Pleurotus tuberregium*
5. Feed + 0.1 g/L lead
6. Control

2.1.1. Collection of Samples for Lipid Profile Analysis

Blood samples were collected from the heart of dissected albino rats using 5 ml disposable sterile syringes and transferred into sterile bottles containing Potassium Ethylene diamine tetra acetic acid (EDTA) anticoagulant. The sample bottles were then briefly kept in ice and transferred to the Haematological laboratory unit at University of Benin Teaching Hospital (UBTH), where they were analyzed for total cholesterol, total triglyceride, High Density lipoprotein-cholesterol (HDL-ch), Low Density lipoprotein-cholesterol (LDL-ch),LDL/HDL, Coronary Risk Index (CRI) which were determined by Sysmex Cell counter (Sysmex, Japan) using the methods of (Dacie and Lewis, 1991).

2.1.2. Statistical Analysis

Data collected for the study were analyzed using general descriptive statistics, one Way Analysis of Variance (ANOVA) at 95% probability level of significant. Duncan's multiple range tests were used to compare the different experimental groups. Computer software Statistical Package for Social Scientists (SPSS) and Microsoft Excel were used for the statistical analyses.

3. Results and Discussion

3.1. Total Cholesterol

The highest mean value recorded for total cholesterol was 101±0.51 mol/l. This value was recorded in the control group while the minimum mean value (75±0.3 mol/l) of total cholesterol was recorded in the group of rats fed with 90% feed+ 10% *P. tuberregium*. However, all other values were lower than the control mean values in the study (Figure 1). The results of plasma lipid distribution of rats fed with the experimental diets and lead showed that there were no significant differences between the mean value of plasma total cholesterol for treated groups and the control groups (p>0.05). However, all other mean values of plasma total cholesterol were lower than the control mean values in the present study. This could be because it was only a marsh diet, unlike the other diets which were supplemented with mushroom. Several studies reported the ability of edible mushrooms in reducing plasma total cholesterol level. A study on rats suggested that mushroom β-glucans were effective cholesterol lowering polysaccharides (Cheung, 1996). Ogundana and Fagadel (1982) reported 7.9% as crude fibre concentration of *P. tuberregium*. Hence, the crude fiber content might have important implications in lowering plasma cholesterol levels. From the results of the present work, it was observed that as the quantity of mushroom increases the total cholesterol were reduced. This agrees with the findings of Cheung (1996) and Oyetayo (2006). A Review of the physiological, biochemical and biotechnological applications of mushroom done by Sanjay and Singh (2013) showed that mushroom decreases concentration of total cholesterol, in the Swiss albino rats' blood sera.

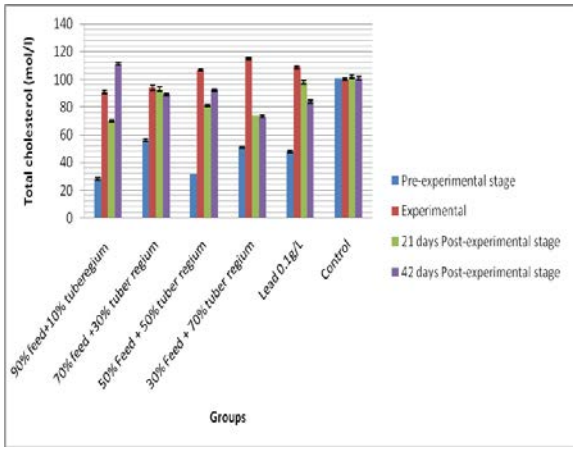


Figure 1. Total Cholesterol of Albino rats feed with various mixture of Pb and *P. tuberrigium*

3.1.1. Total Triglyceride

The highest mean value recorded for total triglyceride was 61±0.19 mol/l. This value was recorded in the group of rats fed with 70% feed+ 30% *P. tuberregium* while the minimum mean value (31 ± 0.42 mol/l) of total triglyceride was recorded in the control group of rats. However, all other values were higher than the control mean values in this study (Figure 2). The mean values of plasma triglyceride distribution was such that treated group showed no significant difference (p>0.05) from the control. Earlier reports by Chorvathova *et al*. (1993) where 4% *Pleurotus ostreatus* diet was fed in hyperlipo and protienemia rats; the results showed no significant effect on the plasma triglyceride levels but Oyetayo (2006) and Sanjay and Singh (2013) reported that plasma triglyceride distribution was such that rats fed mushroom diets had significantly lower plasma triglyceride than the control. However, this was not the same in the present study, as there was high plasma triglyceride. The higher triglyceride concentrations obtained in the present report were associated with low HDL-ch levels observed in the mushroom diets fed rats. High HDL-ch increased the rate of triglyceride catabolism (Oyetayo, 2006) and elevated triglyceride levels, which are frequently associated with

low HDL-ch levels (Oyetayo, 2006). High plasma triglyceride in the blood can increase the risk of heart diseases.

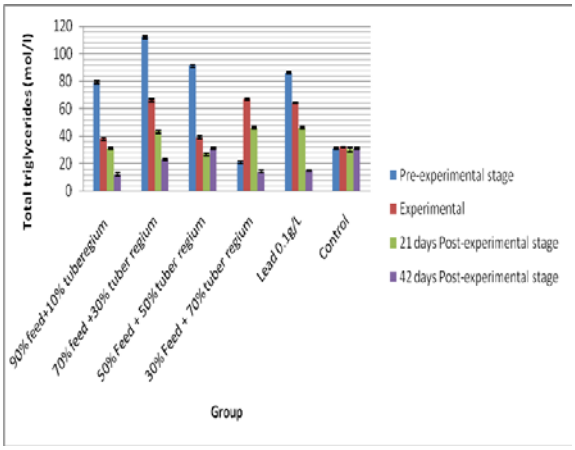


Figure 2. Total Triglycerides of Albino rats feed with various mixture of Pb and *P. tuberrigium*

3.1.2. High Density Lipoprotein-Cholesterol (HDL-ch)

The knowledge of the cholesterol sub-fractions is more meaningful than simple plasma total cholesterol level. The higher the Low Density Lipoprotien-cholesterol (LDL-ch), the greater the athreosclerosis risk and conversely the higher the HDL-ch, the lower the risk. This is true for humans from different racial and ethnic backgrounds and is observed at all adult ages (Baron, 2000).

The highest mean value recorded for HDL-ch was 43.75 ± 4.04 mol/l. This value was recorded in the groups of rats fed with 70% feed+ 30% *P. tuberregium* and in the group where 0.10 g/L of lead was administered while the minimum mean value (25.75 ± 0.00) of HDL-ch was recorded in the group of rats fed with 90% feed+ 10% *P. tuberregium*. However, all other values were higher than the control mean values in the present study except for the group of rats fed with 90% feed+ 10% *P. tuberregium* (Figure 3).

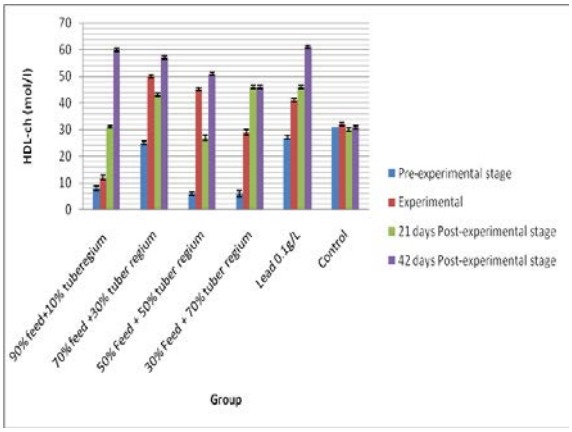
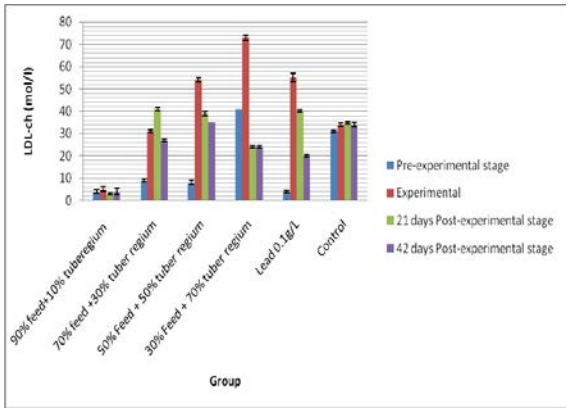


Figure 3. HDL-ch of Albino rats feed with various mixture of Pb and *P. tuberregium*

The mean values of HDL-ch for the treated groups were not significantly different (p>0.05) from the control group. The higher values of HDL-ch were in line with the work of Sanjay and Singh (2010), who reported that when rats feed were supplemented with 450 mg mushroom extract and 800 mg L-carnitine, high density lipoprotein had a higher values (p > 0.05) when compared to those of the control sets. HDL-ch concentrations vary inversely with plasma triglyceride concentration and directly with the activities of lipoprotein lipase (Murray *et al.*, 2003).

3.1.3. Low Density lipoprotein-cholesterol (LDL-ch)

The highest mean value recorded for LDL-ch was 40.5±0.0 mol/l. This value was recorded in the group of rats fed with 30% feed+ 70% *P. tuberregium* while the minimum mean value (4.0 ± 0.82) of LDL-ch was recorded in the group of rats fed with 90% feed+ 10% *P. tuberregium.* However, the control mean values were only lower than the group of rats fed with 50% feed+ 50% *P. tuberregium* and the group of rats fed with 30% feed+ 70% *P. tuberregium* in the present study (Figure 4). Sanjay and Singh (2010) reported that there was a



reduction in the low density lipoprotein when rats feed was supplemented with 450 mg mushroom extract and 800 mg L-carnitine when compared to those of the control sets.

Figure 4. LDL-ch of Albino rats feed with various mixture of Pb and *P. tuberrigium.*

3.1.4. LDL/HDL

The highest mean value recorded for LDL/HDL-ch was 2.0 ± 0.01. This value was recorded in the group of rats fed with 90% feed+ 10% *P. tuberregium* while the minimum mean value (0.626±0.04) of LDL/HDL was recorded in the group of rats fed with 70% feed+ 30% *P. tuberregium.* However, all other values were lower than the control mean values except for the group of rats fed with 90% feed+ 10% *P. tuberregium* (Figure 5). The LDL/HDL cholesterol ratio which is thought to be the athereogenic index of lipoproteins (El-Gengaili *et al.*, 2004) were lower in rats fed with mushroom diets (except for the group of rats fed with 90% feed+ 10% *P. tuberregium* and the group of rats fed with 30% feed+ 70% *P. tuberregium*) fed rats than the control group. This could be due to the high concentration of polyunsaturated fatty acid linoleic acid present in mushrooms. Cheung (1996) reported that about 72% linoleic acids constitute mushroom fat. A study on women by Muller (2003) showed that serum LDL/HDL cholesterol ratio was

influenced more favourably by exchanging saturated fat for unsaturated than reducing saturated fat composition of diets. The ratio is the predictive relation of coronary heart disease; the lower the ratio, the less athreogenic the lipoprotein profile is thought to be (Murray *et al*., 2003).

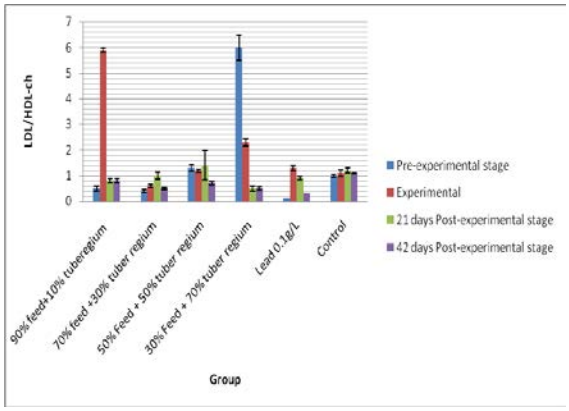


Figure 5. LDL/HDL of Albino rats fed with various mixture of Pb and *P. tuberrigium*

3.1.5. Coronary Risk Index (CRI)

The Coronary Risk Index (CRI) is a ratio of total cholesterol to HDL cholesterol (Oyetayo, 2006). Cholesterol research scientists and doctors are using this cholesterol ratio for predicting the chances of developing heart disease. This is the ratio between total cholesterol and HDL. The lower the ratio (that is less than 4), the better the outcome is. The highest mean value recorded for CRI was 3.825 ± 0.15. This value was recorded in the group of rats fed with 90% feed+ 10% *P. tuberregium* while the minimum mean value (2.0±0.02) of CRI was recorded in the group of rats fed with 0.1 g/l. However, all other values were lower than the control mean values except for the group of rats feed with 90% feed+ 10% *P. tuberregium* and the group of rats fed with 30% feed+ 70% *P. tuberregium* (Figure 6). This may be because of the little amount of mushroom present in the diets compare to the control group. Ogundana and Fageda (1982) reported that *P. tuberregium* is about 14.6% crude protein which may be the reason for the low coronary risk index in this study.

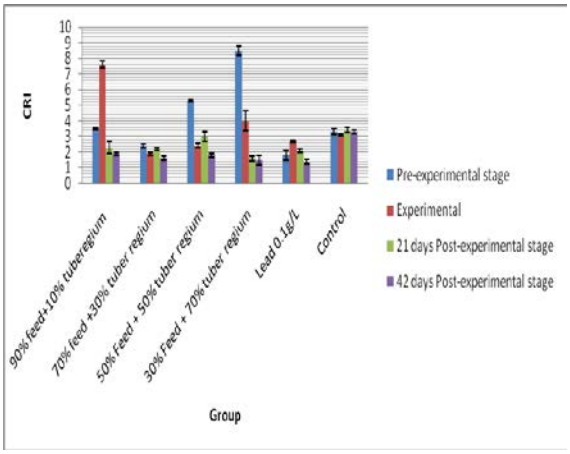


Figure 6. CRI of Albino rats fed with various mixture of Pb and *P. tuberrigium*

4. Conclusion

Even though previous studies suggest that lead exposed persons have altered lipid profile, increased total cholesterol and decreased HDL cholesterol, which can cause a high risk of cardiovascular diseases (Shyam *et al.*, 2012), the results of the present work showed that mushroom *(P. tuberregium*) was able to ameliorate the effect of lead toxicity by reducing total cholesterol, Low Density Lipoprotein/ High Density Lipoprotein-cholesterol (LDL/ HDL- ch) and Coronary Risk Index (CRI) (except for the group of rats fed with 90% feed+ 10% *P. tuberregium*) and to increase HDL-ch in the experimental rats (except for the group of rats fed with 90% feed+ 10% *P. tuberregium*) when compared to the control.

Acknowledgement

I wish to express my heartfelt gratitude to my project supervisor Prof. (Mrs) P. Tawari-Fufeyin. I also acknowledge Dr. O. Osemwegie and Mr. S.A. Ekaye for their profound assistance, understanding and constant availability throughout the period of preparing the present study. Thanks are due to all other lecturers in the Department of Animal and Environmental Biology, University of Benin, Benin City, Nigeria for their contribution to the successful completion of the present work. I also give thanks to Mr. N. O. Igiehon from the Department of Microbiology, Faculty of Life Sciences, University of Benin, Benin City, Nigeria for his assistance in writing the manuscript of the present study.

References

Ademuyiwa O, Arowolo T, Ojo DA, Odukoya OO, Yusuf AA, and Akinhanmi TF. 2002. Lead levels in blood and urine of some residents of Abeokuta, Nigeria. *Trace Elem Electro.*, **19**:63-69.

Agency for Toxic Substances and Disease Registry. (ATSDR). (2007). **Lead Toxicity**: what is the physiological effect of lead exposure, ATSDR, Atlanta, Georgia, 125 pp.

Anuradha M. 2007. Lead hepatotoxicity and potential health effects. *J Med Res.*, **126**: 518-527.

Babalola OO, Okonji RE, Atoyebi JO, Sennuga TF, Raimi MM, Ejim-Eze EE, Adeniran OA, Akinsiku OT, Areola JO, John OO and Odebunmi SO. 2010. Distribution of lead in selected organs and tissues of albino rats exposed to acute lead toxicity. *Scientific Res Essay*, **5(9)**: 845-848.

Baron RB. 2000. Lipid abnormalities. In: Tierney Jr. LM, Mephee SJ and Papadakins MA (Eds.), **Current Medical Diagnosis and Treatment**. McGraw Hill, pp.1198-1210.

Bhatnagar A. 2006. Environmental cardiology: studying mechanistic links between pollution and heart disease. *Circ Res.*, **99**:692–705.

Bradman A, Eskenazi B, Sutton P, Athanasoulis M and Goldman LR.2001. Iron deficiency associated with higher blood lead in children living in contaminated environments. *Environ Health Perspect.*, **109(10)**:1079-1084.

Chorvathova V, Bobek P, Ginter E and Kivanova J. 1993. Effect of oyster fungi on glycemia and cholesterolemia in rats with insulin depended-diabetes. *Physiol Res.*, **42(3)**:175-179.

Cheung PCK. 1996. Hypocholesterolemic effects of two edible mushrooms: *Auricula auricularia* (tree ear) and *Tremelia fuciforms* (white jelly leaf) in hypocholesterolemicrats. *Nutr Res.*, **16**:1721-1725.

Dacie JV and Lewis SM. 1999. **Practical Haematology**, Eight ed. Pp. 262-270.Churchill Livingstone. London.

El-Gengaihi SE, Sale A, Bashandi SWA, Ibrahim SA and Abdel-Hamid SR. 2004. Hypolipidemic effects of some vegetable oils in rats. *Food Agric and Environ.*, **2(2)**: 88-93.

Lynda A, Mohamed H, Abderrezek T, Seddik K. 2011. Effect of long-term exposure to low or moderate lead concentrations on growth, lipid profile and liver function in albino rats. *Advances in Biol Res.*, **5(6)**: 339-347.

Mark L and Ellen S. 2002. Blood lead levels and mortality free. *Arch Intern Med.*, **162(21)**:2443-2449.

Mishra, S. and Singh, RB. 2013. A Review on physiological, biochemical and biotechnological applications of Mushroom. *J of Pharm and Biol Sci.*, **8(2)**: 31-34.

Mishra, S. and Singh, RB. 2010. Effect of mushroom on the lipid profile, lipid peroxidation and liver functions of aging Swiss Abino rats. *The Open Nutraceuticals J.*, **3**: 248-253.

Mishra, S, Dwivedi, SP. and Singh, RB. 2010. A review on epigenetic effect of heavy metal carcinogens on human health. *The Open Nutraceuticals J.*, **3**: 188-193

Muller H, Lindman AS, Branlsaeler AL and Pederson JL. 2003. The serum LDL/HDLcholesterol is influenced more favourably by exchanging saturated with unsaturated fat than reducing saturated fat in the diet of women. *The Am Sci J Nutr.*, **133(1)**: 78-83.

Murray RK, Greener DK, Mayes PA and Rodwell VW. 2003. **Harper's Biochemistry**. McGraw-Hill.

Ogundana SK and Fageda EO. 1982. Nutritive value of some Nigeria edible mushrooms. *Food Chem.*, **8(4)**:263-268.

Oyetayo FL. 2006. Responses of plasma lipids to edible mushroom diets in albino rats. *Afri J Biotech..*, **5(13)**:1263-1266.

Shyam VS, Pradeep K, Virendra A, Anoop V and Murthy R. 2012. Lipid profiles with increase blood lead level: risk of cardiovascular disease in battery workers of Lucknow City. *J Indian Acad Forensic*, **34(4)**: 0971-0973.