www.ajbrui.org

Afr. J. Biomed. Res. Vol. 22 (January, 2019); 101- 104

Short communication

Effect of Unripe *Musa paradisiaca* Fruit Diet on Iron-Induced Renal Impairment in Rats

***Ige A.O, Onipede O.T, Mobolade K.Y., Adewoye E.O**

Applied and Environmental Physiology Unit, Department of Physiology, University of Ibadan

ABSTRACT

Unripe *cvc* fruit meal has been suggested to possess antioxidant potentials. This study thus investigated the effect of unripe *Musa paradisiaca* fruit (UMP) diet on iron-induced renal impairment, a likely consequence of iron-induced oxidative stress, in Wistar rats. Thirty-rats were equally divided into five groups. Group 1 (control) received standard rat chow only. Renal impairment via oxidative stress was induced with ferrous-sulphate (3mg/kg, i.p.) in groups 2–5 and animals were simultaneously maintained on standard rat chow (group2), 20%UMP-diet (group3), 40%UMP-diet (group4) and 80%UMP-diet (group5) respectively, for 28days. Thereafter blood samples were obtained from the retro-orbital sinus after light di-ethyl ether anesthesia into plain sample bottles. Serum was obtained from these samples and analyzed for urea and creatinine levels. Kidney samples were also obtained from each animal for histological evaluation using H and E stains. Urea and creatinine were significantly reduced in groups 4 and 5 compared to group 2. Animals in group 2 (iron only) had kidneys samples with poor architecture; renal cortices had moderate peri-glomerular, glomeruli and perivascular infiltration. The renal tubules in this group also lacked luminar space and exhibited epithelia depletion. These pathologies were partially prevented in groups 3 and 4 while group 5 (80%UMP-diet) showed kidney samples that were comparable with control. This study suggests that unripe *Musa paradisiaca* rich diet may reduce iron-induced renal impairment.

Keywords: *Unripe Musa paradisiaca , renal function, renal impairment, iron*

*Author for correspondence: *E-mail*: *aby_ige@yahoo.com;* +234 08033787617

Received: August, 2018; Accepted: November, 2018

Abstracted by:
Bioline International, African Journals online (AJOL), Index Copernicus, African Index Medicus (WHO), Excerpta medica (EMBASE), CAB Abstracts, SCOPUS, Global Health Abstracts, Asian Science Index, Index Veterinarius

INTRODUCTION

Renal disease is associated with a graded increase in markers of oxidative stress even in early chronic kidney disease (Cachofeiro *et al*., 2008) This has been ascribed to be likely due to an increase in reactive oxygen species as well a concomitant decline in antioxidant defense mechanisms which in most cases causes an acceleration of renal injury progression.

Iron, a macronutrient essential for life, plays essential roles in metabolic processes such as oxygen transport, electron transport, oxidative phosphorylation and energy production, xenobiotic metabolism, DNA synthesis, cell growth, apoptosis and inflammation (Outten and Theil, 2009; Wang and Pantopoulos, 2011). The human body also possesses a precise control mechanism to maintain iron homeostasis, as excess iron in the body is toxic. When in excess, iron acts as a catalyst in the Fenton reaction leading to the generation of free radicals (Crichton *et al*., 2002) and hence oxidative stress in the body.

Musa paradisiaca (plantain), a crop indigenous to the tropical and subtropical regions of the world (Alabi et al., 2013), has been reported to promote healthy digestion, improve affective state and serve as a good source of electrolytes for the body (Imam and Akter, 2011). The fruits can be consumed when ripe or unripe, cooked, roasted, steamed, baked or grilled. Green plantain has also been observed to be high in total dietary fibre content (Kirtikar and Basu, 1991), which suggests that it may lower glycaemic response by forming a physical barrier to enzymatic hydrolysis of starch. In folklore medicine, unripe plantain meal has been observed to exert anti-ulcer, cholesterol lowering and antidiarrheal effects; it has also been shown to be useful in the management of diabetes, treatment of anemia, liver disorders (independent of diabetes) (Eleazu and Okafor, 2012) and nephritis (Ghani, 2003). In previous studies, it has also been suggested that unripe *Musa paradisiaca* fruit diet may reduce the deleterious effects of iron-induced oxidative stress on glucose regulatory indices (Ige et al., 2017). In this study, the effects of varying

compositions of unripe *Musa paradisiaca* fruit (UMP) diet on iron-induced renal impairment will be investigated in Wistar rats.

MATERIALS AND METHODS

Plant collection, preparation and diet formulation; Commercially available dried sliced unripe *Musa paradisiaca* (UMP) fruits were purchased from Oje market in Ibadan metropolis. Plant preparation and diet composition are as previously described (Ige et al., 2017). Briefly, standard rat chow was obtained from Ladokun feed, Ibadan, Nigeria (carbohydrate 67%, protein 21%, fat 3.5%, fiber 6%, calcium 0.8%, phosphorus 0.8%). The chow were ground into powdery form and mixed with dried ground UMP fruits in the ratio 80% standard feed: 20% UMP; 60% standard feed: 40% UMP; and 20% standard feed: 80% UMP respectively. This was then reconstituted into pellets and given to the experimental animals.

Animals and Experimental protocol; Thirty (30) male Wistar rats (140-170g) were housed in well-ventilated cages, exposed to alternate day and night cycles, maintained at room temperature with low relative humidity, fed on standard rat chow and allowed free access to drinking water *ad libitum* for two weeks prior to experimental procedures. All experiments and groupings were carried out as previously described (Ige *et al*., 2017). Briefly, group 1 was control and maintained on standard rat chow throughout the duration of study. Renal impairment via oxidative stress was induced with daily intraperitoneal administrations of ferrous sulphate (3mg/kg) (Abd Allah *et al*, 2014) in groups 2 – 5 and these animals were simultaneously maintained on standard rat chow (group 2), 20% UMP-diet (group 3), 40% UMP-diet (group 4) and 80% UMP-diet (group 5) respectively for 28 days.

Sample Analysis; On day-28 post treatment, blood samples were obtained from the retro-orbital sinus after light di-ethyl ether anesthesia into plain sample tubes. The blood was allowed to stand at room temperature to obtain serum and thereafter centrifuged at 3000rpm for ten minutes to isolate the serum. The clear serum obtained was analyzed for urea (Fawcett *et al*., 1960) and creatinine (Bartels and Bohmer, 1973) levels respectively. Kidney samples were also excised after cervical dislocation from animals in each experimental group and analyzed histologically for structural changes using Haematoxylin and Eosin stains.

Statistical Analysis; Data were expressed as Mean ± SEM and this was analyzed using ANOVA and Student T-test to establish the statistical significance at $P<0.05$.

RESULTS AND DISCUSSION

Epidemiological studies has indicated that woman may be highly susceptible to iron overload therefore it has been suggested that laboratory investigations to ascertain iron status should be carried out routinely in women (Fashola *et al.*, 2013). Iron overload has been reported to result in increased production of reactive oxygen species and within the kidneys these has been suggested to result in renal impairment arising from necrotic renal cells (Ebina *et al.*, 1986). Amongst several markers used to predict renal function, creatinine, urea, uric acid and electrolytes have been suggested for routine analysis (Gowda *et al*, 2010). In the kidneys urea that is produced by liver as a bi product of amino acid catabolism is filtered out of blood by glomerulli and is partially being reabsorbed with water (Corbett, 2008). Serum urea concentration is one of the most frequently determined clinical indices for estimating renal function and has been found useful in the differential diagnosis of acute renal failure and pre-renal conditions (Mtchell and Kline, 2006). In this study, urea (mg/dl) values obtained in the control (13.72±0.14), 40% (13.62±0.17) and 80% (14.46±0.26) UMP-diet group were reduced compared to iron only group (17.04±0.03) which suggests a renal impairment in iron only group and suggests a possible attenuation of iron induced renal impairment in the 40% and 80% UMP-diet group as values obtained were comparable to control. The serum urea value obtained the 20% UMP-diet (15.45±0.43) though reduced, was still comparable to the iron only group and suggests impaired renal function as a result of iron stress may not be ameliorated by the 20% UMP-diet (Table 1).

Table 1
Urea and Creatinine level in control and experimental groups

GROUP	Urea (mg/dl)	Creatinine (mg/dl)
1	13.72±1.04	1.04±0.08
2	17.04±0.3	1.12±0.11
3	15.45±0.43	0.85±0.09
4	13.62±0.17*	0.72±0.04*
5	14.46±0.26*	0.70±0.02*

*Values are Mean ± SEM. * indicates values that are significantly different from group 2. Group 1 = Control (Normal diet only); Group 2 = Iron-induced renal impairment only; Group 3 = Iron-induced renal impaired fed 20% UMP-diet group; Group 4 = Iron-induced renal impaired fed 40% UMP-diet group; Group 5 = Iron-induced renal impaired fed 80% UMP-diet group.*

Creatinine, a bi-product of muscle creatine phosphate breakdown is also a routine measure of kidney function that is used to monitor the progression of renal disease (Gowda et al., 2010). Creatinine values (mg/dl) obtained in the 20% (0.85±0.09), 40% (0.72±0.04) and 80% (0.70±0.02) UMP-diet group were reduced respectively compared to iron only (1.12±0.11) diet group. These observations again suggest a concentration dependent effect of UMP-diet in ameliorating iron-induced renal impairment with the 80% UMP-diet having the highest effect. Histological assessment of the kidney sample also further corroborates results obtained from urea and creatinine studies with the iron only group (Plate 1B) showing pathologies that were consistent with renal impairment that may have resulted from iron-induced oxidative stress. These include renal cortex that show moderate peri-glomerular infiltration (white arrow). Some glomeruli in this group have mild infiltration with inflammatory cells and mild perivascular infiltration observed (red arrow). Some of the renal tubules in this group also lack luminar space and show epithelia depletion (blue arrow.

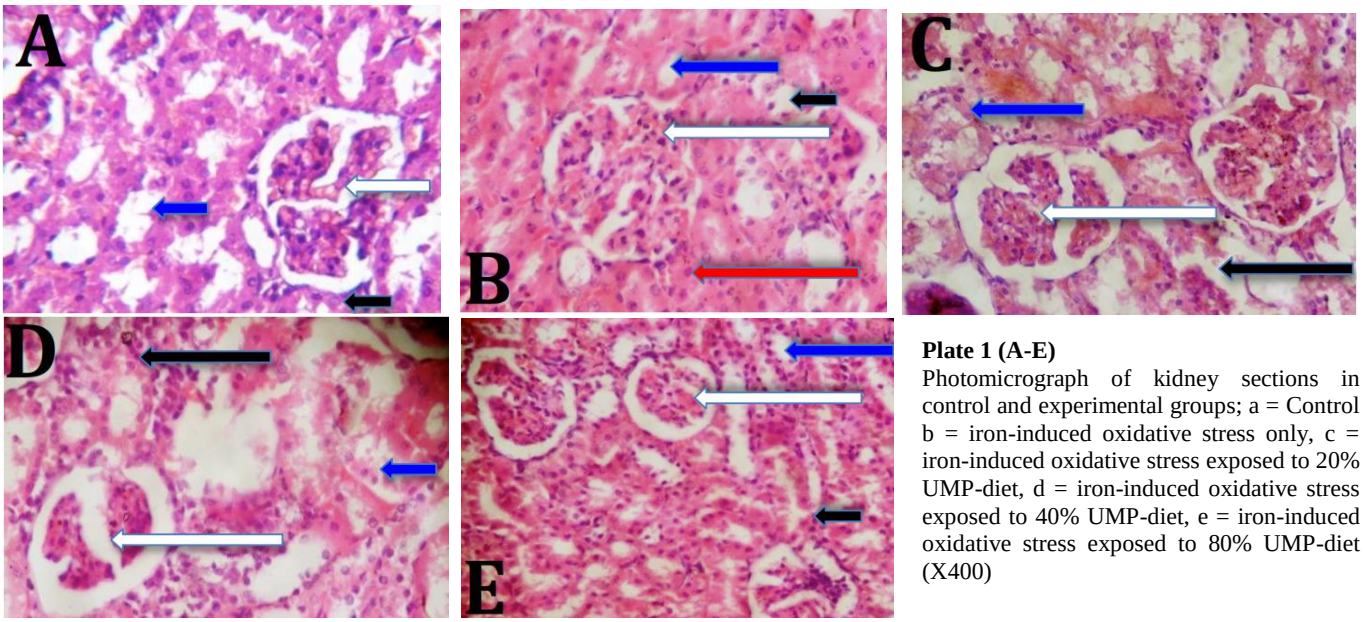

Plate 1 (A-E)
Photomicrograph of kidney sections in control and experimental groups; a = Control b = iron-induced oxidative stress only, c = iron-induced oxidative stress exposed to 20% UMP-diet, d = iron-induced oxidative stress exposed to 40% UMP-diet, e = iron-induced oxidative stress exposed to 80% UMP-diet (X400)

The 20% UMP diet group (Plate 1C) also showed pathologies that were similar to those obtained in the iron only group and suggest the presence of renal impairment in this group despite the 20% UMP-diet intervention. However, evaluation of kidney samples obtained in the 40% UMP-diet group (Plate 1D) showed a gradual amelioration of iron-induced renal impairment as pathologies with kidney samples in this group showing renal cortex with normal glomeruli that have normal messengial cells and capsular spaces (white arrow). There is however in this group moderate epithelial degeneration of the renal tubules (blue arrow) and the interstitial spaces have areas of inflammatory cells aggregate (black arrow). Kidney samples in the 80% UMP-diet group (Plate 1E) were normal and comparable to that obtained in the control group (Plate 1A), with sections showing normal renal cortex that have normal glomeruli with normal messengial cells and capsular spaces (white arrow), the renal tubule in this group (blue arrow) and the interstitial spaces were also normal (slender arrow). This suggest either an amelioration or reversal of iron-induced renal impairment and further corroborate the earlier stated dietary concentration dependent effect of UMP-diet in ameliorating renal impairment.

It is likely that the observed ameliorative effect of UMP-diet on iron induced-renal impairment may be due to the reported antioxidant potential of the UMP meal as has been reported in diabetic subjects (Eleazu and Okafor, 2012).

In conclusion this study suggests that unripe *Musa paradisiaca* fruit diet ameliorates iron-induced renal impairment. Dietary concentrations at 40% and 80% seem to have the higher efficacy in ameliorating iron induced-renal impairment than lower concentrations

REFERENCES

Abd Allah, E.S.H., Ahmed, M.A., Abdel Mola, A.F. (2014): Comparative study of the effect of verapamil and vitamin D on iron overload-induced oxidative stress and cardiac structural changes in adult male rats. Pathophysiology, 21: 293–300

Alabi, A.S., Omotoso, G.O., Enaibe, B.U., Akinola, O.B., Tagoe, C.N.B. (2013): Beneficial effects of low dose *Musa paradisiaca* on the semen quality of male Wistar rats. Nigerian Medical Journal, 54(2): 92- 95.

Bartels, H., Böhmer, M. (1973): A kinetic method for measurement of creatinine in serum. Das Medizinische Laboratorium. 26(9): 209-15.

Cachofeiro, V., Goicochea, M., de Vinuesa, S.G., Oubiña, P., Lahera, V., Luño, J. (2008): Oxidative stress and inflammation, a link between chronic kidney disease and cardiovascular disease. Kidney International Supplements, 111: S4-9. doi: 10.1038/ki.2008.516.

Corbett, J.V. (2008): Laboratory tests and diagnostic procedures with nursing diagnoses; 7th Edition, 90–107.

Crichton, R.R., Wilmet, S., Legssyer, R., Ward, R.J. (2002): Molecular and cellular mechanisms of iron homeostasis and toxicity in mammalian cells. Journal of Inorganic Biochemistry. 91: 9–18.

Ebina Yoshihito, Okada Shigeru, Hamazaki Shuji, Ogino Fumio, Li Jia-li, Midorikawa Osamu. (1986): Nephrotoxicity and Renal Cell Carcinoma After Use of Iron- and Aluminum-Nitrilotriacetate Complexes in Rats. Journal of the National Cancer Institute, 76 (1): 107–113.

Eleazu, C.O, Okafor, P.N. (2012): Antioxidant effect of unripe plantain (*Musa paradisiaca* e) on oxidative stress in alloxan-induced diabetic rabbits. International Journal of Medicine and Biomedical Research 1(3): 232 – 241.

Fasola, F.A., Anetor, J.I., Ilesanmi, O.S. (2013): An investigation of the prevalence of iron overload in Nigerian women. African Journal of Medicine and Medical Sciences. 42(3): 231-7.

Ghani, A. (2003): Medicinal Plants of Bangladesh: Chemical Constituents and Uses. 2nd Ed. The Asiatic Society of Bangladesh, Dhaka, Bangladesh, 315.

Gowda, S., Desai, P.B., Kulkarni, S.S., Hull, V.V., Math, A.A.K., Vernekar, S.N. (2010). Markers of renal function

tests. North American Journal of Medical Sciences. 2010;2(4):170-173.

Ige, A.O., Ojekunle, A.O., Olaoye, M. O., Adewoye, E.O. (2017). Unripe *Musa paradisiaca* Fruit Diet Ameliorates Impaired Glucose Regulation Caused by Iron-Induced Oxidative Stress. Afr. J. Biomed. Res. 20(3) 301- 308.

Imam, M.Z., Akter, S. (2011). *Musa paradisiaca* L. and *Musa sapientum* L: A phytochemical and pharmacological review. Journal of Applied Pharmaceutical Sciences, 1:14–20. Kirtikar, K.R., Basu, B.D. (1991). *Musa paradisiaca* in Indian medicinal plant. Vol 4. Delhi: Rexiodical Experts Book Agency.

Mitchell, H.R., Kline, W. (2006). Core curriculum in nephrology, Renal Function Testing. American Journal of Kidney Disease, 47:174–183.

National Research Council (1996). Guide for the Care and Use of Laboratory Animals, National Academy Press, Washington, DC.

Outten, F.W., Theil, E.C. (2009): Iron-based redox switches in biology. Antioxidants and Redox Signaling. 11(5):1029-46. doi: 10.1089/ARS.2008.2296.

Wang, J., Pantopoulos, K. (2011): Regulation of cellular iron metabolism. Biochemical Journal, 434(3): 365-81. doi: 10.1042/BJ20101825.

.