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

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***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

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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].

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

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