International Journal of Biological, Life and Agricultural Sciences
ISSN: 2415-6612
Vol:9, No:8, 2015

Plasma Lipid Profiles and Atherogenic Indices of Rats Fed Raw and Processed Jack Fruit (*Artocarpus heterophyllus)* Seeds Diets at Different Concentrations

O. E. Okafor, L. U. S. Ezeanyika, C. G. Nkwonta, C. J. Okonkwo

***Abstract*—**The effect of processing on plasma lipid profile and atherogenic indices of rats fed *Artocarpus heterophyllus* seed diets at different concentrations were investigated. Fifty five rats were used for this study, they were divided into eleven groups of five rats each (one control group and ten test groups), the test groups were fed raw, boiled, roasted, fermented and soaked diets at 10% and 40% concentrations. The study lasted for thirty five days. The diets led to significant decrease ($p<0.05$) in plasma cholesterol and triacylglycerol of rats fed 10% and 40% concentrations of the diets, and a significant increase ($p<0.05$) in high density lipoprotein (HDL) levels at 40% concentrations of the test diets. The diets also produced decrease in low density lipoprotein (LDL), very low density lipoprotein (VLDL), cardiac risk ratio (CRR), atherogenic index of plasma (AIP) and atherogenic coefficient (AC) at 40% concentrations except the soaked group that showed slight elevation of LDL, CRR, AC and AIP at 40% concentration. *Artocarpus heterophyllus* seeds could be beneficial to health because of its ability to increase plasma HDL and reduce plasma LDL, VLDL, cholesterol, triglycerides and atherogenic indices at higher diet concentration.

Keywords*—Artocarpus heterophyllus,* atherogenic indices, concentrations, lipid profile.

I. Introduction

CARDIOVASCULAR diseases have remained one of the leading causes of morbidity and mortality worldwide. Although genetic factors and aging are important in determining the overall risk, a substantial proportion of these diseases are dependent on modifiable risk factors such as dyslipidemia or oxidative stress which are susceptible to lifestyle and notably diet [1]. Dyslipidemia may be primary or associated with hypertension, diabetes mellitus and obesity [2]-[7].

Dyslipidemia usually involve elevated plasma levels of triglycerides (TG), total cholesterol, low density lipoprotein (LDL) and very low density lipoprotein (VLDL) cholesterol and a low level of high density lipoprotein (HDL) cholesterol [2], [3], [6], [7]. Therefore, any nutritional and pharmacologic intervention that improves or normalizes abnormal lipid metabolism may be useful for reducing the risk of cardiovascular diseases [2], [7].

Indeed, food nutrients have been recognized to play a role in the initiation or prevention of cardiovascular diseases. Initially, dietary interventions mostly focused on the quality of fat and it is now recognized that saturated and *trans* monounsaturated fatty acids are related with elevated cardiovascular risk whereas *cis* monounsaturated and long chain polyunsaturated fatty acids are associated with a decrease risk of cardiovascular diseases [8], [1]. Recently, findings from epidemiological and clinical studies have shown that consumption of plant products (fruits and vegetables) prevents several major diseases including cancer and cardiovascular diseases [1]. Some micronutrients are able to modulate oxidative components of cardiovascular diseases but polyphenols have also been involved in several other mechanisms including the improvement of endothelial function or modulation of inflammation [9], [1].

A great number of plants are currently used in the management of a wide range of illnesses by traditional medical practitioners, *Artocarpus heterophyllus* seeds is one of such plant. It has hypoglycaemic effect and anticarcinogenic effect [10]-[13]. In view of this, we did a preliminary investigation and found out that *Artocarpus heterophyllus* seeds are high in nutrients and important phytochemicals. The present study was designed to investigate the effect of processing on plasma lipid profiles and atherogenic indices of rats fed *Artocarpus heterophyllus* seeds at different concentrations**.**

II. Materials and Methods

A. Sample Preparation

Fresh *Artocarpus heterophyllus* fruits were bought from Eke Umuoji local market in Idemili Local Government Area of Anambra State, Nigeria. The fruits were sliced opened and the seeds were extracted manually, they were sorted and the spoilt seeds removed. The raw seeds were shared into five equal parts and each part processed by one of the following methods: boiling, roasting, soaking and fermentation. The fifth part was unprocessed. The boiled sample was prepared by boiling in a clean tap water until the seeds were soft, the seed coats were removed and the seeds dried. The roasted samples

This work was supported in part by the Nigeria Tertiary Education Trust Fund (TET fund) Scholarship and Association of Commonwealth University (ACU) Early Careers Academic Grant.

O. E. Okafor is a lecturer in the Department of Biochemistry, University of Port Harcourt, Rivers State Nigeria and a Ph.D researcher in the Department of Biochemistry, University of Nigeria. (Corresponding author; Phone no: +234(0)8038258457, e-mail: ogechukwu.okafor@uniport.edu.ng).

L. U. S. Ezeanyika is a professor in the Department of Biochemistry, University of Nigeria Nsukka, Enugu State Nigeria.

C. G. Nkwonta is a Ph.D researcher with Cranfield University Bedfordshire MK 43 0HR England.

C. J. Okonkwo is a lecturer in the Department of Biochemistry, University of Port Harcourt, Rivers State Nigeria and a Ph.D researcher in the Department of Biochemistry, University of Nigeria.

were roasted in fine sand for sixty (60) minutes, the seed coats were removed and the seeds dried. The soaked samples was prepared by removing the seed coats and soaking for forty eight (48) hours (the water was changed at twenty four (24) hours intervals), they were boiled for 60 minutes and the seeds dried. Fermented samples were boiled for 60 minutes, the seed coats were removed and the seeds were tied in black nylon and kept in a cupboard for 48 hours. Drying of seeds (to a constant weight) was done in a laboratory oven at a temperature of 50°C. The processed seeds were each ground into fine powder using a laboratory mill and fractions of each were used for the analysis of their constituents.

10% diets were prepared by mixing 90% normal rat chow with 10% processed seeds, 40% diets were prepared by mixing 60% normal rat chow with 40% processed seeds while the control diets were 100% normal rat chow.

B. Experimental Design

Fifty five male albino rats were obtained from the animal breading unit of the Department of Biochemistry, University of Port Harcourt, Rivers State. They were housed in eleven cages of five rats each and acclimatized to the animal house for one week during which they were fed with normal rat chow. After the one week of acclimatization period, the rats were assigned to their respective cages according to their body weight. Rats in a particular cage received the same diet and had access to clean water. The rats were grouped into eleven groups, one control group and ten experimental groups. Rats in group one (control) received the normal rat chow, group two received 10% raw/unprocessed *Artocarpus heterophyllus* seed diet (10% UAHDG), group three received 40% raw/unprocesssed *Artocarpus heterophllus* seed diet (40% UAHDG), group four received 10% boiled *Artocarpus heterophllus* seed diet (10% BAHDG), group five received 40% boiled *Artocarpus heterophllus* seed diet (40% BAHDG), group six received 10% roasted *Artocarpus heterophllus* seed diet (10% RAHDG), group seven received 40% roasted *Artocarpus heterophllus* seed diet (40% RAHDG), group eight received 10% soaked *Artocarpus heterophllus* seed diet (10% SAHDG), group nine received 40% soaked *Artocarpus heterophllus* seed diet (40% SAHDG), group ten received 10% fermented *Artocarpus heterophllus* seed diet (10% FAHDG), group eleven received 40% fermented *Artocarpus heterophllus* seed diet (40% UAHDG). The study lasted for five weeks, at the end of the study period, the rats were killed and their blood collected for determination of plasma lipid profile.

C. Determination of the Plasma Lipid Profiles/Indices

Plasma total cholesterol (TC), HDL-cholesterol (HDLC) and triglyceride (TG) were assayed with commercial test kits (Biosystem S.A Spain), at the Department of Biochemistry research laboratory, University of Port Harcourt, Rivers State, Nigeria. Plasma LDL-cholesterol was calculated using the Friedewald equation [14], as follows:

$$LDLC = TC - HDLC - TG/2.2.\ VLDLC = TG/2.2.$$

The atherogenic indices were calculated as:

$$Cardiac\ Risk\ Ratio\ (CRR) = TC/HDLC$$
$$Atherogenic\ Coefficient\ (AC) = (TC - HDLC)/HDLC$$
$$Atherogenic\ Index\ of\ Plasma\ (AIP) = log(TG/HDLC)$$

III. Results and Discussion

TABLE I
Result of Plasma Lipid Profile of Rats (mmol/L)

Group	Cholesterol	Triacylglycerol	HDL	LDL	VLDL
Control	1.75±0.03	1.47±0.01	0.82±0.06	0.26±0.07	0.67±0.01
10% BAHDG	1.73±0.09	1.39±0.07	0.83±0.06	0.27±0.03	0.63±0.03
40% BAHDG	1.74±0.03	1.37±0.06	0.95±0.01	0.17±0.03	0.62±0.08
10% FAHDG	1.71±0.06	1.32±0.05	0.80±0.08	0.31±0.02	0.60±0.05
40% FAHDG	1.57±0.07	0.99±0.07	0.81±0.03	0.31±0.08	0.45±0.05
10% UAHDG	1.72±0.04	1.33±0.03	0.81±0.06	0.31±0.06	0.60±0.04
40% UAHDG	1.64±0.06	1.03±0.09	0.96±0.03	0.21±0.04	0.47±0.02
10% RAHDG	1.70±0.07	1.31±0.06	0.82±0.07	0.28±0.02	0.60±0.06
40% RAHDG	1.50±0.01	1.01±0.03	0.82±0.03	0.22±0.04	0.46±0.06
10% SAHDG	1.72±0.09	1.37±0.08	0.81±0.03	0.29±0.07	0.62±0.02
40% SAHDG	1.71±0.02	1.06±0.09	0.75±0.04	0.48±0.05	0.48±0.03

HDL- high density lipoprotein, LDL- low density lipoprotein, VLDL- very low density lipoprotein, BAHDG- boiled *Artocarpus heterophllus* diet group , FAHDG- fermented *Artocarpus heterophllus* diet group, UAHDG- unprocessed *Artocarpus heterophllus* diet group, RAHDG- roasted *Artocarpus heterophllus* diet group, SAHDG- soaked *Artocarpus heterophllus* diet group.

Rats fed *Artocarpus heterophllus* seed diets showed a significant decrease ($p<0.05$) in plasma cholesterol, VLDL, LDL and triacylglycerol at 40% concentrations of the test diets and a significant increase ($p<0.05$) in HDL concentrations when compared with the control diet group. The soaked diet group showed slight increase in plasma LDL and a decrease in plasma HDL although they were not significantly different from other test diets.

Rats that fed the different diet groups showed decrease in plasma CRR, AIP and AC except the soaked diet group that had slight higher plasma CRR, AIP and AC.

IV. Discussion

Elevated concentration of total cholesterol in the blood has been shown by epidemiological studies as a powerful risk factor for coronary disease [7], [15], [16]. In this study, rats fed *Artocarpus heterophyllus* seed diets had lower plasma total cholesterol.

Elevated plasma levels of LDL and VLDL cholesterol is often found in hypertension and diabetes mellitus and is a risk factor for cardiovascular disease [3], [6], [7]. In this study, the LDL and VLDL levels were reduced at 40% concentration of the test diets but there was a slight higher plasma LDL levels in rats fed soaked *Artocarpus heterophyllus* diets. This effect may be attributable to the flavonoid content of the plant,

soaking might have reduced the flavonoid level. Middleton had earlier reported that citrus flavonoids lower plasma LDL cholesterol in both normolipidemic and hyperlipidemic rats [17]. Plant sterols are also known to lower plasma LDL cholesterol [18]. Decreases in plasma LDL cholesterol have been considered to reduce risk of coronary heart disease [7].

TABLE II
RESULTS OF ATHEROGENIC INDICES OF RATS

Group	CRR	AC	AIP
Control	2.13±0.14	1.13±0.13	0.33±0.04
10% BAHDG	2.08±0.07	1.08±0.05	0.32±0.05
40% BAHDG	1.83±0.12	0.79±0.09	0.26±0.07
10% FAHDG	2.14±0.05	1.14±0.06	0.33±0.03
40% FAHDG	1.94±0.06	0.94±0.08	0.29±0.05
10% UAHDG	2.12±0.07	1.12±0.04	0.33±0.06
40% UAHDG	1.71±0.09	0.71±0.08	0.23±0.07
10% RAHDG	2.07±0.03	1.07±0.04	0.32±0.01
40% RAHDG	1.83±0.07	0.83±0.10	0.26±0.05
10% SAHDG	2.12±0.02	1.12±0.04	0.33±0.02
40% SAHDG	2.29±0.09	1.29±0.08	0.36±0.08

CRR- cardiac risk ratio, AC-atherogenic coefficient, AIP-atherogenic index of plasma, BAHDG- boiled *Artocarpus heterophllus* diet group , FAHDG- fermented *Artocarpus heterophllus* diet group, UAHDG- unprocessed *Artocarpus heterophllus* diet group, RAHDG- roasted *Artocarpus heterophllus* diet group, SAHDG- soaked *Artocarpus heterophllus* diet group.

A high plasma triglyceride level is both an independent and synergistic risk factor for cardiovascular diseases and is often associated with hypertension [2], [7], [19] abnormal lipoprotein metabolism, obesity, insulin resistance and diabetes mellitus [2], [7], [19]. *Artocarpus heterophyllus* seed diets reduced the plasma triglyceride levels of rats fed the seed diets. This effect may have been mediated by the flavonoid content of the plant. Flavonoids decrease plasma levels of triglycerides [7], [17].

The concentration of HDL-cholesterol is an inverse predictor of cardiovascular disease, the cardioprotective properties of HDL are mainly due to its ability to promote the efflux of cholesterol. High HDL exerts a protective effect by enhancing reverse cholesterol transport by scavenging excess cholesterol from peripheral tissues, which it esterifies with the aid of lecithin: cholesterol acyltransferase, and delivers to the liver and steroidogenic organs for subsequent synthesis of bile acids and lipoproteins, and eventual elimination from the body [7], [16], [20], [21]. However, it also has antioxidant, anti-inflammatory and antithrombotic properties which contribute to the prevention of atherosclerosis and the associated cardiovascular diseases [1], [22].

Atherogenic indices is one of the powerful indicators of the risk of heart disease , the higher the value, the higher the risk of developing cardiovascular disease and *vice* versa [7], [23]-[27]. In this study, we observed that *Artocarpus heterophyllus* seed diets reduced atherogenic indices, although there was a slight increase in the indices of rats fed the soaked sample but it was not significantly different from other diet groups. Lower atherogenic index is protective against coronary heart disease [27].

REFERENCES

[1] C. Gladine, *et al*. "Optimized rapeseed oil enriched with healthy micronutrients: a relevant nutritional approach to prevent cardiovascular diseases," Results of the Optim'Oils randomized intervention trial. The Journal of Nutritional Biochemistry, March 2013, vol. 24, Issue 3, pp. 544–549

[2] J. Zicha, J. Kunes, and M .A. Devynck, "Abnormalities of membrane function and lipid metabolism in hypertension: a review," *Am. J. Hypertens*., 1999, vol. 12, pp. 315-331.

[3] M. J. Franz, J. P. Bantle, C. A. Beebe, J. D. Brunzell, J. L. Chiasson, A. Garg, L. A. Holzeister, B. Hoogwerf, E. Mayer-Davies, A. D. Mooradian, J. Q. Purnell and M. Wheeler, "Evidence-Based Nutrition Principles and Recommendations for the Treatment and Prevention of Diabetes and Related Complications, " *Dabetes Care,* 2002, vol. 25, pp. 148-198.

[4] H. Gyling, J. A. Tuominen, V. A. Koivsto and T. A. Miettinen, "Cholesterol Metabolism in Type 1 Diabetes," *Diabetes Care*, 2004, vol. 53, pp. 2217-2222.

[5] D. M. Martirosyan, L. A. Miroshnichenko, S. N. Kulokawa, A. V. Pogojeva and V. I. Zoloedov, "Amaranth oil application for heart disease and hypertension," *Lipids Health Dis.*, 2007, vol. 6 no. 1, doi:10.1186/1476-511X-6-1.

[6] G. X. Shen, "Lipid Disorders in Diabetes Mellitus and Current Management," *Curr. Pharmaceut. Analys*., 2007, vol. 3, pp. 17-24.

[7] C. J. Ikewuchi and C. C. Ikewuchi, "Alteration of Plasma Lipid Profiles and Atherogenic Indices by *Stachytarpheta jamaicensis* L. (Vahl)," *Biokemistri*, 2009, vol. 21, pp. 71-77.

[8] F.B. Hu, J.E. Manson, W.C. Willett, "Types of dietary fat and risk of coronary heart disease: A critical review," J. Am. Coll. Nutr, 2001, vol. 20, pp. 5–19.

[9] C. Manach, A. Mazur, A. Scalbert, "Polyphenols and prevention of cardiovascular diseases," Curr Opin Lipidol, 2005, vol. 16, pp. 77–84.

[10] M. R. Fernando, M. I. Thabrew and E. H. Karunanayake, "Hypoglycaemic activity of some medicinal plants in Sri-Lanka," General Pharmacology, 1990, vol. 21, pp. 779−782.

[11] M. Sato, S. Fujiwara, H. Tsuchiya, T. Fujii, M. Iinuma, H. Tosa, "Flavones with antibacterial activity against cariogenic bacteria," *Journal of Ethnopharmacology*, 1996, vol. 54, pp. 171−176.

[12] U. B. Jagtap, S. N. Panaskar, and V. A. Bapat, "Evaluation of antioxidant capacity and phenol content in jackfruit (Artocarpus heterophyllus Lam.) fruit pulp, " *Plant Foods for Human Nutrition*, 2010, vol. 65, pp. 99−104.

[13] S.B. Manjeshwar *et al*, "Phytochemistry, nutritional and pharmacological properties of Artocarpus heterophyllus Lam (jackfruit): A review," Food Research International, 2011, vol. 44, pp. 1800–1811.

[14] W. T. Friedewald, R. I. Levy, and D. S. Friedrickson, "Estimation of the concentration of low-density lipoprotein cholesterol in plasma, without use of the preparative ultracentrifuge". *Clin. Chem.* 1972, vol. 18, pp. 499-502.

[15] M. R. Law, "Lowering heart disease risk with cholesterol reduction: evidence from observational studies and clinical trials," Eur. *Heart J. Suppl.,* 1999, vol. 1, pp. S3-S8.

[16] O. Ademuyiwa, R. N. Ugbaja, I F. Dumebor, and O. Adebawo, "Plasma lipid profiles and risk of cardiovascular disease in occupational lead exposure in Abeokuta, Nigeria," *Lipids Health Dis.,* 2005, vol. 4, pp. 19.

[17] E. Jr . Middleton, C. Kandaswami, and T.C. Theoharides, "The Effects of Plant Flavonoids on Mammalian Cells: Implications for Inflammation, Heart Disease and Cancer," *Pharmacol. Rev*., 2000, vol. 52, pp. 673-751.

[18] American Dietetic Association, "Disorders of Lipid Metabolism Evidence-Based Nutrition Practice Guideline," American Dietetic Association, Chicago (IL), August 2005, 17p.

[19] P. E. McBride, "Triglycerides and Risk for Coronary Heart Disease," *J.A.M.A.*, 2007, vol. 298, pp. 336-338.

[20] D. K. Das, "Cardioprotection with high density lipoproteins. Fact or Fiction?," *Cir. Res.,* 2003, vol. 92, pp. 258-260.

[21] G.Assmann and A. M. Jr. Gotto, "HDL Cholesterol and Protective Factors in Atherosclerosis," *Circulation*, 2004, vol. 109, (*suppl* III): III-8 –III-14.

[22] B.J. Ansell, K.E. Watson, A.M. Fogelman, M. Navab, and G.C. Fonarow, "High-density lipoprotein function - Recent advances," J Am Coll Cardiol, 2005, vol. 46, pp. 1792–1798.

[23] J. Frohlich and M. Dobiásová, "Fractional Esterification Rate of Cholesterol and Ratio of Triglycerides to HDL-Cholesterol Are

Powerful Predictors of Positive Findings in Coronary Angiography," *Clin. Chem*., 2003, vol. 49, pp. 1873-1880.
[24] A. Brehm, G. Pfeiler, G. Pacini, H. Vierhapper and M. Roden, "Relationship between Serum Lipoprotein Ratios and Insulin Resistance in Obesity," *Clin. Chem*., 2004, vol. 50, pp. 2316–2322.
[25] M. Dobiásová, "Atherogenic Index of Plasma (log(triglyceride/HDL-Cholesterol): Theoretical and Practical Implications," *Clin. Chem*., 2004, vol. 50, pp. 1113-1115.
[26] Y. Takasaki, "Serum Lipid Levels and Factors Affecting atherogenic Index in Japanese Children," *J. Physiol. Anthropol. Appl. Human. Sci*., 2005, vol. 24, pp. 511-515.
[27] C. A. O. Usoro, C. C. Adikwuru, I. N. Usoro and A. C. Nsonwu, "Lipid Profile of Postmenopausal Women in Calabar, Nigeria," *Pak. J. Nutr*. 2006, vol. 5, pp. 79-82.

Okafor, Ogechukwu Ebere was born at Granader hospital Nkpor, Nigeria on September 18, 1982. She attended Premier Primary School, Obosi, Anambra State from 1989 – 1993 were she obtained a Primary School Leaving Certificate (P.S.L.C). In 1999, she got West African Senior School Certificate (WASSC) from Holy Innocents' Juniorate Convent, Nkpor Anambra State. In 2005, she had a Bachelor of Science (B.Sc.) degree in Biochemistry from Madonna University Nigeria. In 2009, she had a Master of Science (M.Sc.) degree in Biochemistry (Nutrition and food) from University of Nigeria Nsukka, Enugu State Nigeria. In 2011, she had a Post Graduate Diploma (P.G.D) in Education from Ahmadu Bello University Zaria. She is currently a Ph.D. researcher in Nutritional biochemistry at the University of Nigeria Nsukka.

She worked as a practical demonstrator at the University of Nigeria Nsukka from 2007-2008. She worked as an Assistant Lecturer at Tansian University Umunya (Oba campus) from 2011-2012. She is currently employed as a Lecturer at University of Port Harcourt, Rivers State Nigeria from 2012 till date. She had authored a number of scientific articles published in peer reviewed academic journals, some of which includes;

Evaluation of the Chemical Composition of *Mucuna utilis* leaves used in herbal medicine in Southeastern Nigeria, *African Journal of Pharmacy and Pharmacology,* 2012. vol. 4, pp. 811-816.

Effects of levonorgestrel, ethinylestradiol and norethisterone on plasma cholesterol and triglycerides of wistar albino rat (*Rattus rattus; Indian Journal of Medicine and Healthcare*, 2010, vol.1 pp.85-89.

Evaluation of the chemical composition of *Dacryodes edulis* (G. Don) seeds. *Int. J. Biol. Chem. Sci*. 2010, vol. 4, pp. 1225-1233.

Ms Okafor, Ogechukwu Ebere is one of the recipients of Nigeria Tertiary Education Trust Fund (TET Fund) Scholarship for Ph.D. scholars. She is also one of the recipients of Association of Commonwealth Universities (ACU) early careers academic grant.

EZEANYIKA, Lawrence Uchenna Sunday, Ph.D (Professor) had his primary education at Holy Ghost Primary School, now Cathedral Primary School Enugu between 1971 and 1975. Thereafter, he proceeded to Merchants' of Light School, Oba (1975 – 1980) and the University of Nigeria, Nsukka 1981 – 1985; 1987 – 1989; and 1991 – 1995. He has the following certificates/degrees; First School Leaving Certificate (credit level), 1975, West African School Certificate, 1980, B.Sc. (Hons) Biochemistry (Second Class, upper division), 1985, M.Sc., 1989 and Ph.D., 1995.

He was the best graduating student of his class and won the Federal Government of Nigeria Postgraduate Scholarship (1988) and the Commonwealth Scholarship (alternate candidate), 1992. Lawrence U. S. Ezeanyika worked briefly at Kami Laboratories Ltd, Enugu in 1981, was a tutor at St. Roses Girls' Grammar School, Ogwashi-Uku (National Youth Service, 1985 – 1986) and lectured at the Department of Biochemistry, University of Maiduguri, Maiduguri, 1990 – 1999. He has been lecturing at the Department of Biochemistry, University of Nigeria, Nsukka since April, 1999. He spent his sabbatical leave at the Department of Biochemistry, Kogi State University, Anyigba during which period he was the acting Head of the Department.

Lawrence has within his time as a university lecturer taught the following courses at undergraduate and/or postgraduate levels. Nutritional Biochemistry, Pharmacological Biochemistry, Tissue and Organ Biochemistry, Plant Biochemistry, Medical Biochemistry, Industrial Biochemistry, Biochemical Instrumentation, Genetic Engineering, Biochemical Reasoning, General and Advanced General Biochemistry, currently supervising over fifteen doctorate and ten masters degree students. He has served in a number of committees at the departmental, faculty and university levels in the Universities he has worked and was from August 2010 to July 2013 the Head, Department of Biochemistry, University of Nigeria, Nsukka.

Current Concepts in Enzymology and Bioinorganic Chemistry. He has successfully supervised scores of students at the undergraduate level, about 20 masters and eight doctorate degree students. Prof. Ezeanyika is He has worked on various topical issues including: the properties of gamma-glutamyl transferase (γ- GT) from cowpeas, polymorphic distribution and some properties of serum paraoxonase in a Nigerian population and biochemical and nutritional toxicological studies of rats fed garri (cassava), scopoletin and cyanide containing diets. Presently, he is working on the clinical chemistry of tropical diseases and the place of nutraceuticals in the management of tropical diseases. Prof. Ezeanyika is on the membership of several professional bodies relevant to biochemistry, has attended several workshops/ conferences/symposia.

He has served at various times as an external examiner to several universities within and outside Nigeria including the Universities of Lagos, Calabar, Benin, Port – Harcourt, Ilorin, Ahmadu Bello, Nnamdi Azikiwe, Michael Okpara University of Agriculture, Abia State University, Uturu, Abia State, Anambra State University, Uli, Anambra State, Nigeria and the University of Yenepoya, Mangalore, India. He has also assessed professorial candidates for the following national and overseas universities; Nnamdi Azikiwe University, Awka, University of Maiduguri, Maiduguri, Usmanu Danfodiyo University, Sokoto, Federal University of Technology, Owerri, and Federal University of Petroleum Resources, Efurun, Delta State, Nigeria and the Unversity of West Indies, St. Augustine, Trinidad and Tobago. Prof Lawrence U. S. Ezeanyika has also reviewed manuscripts for publication for dozens of notable local and international journal publishing houses.

Prof Lawrence Uchenna Sunday Ezeanyika is happily married to Mrs Ogechi Nnenna Ezeanyika with whom he has five children. He has about 70 journal articles most of which are accessible online.

Chikere G. Nkwonta was born on June 24, 1977in Nsukka, Enugu State, Nigeria. He holds a Bachelor of Science degree in Biochemistry/Microbiology (combined honours) and a Master of Science degree in Biochemistry with specialization in nutritional biochemistry. Both degrees were obtained from University of Nigeria, Nsukka, Enugu State in 2004 and 2008 respectively.

He is a research fellow with the Biotechnology Centre (South-East Zonal Biotechnology Centre), University of Nigeria Nsukka, Enugu State and currently a Doctor of Philosophy (PhD) researcher at Cranfield University, England, United Kingdom. He has authored several peer reviewed articles some of which includes; (a) Impact of postharvest processing on the fungal population contaminating African walnut shells (*Tetracarpidium conophorum* Mull. Arg) at different maturity stages and potential mycotoxigenic implications. International Journal of Food Microbiology 19415-20, 2015: (b) Comparative effects of moist and dry heat on nutrient potentials of *Tetracarpidium conophorum* nut in rats. Pakistan Journal of Nutrition 12 (1) 89-92, 2013 and (c)Effects of Roasted *Tetracarpidium conophorum*- Based Diet on some haematological parameters renal and liver function biomarkers in male Wister rats. Journal of Pharmacy Research, 3 (8) 1865-1871, 2010. He has also featured as primary speaker in key international conferences/seminars including Gordon Research Conferences and Seminars on Mycotoxins and Phycotoxins 2013 at Stone Hill College, Easton, Massachusetts, United States.

Mr. Chikere is a members of the Society of Biology, United Kingdom: International Society of Horticultural Science, United Kingdom and Nutrition Society of Nigeria among others. He is currently a scholar under the Tertiary Education Trust Fund Scholarship (2011/2012) of the Federal Republic of Nigeria and an awardee of the World Bank "Innovators of Tomorrow's (IOT)" 2007 awards.

Mr. Okonkwo, Chinedu Joseph was born on 19 May 1982 at Enugwu-Ukwu in Njikoka Local Government Area of Anambra State, Nigeria. He has a bachelor's degree (B.Sc.) in Applied Biochemistry from Nnamdi Azikiwe University, Awka, Anambra State Nigeria, 2005; a master's degree (M.Sc.) in Pharmacological Biochemistry from the University of Nigeria, Nsukka, Enugu state, Nigeria, 2010. He is currently pursuing a doctorate degree (Ph.D) in Pharmacological Biochemistry at the latter University.

He was a Graduate Assistant from 2007 to 2011 at Novena University Ogume, Delta State, Nigeria. Presently, He is a Lecturer in the Department of Biochemistry, University of Port Harcourt, Rivers State, Nigeria. He has

authored a number of scientific articles published in peer reviewed academic journals; a few of them are listed below:

- Antioxidant Effect of *Ocimum gratissimum* Linn. Leaf Against Carbon tetrachloride-induced Oxidative Stress in Wistar Albino Rats. *International Journal of Current Research,*2(1): 001-007 (2011).
- Analysis of Zinc, Iron and Lead Contents of Water, Soil and Some Staple Foods in Isigwe and Ihuona Villages of Ugbawka Community, Enugu State, Nigeria. *Bio-Research*, 9(2): 712-718 (2011).
- Evaluation of the effects of *Colatropis gigantean* Leaf extracts on blood pH, blood glucose and total protein Concentrations in Diabetic Rats. *Journal of American Science*, 7(5): 819-826 (2011).

He is interested in Phytomedicine and Natural Product Research.

Mr. Okonkwo is a member of the Nigerian Society of Biochemistry and Molecular Biology (NSBMB), as well as, a recipient of the Early Careers Academic Grant awarded by the Association of Commonwealth Universities, London.