

SJMLS-3(1)-003

Influence of *Monodora Myristica* Extracts on Lipid Profile of Rats Fed with Crude Petroleum Oil Contaminated Catfish DietOkpoghono, J.*¹, Achuba, F.I.¹ and George, B.O.¹Department of Biochemistry, Faculty of Science, Delta State University, Abraka, Delta State, Nigeria¹Author for Correspondence *: okpoghono@gmail.com/+234-806-461-8605**Abstract**

This study examined the influence of *M. myristica* extracts on lipid profile of rats fed crude petroleum oil contaminated catfish diet. Thirty albino wistar rats were divided into six groups of five rats each. Group 1: control, group 2: rats were fed crude petroleum oil contaminated catfish diet (CPO-CCD) only, group 3: CPO-CCD plus tween 80, group 4: CPO-CCD plus *M. myristica* water extract (MWE), group 5: CPO-CCD plus *M. myristica* ethanol extract (MEE) and group 6: CPO-CCD plus *M. myristica* diethyl ether extract of (MDEE). Treatment lasted for four weeks. Lipid profile was evaluated in serum and tissue homogenate and the results showed significant ($p < 0.05$) increase in total cholesterol (T-Chl), low density lipoprotein cholesterol (LDL-C), triacylglycerol (TAG) and decreased high density lipoprotein cholesterol (HDL-C) levels in the serum and tissues (liver, kidney and brain) of rats fed CPO-CCD only and CPO-CCD plus tween 80 when compared with controls. **Treatments of rats with MWE, MEE and MDEE resulted in a significant ($p < 0.05$) decreased in T-Chl, LDL-C, TAG and increased HDL-C levels in the serum and tissues when compare with CPO-CCD only and CPO-CCD plus tween 80. No significant difference ($p > 0.05$) was observed in the atherogenic index of all the experimental groups. It is therefore concluded that *M. myristica* extracts can be utilized in prevention of alterations in lipids in crude petroleum oil toxicity.**

Key words: Lipid profile, petroleum, diet, atherogenic index

Introduction

Petroleum and natural gas are the components of crude oil. Petroleum occurs as a dark, sticky, toxic and viscous liquid (Jing *et al.*, 2016). It is a mixture that comprises gaseous, liquid and solid alkanes, alkenes, cycloalkanes, aromatic hydrocarbon and others (Al-Sayegh *et al.*, 2016; Ekperusi and Aigbodion, 2015; Rafik *et al.*, 2013). According to Aluko (2004), fishing occupation which is a means of livelihood for the women in Niger Delta has been denied since their waters have been polluted and fishes died due to crude petroleum oil pollution. Abnormalities in lipid metabolism in crude petroleum oil induced oxidative stress have been reported (Ujowundu *et al.*, 2012).

Lipids are diverse groups of biological substances which are made up of non-polar groups (Gurr and Harwood, 1991). Having the knowledge of lipid biochemistry is very important in nutrition and health (Gurr and Harwood, 1991). Hypercholesterolemia is a major health challenge. Atherosclerosis is connected to high levels of cholesterol in the blood, and to be specific high levels of LDL-bound cholesterol (Murray *et al.*, 2003). Low atherogenic indices are protective against coronary heart disease. Studies have shown that oxidative stress increases atherogenic index (Niroumand *et al.*, 2015). Animal models give better understanding of the relationship between disorders in cholesterol metabolism and atherogenesis (Moghadasian *et al.*, 2001).

Monodora myristica (family of flowering plants: *Annonaceae*) is common spice use in the Niger

Delta part of Nigeria. The kernel of *M. myristica* is used to prepare pepper soup for women immediately after child birth to control passive uterine haemorrhage (Iwu, 2002). The aim of this study was to examine protective influence of *M. myristica* extracts on alterations of lipid profile in rats fed crude petroleum oil contaminated catfish prepared diet.

Materials and Methods

Preparation of the *Monodora myristica* Extracts

M. myristica was obtained from Obiaruku, local market in Delta State and then identified at the Department of Botany, Delta State University, Abraka, Delta State. The method described by George *et al.* (2012) was adapted for the preparation of the *M. myristica* water, ethanol, and diethyl ether extracts.

Stimulation of Crude Petroleum Oil Pollution

The crude petroleum oil (CPO) was obtained from the Nigerian National Petroleum Cooperation (NNPC), refinery, Warri in Delta State, Nigeria.

Formulation of Diet

Formulation of diet was carried out following the method described by Sunmonu and Oloyede (2007).

Determination of Dosage

The rats were divided into five groups of four rats in each group. The *M. myristica* water extract was administered separately to the four rats in each group at starting single dose of 100 mg/kg b. wt. (Group 1). The rats were observed for the period of 1 hour, occasionally for 3 h for severity of any toxic sign and mortality. If no mortality is observed at this dose, the same procedure was repeated for dose level of 200 mg/kg b. wt. (group 2), 500 mg/kg b. wt. (group 3), 1000 mg/kg b. wt. (group 4), and 2000 mg/kg b. wt. of extract (group 5). The LD₅₀ was thus determined, which was selected to ensure that the the interest of the animals used for the study are protected. The animals were observed up to 7 days after *M. myristica* water extract administration to find out for any delayed mortality. The same procedure was repeated for *M. myristica* ethanol extract and diethyl ether extract.

Determination of LD₅₀

The LD₅₀ value was calculated using the formula described by Lorke (1983)

$$LD_{50} = \frac{LD_{100} - LD_{0}}{N} = ? (Dd \times Md)$$

LD₅₀ = Dose that killed 50 % of a given population of rats

LD₁₀₀ = Dose that killed all the rats in the group.

? (Dd x Md) = Summation of all products of dose difference (Dd) and mean death (Md) of rats

N = Number of rats in each group.

Experimental Rats

Thirty male albino Wistar rats of 7 – 9 weeks were used for the study. Acclimatization was allowed for a period of two weeks to suite the laboratory condition. During the period, the rats had free access to water and standard growers mash diet. The rats were used for the study following guide for the care and use of laboratory animals (NIH, 1985). The rats were divided into six groups of five rats. Rats in group 1 to 6 received tap water daily throughout the experiment. The administration of the crude petroleum oil contaminated catfish diet (CPO-CCD) and extracts orally using cannula was allowed for a period of four weeks.

Group 1: Control

Group 2: CPO-CCD control

Group 3: CPO-CCD plus 1 ml/kg b. wt. of 1 % tween 80.

Group 4: CPO-CCD plus 200 mg/kg b. wt. of *M. myristica* water extract (MWE)

Group 5: CPO-CCD plus 200 mg/kg b. wt. of *M. myristica* ethanol extract (MEE)

Group 6: CPO-CCD plus 200 mg/kg b. wt. of *M. myristica* diethyl ether extract (MDEE)

Biochemical Analysis

Total cholesterol in the serum, liver, kidney and brain were determined according to the method described by Allan *et al.* (1979). Triacylglycerol in the serum, liver, kidney and brain was determined according to the method of Fossati and Prencipe (1982). High-density lipoprotein – cholesterol in the serum, liver, kidney and brain was determined according to the method described by Badimon *et al.* (1990). LDL-C was calculated using Friedewald formula (Martin *et*

al., 2013). LDL-C (mg/dl) = (Total cholesterol - HDL)-Triacylglycerol /5. Atherogenic index was calculated using the formula described by Dobiasova and Frohlich (2001). Atherogenic index = log (Triacylglycerol / High density lipoprotein –Cholesterol)

Statistical Analysis

The data obtained in the experiment was expressed as means ± standard deviation. The values were analyzed using analysis of variance and the group means were compare using last significant difference. A p-value of ≤ 0.05 was considered significant in all statistical analysis.

Results

The administration of *M. myristica* water, ethanol and diethyl ether extract orally to rats up to 2000 mg/kg b.wt (Tables 1, 2 and 3) after one week did not record any mortality. However, some clinical features such as growing of little new hairs were observed in the rats given 200 mg/kg b.wt. A mild clinical sign of roughness of

hairs in the rats given the dosage of 500-2000 mg/kg b.wt were observed. Therefore, the LD₅₀ may be in excess of 2000 mg/kg b. wt. Finally, the 200 mg/kgb. wt was chosen as a protective dose for the studies. Changes in T. Chl, TAG, HDL-C and LDL-C levels in the serum, liver, kidney and brain of rats fed CPO-CCD treated with extracts of *M. myristica* was demonstrated in Tables 4,5,6 and 7. The levels of T. Chl, TAG and LDL-C of rats fed CPO-CCD only and CPO-CCD + tween 80 in the serum, liver, kidney and brain were significantly (p<0.05) increased while HDL-C was decreased when compared with the controls. On the other hand, among the rats fed CPO-CCD with MWE, MEE and MDEE, there were significant (p<0.05) decrease in T. Chl, TAG, LDL-C and increase HDL-C levels in serum, liver, kidney and brain when compared with rats fed CPO-CCD only and CPO-CCD + tween 80. The level of atherogenic index was found not significant (p<0.05) in all the experimental groups (Table 8).

Table 1: Mortality (LD50) effect of Water extracts of *M. myristica* seeds

Groups	N	Dose mg/kg	No. of death	% mortality	Dose differences (Df)	Mean death (Md)	Dd x Md	Clinical features
1	4	100	0	0	100	0	0	-
2	4	200	0	0	300	0	0	Growth of little new hairs
3	4	500	0	0	500	0	0	Roughness of hairs
4	4	1000	0	0	1000	0	0	Roughness of hairs
5	4	2000	0	0	-	0	0	Roughness of hairs

Table 2: Mortality (LD50) effect of ethanol extract of *M. myristica*

Groups	N	Dose mg/kg	No. of death	% mortality	Dose differences (Df)	Mean death (Md)	Dd x Md	Clinical features
1	4	100	0	0	100	0	0	-
2	4	200	0	0	300	0	0	Growth of little new hairs
3	4	500	0	0	500	0	0	Roughness of hairs.
4	4	1000	0	0	1000	0	0	Roughness of hairs
5	4	2000	0	0	-	0	0	Roughness of hairs

Table 3: Mortality (LD50) effect of diethyl ether extract of *M. myristica*

Groups	N	Dose mg/kg	No. of death	% mortality	Dose differences (Df)	Mean death (Md)	Dd x Md	Clinical features
1	4	100	0	0	100	0	0	-
2	4	200	0	0	300	0	0	Growth of little new hairs
3	4	500	0	0	500	0	0	Roughness of hairs
4	4	1000	0	0	1000	0	0	Roughness of hairs
5	4	2000	0	0	-	0	0	Roughness of hairs

Table 4: Total cholesterol (T. Chl) level in the serum, liver, kidney and brain of rats fed CPO-CCD treated with different extracts of *M. myristica*.

Groups	T. Chl (mg/dl)			
	Serum	Liver	Kidney	Brain
1: Control	250.41 ± 20.10 ^a	310.09 ± 12.36 ^a	270.38 ± 57.04 ^a	360.21 ± 44.07 ^a
2: CPO-CCD only	310.30 ± 46.10 ^b	362.30 ± 41.36 ^b	330.11 ± 19.84 ^b	420.39 ± 10.02 ^b
3: CPO-CCD + Tween 80	311.56 ± 32.10 ^b	362.18 ± 42.30 ^b	332.37 ± 15.00 ^b	420.24 ± 20.09 ^b
4: CPO-CCD + MWE	280.17 ± 27.31 ^c	350.41 ± 25.72 ^c	300.13 ± 37.00 ^c	391.37 ± 11.55 ^c
5: CPO-CCD + MEE	270.70 ± 52.10 ^d	330.39 ± 11.56 ^d	290.43 ± 20.11 ^d	380.25 ± 19.98 ^d
6: CPO-CCD + MDEE	234.29 ± 41.20 ^e	306.50 ± 13.30 ^e	277.71 ± 31.64 ^e	337.29 ± 37.03 ^e

Values are given in mean ± SD. n=5. Mean values with different superscript letter in the same column differ significantly at p<0.05.

CPO-CCD=crude petroleum oil contaminated catfish diet, MWE=*M. myristica* water extract. MEE=*M. myristica* ethanol extract. MDEE=*M. myristica* diethyl ether extract.

Table 5: Triacylglycerol (TAG) level in the serum, liver, kidney and brain of rats fed CPO-CCD treated with different extracts of *M. myristica*

Groups	TAG (mg/dl)			
	Serum	Liver	Kidney	Brain
1: Control	200.34 ± 18.11 ^a	231.00 ± 31.39 ^a	221.43 ± 44.45 ^a	250.25 ± 19.82 ^a
2: CPO-CCD only	300.42 ± 28.15 ^b	331.41 ± 12.42 ^b	320.37 ± 20.06 ^b	350.34 ± 9.96 ^b
3: CPO-CCD + Tween 80	305.13 ± 38.04 ^b	334.89 ± 12.38 ^b	320.41 ± 26.40 ^b	354.40 ± 40.25 ^b
4: CPO-CCD + MWE	270.32 ± 42.30 ^c	301.90 ± 21.19 ^c	290.14 ± 23.07 ^c	336.86 ± 41.52 ^c
5: CPO-CCD + MEE	250.77 ± 29.38 ^d	280.95 ± 37.50 ^d	271.38 ± 33.40 ^d	301.29 ± 10.56 ^d
6: CPO-CCD + MDEE	220.48 ± 18.81 ^e	250.88 ± 13.40 ^e	248.40 ± 10.14 ^e	283.61 ± 61.10 ^e

Values are given in mean ± SD. n=5. Mean values with different superscript letter in the same column differ significantly at p<0.05.

Key: CPO-CCD=crude petroleum oil contaminated catfish diet, MWE=*M. myristica* water extract. MEE=*M. myristica* ethanol extract. MDEE=*M. myristica* diethyl ether extract.

Table 6: High density lipoprotein- cholesterol (HDL-C) level in the serum, liver, kidney and brain of rats fed CPO-CCD treated with different extracts of *M. myristica*

Groups	HDL-C (mg/dl)		
	Liver	Kidney	Brain
1: Control	210.41 ± 18.11 ^a	200.58 ± 21.74 ^a	230.39 ± 30.02 ^a
2: CPO-CCD only	160.37 ± 9.28 ^b	150.43 ± 15.01 ^b	180.38 ± 10.04 ^b
3: CPO-CCD + Tween 80	163.39 ± 27.22 ^b	151.30 ± 36.10 ^b	182.28 ± 7.81 ^b
4: CPO-CCD + MWE	178.48 ± 17.19 ^c	165.91 ± 12.98 ^c	296.86 ± 15.89 ^c
5: CPO-CCD + MEE	188.07 ± 13.30 ^d	173.34 ± 24.37 ^c	200.32 ± 16.99 ^d
6: CPO-CCD + MDEE	199.89 ± 40.40 ^e	185.55 ± 19.42 ^e	215.27 ± 14.97 ^e

Values are given in mean ± SD. n=5. Mean values with different superscript letter in the same column differ significantly at p<0.05.

Table 7: Low density lipoprotein- cholesterol (LDL-C) level in the serum, liver, kidney and brain of rats fed CPO-CCD treated with extracts of *M. myristica*

Groups	LDL-C (mg/dl)			
	Serum	Liver	Kidney	Brain
1: Control	50.81 ± 07.81 ^a	70.14 ± 4.98 ^a	60.23 ± 11.00 ^a	89.56 ± 19.93 ^a
2: CPO-CCD only	120.28 ± 13.41 ^b	147.10 ± 19.42 ^b	141.36 ± 3.38 ^b	170.34 ± 2.00 ^b
3: CPO-CCD + Tween 80	119.38 ± 20.81 ^b	146.89 ± 17.88 ^b	139.32 ± 11.38 ^b	167.39 ± 3.95 ^b
4: CPO-CCD + MWE	90.18 ± 19.12 ^c	120.39 ± 33.89 ^c	110.30 ± 12.00 ^c	141.34 ± 0.96 ^c
5: CPO-CCD + MEE	75.51 ± 18.12 ^d	105.19 ± 19.39 ^d	96.12 ± 7.30 ^d	125.16 ± 6.88 ^d
6: CPO-CCD + MDEE	46.79 ± 14.11 ^a	75.40 ± 7.31 ^a	66.39 ± 11.25 ^a	91.29 ± 7.88 ^a

Values are given in mean ± SD. n=5. Mean values with different superscript letter in the same column differ significantly at p<0.05.

Table 8: Atherogenic index in the serum of rats fed CPO-CCD treated with different extracts of *M. myristica*

Groups	Atherogenic index (mg/dl)
1: Control	0.11 ± 0.09 ^a
2: CPO-CCD only	0.35 ± 0.05 ^a
3: CPO-CCD + Tween 80	0.36 ± 0.06 ^a
4: CPO-CCD + MWE	0.24 ± 0.01 ^a
5: CPO-CCD + MEE	0.23 ± 0.03 ^a
6: CPO-CCD + MDEE	0.12 ± 0.01 ^a

Values are given in mean ± SD. n=5. Mean values with different superscript letter in the same column differ significantly at p<0.05.

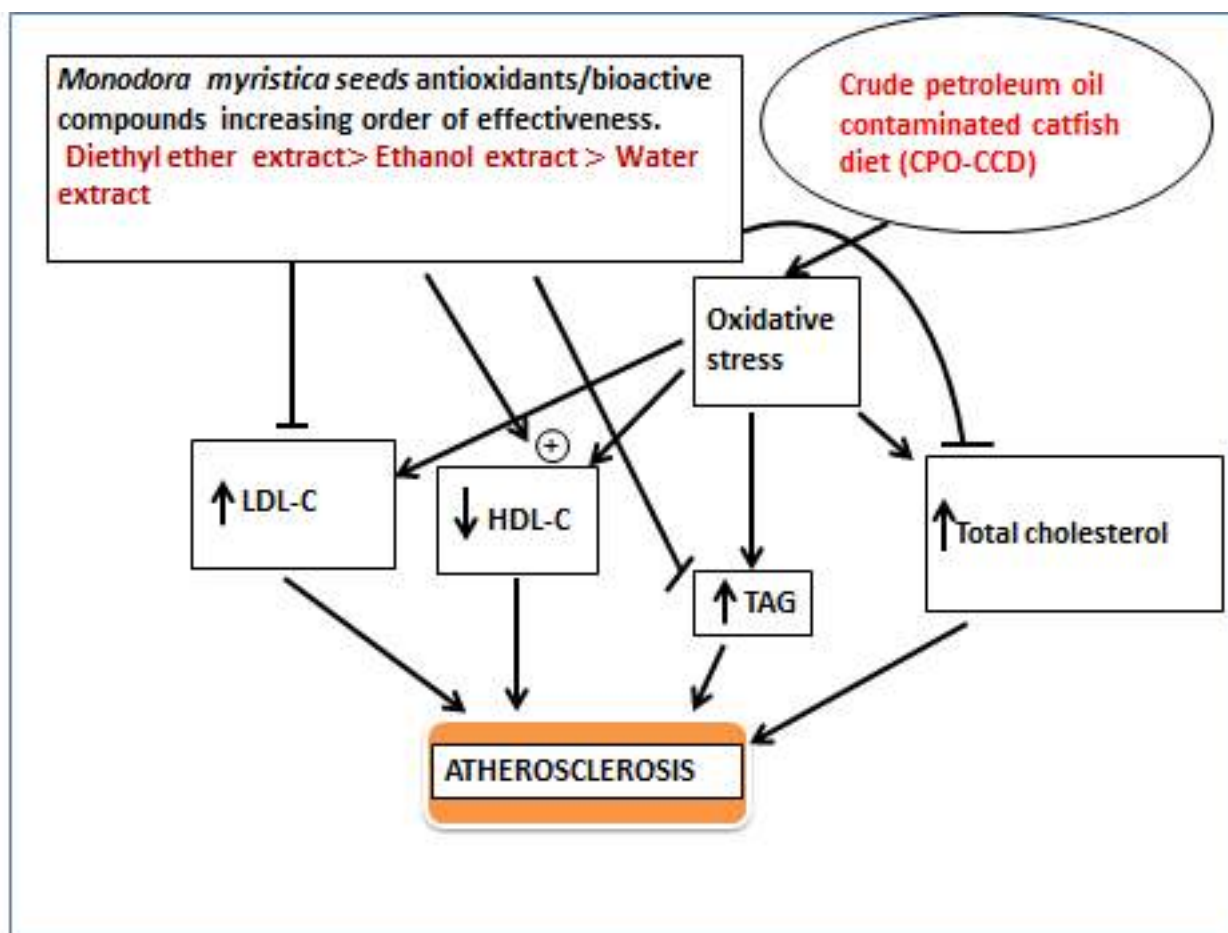


Figure 1. Schematic Representation for the Anti-Atherosclerotic Effect of *M. myristica* Extracts. *M. myristica* extracts contains antioxidants (flavonoids, saponin, tannin, alkaloids) and bioactive compounds, its consumption may also exert inhibitory effect on development of aortic atherosclerotic lesions and LDLs oxidation. Triacylglycerol (TAG), High Density Lipoprotein-Cholesterol (HDL-C), Low Density Lipoprotein-Cholesterol (LDL-C). CPO-CCD= Crude Petroleum Oil Contaminated Catfish Diet. Positive effect (+).

Discussion

It could be hypothesized from the results in Tables 1, 2, 3 and 4 that the observed growth of little new hairs may be due to the antioxidant property of *M. myristica* extracts. The roughness of hairs observed in the rats could be due to oxidative stress from high dose of the spice extracts, which is in line with previous studies (Iyawe and Onigbinde, 2012; Halliwell, 2008), which stated that high intake of antioxidant, may impose oxidative stress.

Hydrocarbon present in crude petroleum oil may result in fluctuations in serum, liver, kidney and brain lipid profile via a mechanism dependent on oxidative stress, increasing lipid peroxidation and decreasing enzymatic antioxidant defense mechanism (Azeez *et al.*,

2013). Petroleum hydrocarbon-induced oxidative stress on liver tissues, renal tissues and brain tissues is associated with hepatotoxicity (Orisakwe *et al.*, 2004), nephrotoxicity (Uboh *et al.*, 2009) and neurotoxicity (Kato *et al.*, 1996). Significant ($p < 0.05$) increase in T-Chl, TAG, LDL-C and decrease HDL-C in the serum and tissues (liver, kidney and brain) were observed in rats fed CPO-CCD alone and CPO-CCD plus tween 80 as when compared to control (Tables 4, 5, 6 and 7). This may indicate tissue damage due to oxidative stress and dysregulation of low lipoprotein receptor (LDLR). The results are line with the study conducted by Zhang *et al.* (2016), which stated that the dysregulation of LDLR expression results in abnormal lipid accumulation. This accumulation of lipid occurs in cells and tissues, such as hepatic cells, renal

mesangial cells (cells that regulate blood flow of the glomerular capillaries by their contractile process), renal tubular cells, podocytes (cells in the Bowman's capsule which wrap around the capillaries of glomerulus) and brain glial cells. George *et al.* (2013) have also reported abnormal lipid accumulation due to oxidative stress in the brain of streptozotocin induced diabetic rats.

The observed elevated levels of serum cholesterol and triglyceride in the fed CPO-CCD alone (Table 5 and 6) indicates their hyperlipidemia potentials. These increases have been implicated as the primary risk factor for cardiovascular heart disease (Ajiboye *et al.*, 2015).

The increased LDL-C level in rats fed CPO-CCD only in the serum and the various tissues may likely due oxidative stress and oxidation of LDLs. This is in line with the previous study of Brunzel *et al.* (2008) which states that increased concentration of serum LDL-cholesterol signified oxidative stress and damage of LDL receptor binding the tissues of the liver.

Treatments of rats with the extracts of *M. myristica* resulted a significant improvement in the tested lipid profile parameters, which could be attributed to increase inhibition of intestinal absorption of cholesterol, interference with lipoprotein production, increased expression of hepatic LDL receptor and their protection. Atherogenic indices are strong indicators of the risk of heart disease. The higher the value, the higher the risk of developing cardiovascular disease and vice versa. Low atherogenic indices are indications of protections against coronary heart disease (Ikewuchi and Ikewuchi, 2009). From the results obtained in this study, the oral administration of *M. myristica* seeds extracts, lowered the atherogenic index was (Table 8), indicating the likely cardioprotective properties of the extracts. *M. myristica* extracts possess anti-antigenic effect as shown in figure 1 above. The anti-lipidaemic and anti-atherogenic effects of *M. myristica* found in this study might be due to the high levels of antioxidants and bioactive compounds present in the *M. myristica* seeds extracts.

Conclusion

It can be concluded from the present data, that the levels of T-Chl, TAG, LDL-C is raised with a concomitant decrease HDL-C in rats fed CPO-CCD. These value were normalized with *M. myristica* extracts treatments. *M. myristica* extracts may have anti-lipidemic and anti-atherosclerosis effects and hence may be utilized for prevention of atherosclerosis in patient with hypercholesterolemia.

References

- Ajiboye, J.A., Erukainure, O.L., Lawal. B.A., Nwachukwu, A.V., Tugbobo-Amisu, A.O. and Okafor, E.N. (2015). Comparative alteration in atherogenic indices and hypocholesteremic effect of palm oil and palm oil mill effluent in normal albino rats. *Heliyon*; 1(1):1-10.
- Allan, C.C., Poon, I.S., Chan C.S., Richmond, W. and Fu, P.C. (1974). Enzymatic determination of total serum cholesterol. *Clinical Chemistry*; 20(4): 470-475.
- Al-Sayegh, Y.A., Sanket J., Saif, A., Abdulkadir, E. and Ali, A. (2016). Bioremediation of Heavy Crude Oil Contamination. *The Open Biotechnology Journal*; 10:301-311
- Aluko, M. A. O. (2004). Sustainable development, environmental degradation and the entrenchment of poverty in the Niger Delta of Nigeria. *Journal of Human Ecology*; 15(1): 63-68.
- Azeez, O.M., Akhigbe, R.E and Anigbogu, C. N. (2013). Oxidative status in rat kidney exposed to petroleum hydrocarbons. *Journal of Natural Science, Biology and Medicine*; 4(1): 149–154.
- Badimon, J.J., Badimon, L. and Fuester, V. (1990). Determination of HDL-cholesterol. *Journal of Clinical Investigation*; 85:1234-1241.
- Dietschy, J.M, and Turley, S.D. (2004). Cholesterol metabolism in the central nervous system during early development and in the mature animal. *Journal of Lipid Research*, 45: 1375-1397.
- Dobiasova M, and Frohlich J. (2001). The plasma/serum parameter log (TG/HDL-C) as atherogenic index; correlation with lipoprotein particle size and esterification rate in apoB-lipoprotein-depleted plasma

- (FERHDL)". *Clinical Biochemistry*; 34: 583-588.
- Ekperusi, O.A. and Aigbodion, F.I. (2015). Bioremediation of petroleum hydrocarbons from crude oil-contaminated soil with the earthworm: *Hyperiodrilus africanus*. *Biotechnology* 5: 957-965.
- Fossati, P. and Precipe, L. (1982). Determination of triglyceride levels in rat tissue. *Clinical Chemistry*; 28:2077-2080.
- George, B. O., Osioma, E. and Okpoghono, J. (2013). Effect of methanolic extract of *Aframomum sceptrum* on brain lipid profile and non-enzymatic antioxidant level in Streptozotocin Induced Diabetic Rats. *Nigerian Journal of Nutritional Sciences*; 34(1): 13-16.
- George, B.O., Okpoghono, J., Osioma, E. and Aina, O.O. (2012). Changes in oxidative indices in *Plasmodium berghei* mice treated with aqueous extract of *Aframomum sceptrum*. *Frontiers in Science*; 2(1): 6-9
- Gurr, M. I., and Harwood. J. L. (1991). *Lipids Biochemistry: An Introduction*, 4th ed. London: Chapman and Hall.
- Halliwell, B. (2008). Are polyphenols antioxidants or pro-oxidant? What do we learn from cell culture and in vivo studies? *Archives of Biochemistry and Biophysics*; 476: 107-112.
- Ikewuchi, C.J. and Ikewuchi, C.C. (2009). Alteration of Plasma Lipid Profiles and Atherogenic Indices by *Stachytarpheta jamaicensis* L. (Vahl). *Boikemistri*; 21(2):71-77.
- Iwu MM (2002). Evaluation of the antihepatotoxic activity of the biflavonoids of *Garciana kola* seeds. *Journal of Ethnopharmacology*; 21:14-19.
- Iyawe H. O. T. and Onigbinde, A. O. (2012). Chloroquine and Vitamin Combination Effects on *P. berghei* Induced Oxidative Stress. *International Journal of Biochemistry Research and Review*; 2(4): 120-122.
- Jing, J., Tan, J., Hu, H. Sun, J. and Jing, P. (2016). Rheological and Emulsification Behavior of Xinjiang Heavy Oil and Model Oils. *The Open Fuels and Energy Science Journal*; 9: 1-10.
- Kato, M., Rocha, M.L, Carvallio, A.B., Chares, M.E., Rana, M.C. and Oliverira, F.C. (1996). Occupational exposure to neurotoxicants; preliminary survey in five industries of Camacari petrochemical complex. *Environmental Research Letters* 136:49-56.
- Lorke, D. (1983). A new approach to practical acute toxicity testing, *Toxicologic Pathology*; 54:275-287.
- Martin, S.S., Blaha, M.J., Elshazly, M.B., Brinton, E.A., Toth, P.P., and McEvoy, J.W. (2013). Friedwald-estimated versus directly measured low-density lipoprotein cholesterol and treatment implications. *Journal of the American College of Cardiology*; 62(8):732-739.
- Moghadasian, M.H., Frohlich, J.J. and McManus, B.M. (2001). Advances in experimental dyslipidemia and atherosclerosis. *Laboratory Investigation*; 81 (9):1173-1183.
- Murray, R.K., Granner, D.K., Mayers, P.A. and Rodwel, V. W. (2003). *Harper's Biochemistry*. 26th ed. McGraw Publishers, New York.
- National Institutes of Health; NIH (1978). Guide for the care and use of Laboratory Animals (Revised). NIH Publication No. 82-83.
- Niroumand, S., Khajedaluae, M., Khadem-Rezaiyan, M., Abrishami, M., Juya, M., Khodae, G. and Dadgarmoghaddam, M. (2015). Atherogenic Index of Plasma (AIP): A marker of cardiovascular disease. *Medical Journal of The Islamic Republic of Iran*; 29: 240-249.
- Orisakwe, D.D., Akumka, A.A. N. and Afonne, O.J. (2004). Testicular toxicity of Nigerian bonny light crude oil in male albino rat. *Reproductive Toxicology*; 18: 439-494.
- Rafik, M.H. and Farid, S. M. (2013). Bioremediation of Libyan crude oil contaminated soil under mesophilic and thermophilic condition. *Asia-Pacific Chemical, Biological and Environmental Engineering Society Procedia*; 5: 82-87.
- Sunmonu, T.O. and Oloyede, O.B. (2007). Biochemical assessment of the effects of crude oil contaminated catfish (*Clarias gariepinus*) on the hepatocytes and performance of rat. *African Journal of Biochemistry Research*; 1 (5): 083-089.
- Uboh, F.E., Akpanabiatu, M.I., Alozie, Y., Edet,

- E.E., Ndem, J.I. and Ebong, P.E. (2009). Comparative effect of vitamins A and E on gasoline vapours–industrial haematotoxicity and weight loss in male rats. *International Journal of Pharmacology*; 5: 215–221.
- Uhegbu, F.O., Iweala E.J. and Kanu, I. (2011). Studies on the chemical and anti-nutritional content of some Nigerian Spices. *International Journal of Nutrition and Metabolism*; 3(6):72-76.
- Ujowundu, C.O., Kalu, F.N., Nwaogu, L.A., Ezeji, E.U. and Igwe, K.O. (2012). Management of changes in liver chemistry in male rats acutely exposed to crude petroleum oil. *Journal of Applied Pharmaceutical Science*; 2(06):116-120.
- Zhang, Y., Ma, K.L., Ruan, X.Z. and Liu, B.C. (2016). Dysregulation of the Low-Density Lipoprotein Receptor Pathway Is Involved in Lipid Disorder-Mediated Organ Injury. *International Journal of Biological Sciences*; 12(5):569-579.

Citation: Okpoghono, J., Achuba, F.I. and George, B.O. Influence of *Monodora Myristica* Extracts on Lipid Profile of Rats Fed Crude Petroleum Oil Contaminated Catfish Diet. *Sokoto Journal of Medical Laboratory Science*; 3(1): 19 - 27.

Copyright. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.