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Research Article

Effects of Ethanolic Extracts of *Phoenix dactylifera* Fruit, *Cyperus esculentus* Nut and *Cocos nucifera* Nut on Selected Indices of Kidney Function in Male Albino Rats

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Abstract

Background and Objective: *Phoenix dactylifera* fruit, *Cyperus esculentus* nut and *Cocos nucifera* nut are widely consumed as food in many parts of the world and are also the major ingredients in the preparation of certain drinks. This study examined the effects of ethanolic extracts of *Phoenix dactylifera* fruit, *Cyperus esculentus* nut and *Cocos nucifera* nut on selected indices of kidney function in male albino rats. **Materials and Methods:** Twenty male albino rats used in this study were distributed randomly into four groups with five rats in each group. Group 1 served as normal control, while groups 2, 3 and 4 served as test animals. The corresponding plant extracts were administered to the animals in the test groups through oral route for three weeks. Thereafter, they were starved overnight, anaesthetized with chloroform and sacrificed. Blood samples and kidneys were collected from the animals for biochemical and histological analysis respectively. **Results:** The results showed that urea decreased in all the groups compared to the control. Urea decreased significantly ($p < 0.05$) in group 3 and 4, but decreased less-significantly ($p > 0.05$) in group 2 compare to the control. Creatinine decreased less-significantly in group 2 and increased less-significantly in group 3 ($p > 0.05$), but increased significantly in group 4 ($p < 0.05$). Sodium, potassium and chlorides increased less-significantly ($p > 0.05$) in all the test groups compared to the control. Sodium increased highest in group 2, potassium increased highest in group 3, while chlorides increased highest in group 4. The histoarchitectural states of the kidney sections showed that the extracts have no apparent toxic effects. However, there were some evidence of mildly altered parts of some kidney tissues. **Conclusion:** The results of this study showed the extracts have no apparent toxic effect on kidney function of the experimental rats. The results also showed the plant extracts may help to reduce the retention of urea, thereby supporting kidney functions. The three plant materials are therefore encouraged for use in general nutrition.

Key words: *Cocos nucifera*, *Cyperus esculentus*, herbal medicine, kidney, kunu, *Phoenix dactylifera*

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Many plant materials are commonly used in nutrition for many reasons. Some of these plant parts (especially, some fruits and nuts) are usually consumed in their raw or fresh form. Some are processed into various forms before being used as food. Some of these plant parts may play certain roles by improving the human immune system as well as in the treatment and management of certain diseases.

Phoenix dactylifera L. belongs to Arecaceae family and is commonly known as Date palm. It grows in many parts of the world. The fruit contains a single seed. Al-Harrasi *et al.*¹ and Hazzouri *et al.*² reported that it grows in Africa, South America, Australia, Mexico and parts of the United States. In Nigeria, it is called "dabino". The fruit is oval in shape and sweet. It is often used as an energy booster. It is believed that the fruit possess many medicinal properties and also a good aphrodisiac. The fruits may be eaten alone or in conjunction with other food materials. The fruit has been reported to possess adequate nutritional value and to also be a good source of vitamin B complex³. Al-Alawi *et al.*⁴ has reported the therapeutic properties of date fruits, such as antioxidant, antifungal, antibacterial and anti-proliferative.

Cyperus esculentus L. belongs to cyperaceae family that produces rhizomes. The nut which is usually spherical is commonly known as tiger nut which is an edible tuber crop⁵. Tiger nut is used widely in some parts of the world for human and other animal consumption^{6,7}. It grows freely and is usually cultivated in northern Nigeria. The Igbos in Nigeria call it "Aki Hausa", the Hausas call it "Aya" while the Yorubas call it "Ofio." The fresh nut which is often yellow/milky colour may be processed into a dried form which is usually brownish. Ezeonu *et al.*⁸ reported that the nuts can be processed into flavouring agent, milk, yoghurt and other forms of drink.

Cocos nucifera belongs to Arecaceae family commonly cultivated in many parts of the world. It is commonly known as coconut. In Nigeria, it is called "Aki Oyibo" or "Aki bekee" in Igbo, "Kwakwa" in Hausa and "Agbon" in Yoruba⁹. The nut, which some people refer to as the seed has been reported by Imo *et al.*⁹ to be usually eaten in its raw form and most times consumed alongside other food materials such as date fruit, maize and cassava chips, among others. It is used as food and believed to possess some medicinal properties. It is also commonly used with tiger nut and date fruit for preparing "Kunun aya" which is a popular drink consumed in Nigeria (especially, northern Nigeria). This drink (Kunun aya) is

believed to serve as food and also as a sexual fertility booster⁹. *Cocos nucifera* nut is believed to have low toxicity, but many potential nutritional, medicinal and pharmaceutical uses. The fruit contains fluid usually referred to as coconut water. Imo *et al.*⁹ evaluated the proximate, mineral and phytochemical composition of *Cocos nucifera* nut and established that coconut is a good source of energy and may play some immunological, nutritional, physiological and pharmacological roles. In traditional medicine, coconut (especially, the coconut water) is believed to be an effective agent for treating some conditions such as poisoning, stomach and kidney problems.

The aim of this study was to examine the effects of ethanolic extracts of *Phoenix dactylifera* fruit, *Cyperus esculentus* nut and *Cocos nucifera* nut on selected indices of kidney function in male albino rats. This study is important because *Phoenix dactylifera* fruit, *Cyperus esculentus* nut and *Cocos nucifera* nut are widely eaten in their raw forms as food in many parts of the world and also used in preparation of different drinks such as "Kunun aya" consumed widely in northern Nigeria. There is no relevant data on the comparative effects of ethanolic extracts of these three plant materials on kidney function of the consumers. It is important that data or research findings on the effects of the extracts of these plant materials on kidney function should be established. Therefore, the investigation of the effects of ethanolic extracts of *Phoenix dactylifera* fruit, *Cyperus esculentus* nut and *Cocos nucifera* nut on selected indices of kidney function in male albino rats will reveal the possible effects of the plant materials on kidney function of the consumers. This therefore warrants research into the present study in order to bridge this existing gap in literature.

MATERIALS AND METHODS

Plant materials and extraction: *Phoenix dactylifera* fruit, *Cyperus esculentus* nut and *Cocos nucifera* nut were purchased in Wukari, Taraba State, Nigeria. The different plant materials were properly identified at Biological Science Department, Federal University Wukari, Taraba State, Nigeria. The three plant materials were properly cleaned and the healthy parts selected. They were sun-dried and pulverized to powder with the use of a laboratory blender. The powder of each sample was macerated in 70% ethanol with occasional shaking for 2 days, thereafter filtered. Rotary evaporator was used to concentrate the filtrates and the extracts re-dissolved in normal saline for the experiment.

Experimental animals: Twenty healthy male albino rats aged eight weeks were used. The rats weighed between 91-120 g. They were purchased from Department of Animal Production, National Veterinary Research Institute (NVRI) Vom, Plateau State, Nigeria and transferred to the animal house, Department of Biochemistry, Federal University Wukari, Taraba State, Nigeria. The albino rats were allowed to acclimatize for 2 weeks before being used for the experiment. All the rats were allowed free access to water and feed *ad libitum* throughout the period of the experiment. Standard laboratory protocols for animal studies were maintained as approved by the Faculty of Pure and Applied Sciences, Federal University Wukari, Nigeria.

Experimental design: The albino rats were distributed randomly into four groups. Five animals were placed in each group. Group 1 served as normal control, while groups 2, 3 and 4 served as test animals. Group 1 animals were administered a placebo of normal saline. Group 2 animals were administered ethanolic extract of *Phoenix dactylifera* fruit (200 mg kg⁻¹ b.wt.); group 3 animals were administered ethanolic extract of *Cyperus esculentus* nut (200 mg kg⁻¹ b.wt.), while group 4 animals were administered ethanolic extract of *Cocos nucifera* nut (200 mg kg⁻¹ body weight). The extracts were administered to the animals through oral route for 3 weeks (21 days).

Blood collection: After the 21 days administration of the extracts to the experimental animals, they were starved overnight, anaesthetized with chloroform and sacrificed. Blood samples were collected from the animals through cardiac puncture, dispensed into cleaned plain sample tubes and allowed to clot for about 15 min and centrifuged at 4000 rpm for 10 min. Serum was separated from the clot with pasteur pipette and dispensed into clean tube for the measurement of the selected biochemical indices of kidney function.

Biochemical and histological analysis: Analysis of the selected serum biochemical indices of kidney function were carried out on each sample. The concentrations of creatinine, urea, potassium, chlorides and sodium were determined with

the use of an auto-analyzer (Cobas C111 Chemistry analyzer). After the animal sacrifice, the kidneys of animals in all the groups were harvested and examined histologically (Stain: Haematoxylin and Eosin). Photomicrographs of all the rat's kidney sections were taken and examined.

Statistical analysis: The serum biochemical results were analyzed statistically with the use of one-way analysis of variance (ANOVA) and further with Duncan Multiple Comparisons using Statistical Package for Social Sciences (SPSS) version 21. The means were compared for significance at $p \leq 0.05$ and the group results were presented as Mean \pm SD (n = 5).

RESULTS AND DISCUSSION

Urea decreased in all the test groups compared to the control. Urea decreased significantly ($p < 0.05$) in groups 3 and 4, but decreased less-significantly ($p > 0.05$) in group 2 compared to the control. Creatinine decreased less-significantly in group 2 and increased less-significantly in group 3 ($p > 0.05$), but increased significantly in group 4 ($p < 0.05$).

One of the functions of kidneys is to maintain homeostasis in animal body system¹⁰. This ensures the proper excretion of certain metabolic waste materials and also the reabsorption of selected useful materials by the kidneys. Creatinine is used as one of the parameters or indices for ascertaining the status of kidney function in an animal. It is a metabolic waste product of creatine phosphate metabolism which is excreted by the kidneys. In the body, creatinine is often produced at a fairly constant rate¹¹. Creatine is produced in the liver before its distribution into circulation.

When creatinine and urea are retained in the blood, it showed a possible impairment of the kidneys^{12,10}. The results of this study (Table 1) showed that creatinine was properly excreted in the test animals administered ethanolic extracts of *Phoenix dactylifera* fruit and non significantly retained in the rats administered ethanolic extract of *Cyperus esculentus* nut. Creatinine was significantly retained in the rats administered ethanolic extract of *Cocos nucifera* nut compared with the

Table 1: Concentrations of urea and creatinine in rats administered ethanolic extracts of *Phoenix dactylifera* fruit, *Cyperus esculentus* nut and *Cocos nucifera* nut

Parameters	Group 1 (Normal control)	Group 2 (<i>Phoenix dactylifera</i> fruit 200 mg kg ⁻¹ b.wt.)	Group 3 (<i>Cyperus esculentus</i> nut 200 mg kg ⁻¹ b.wt.)	Group 4 (<i>Cocos nucifera</i> nut 200 mg kg ⁻¹ b.wt.)
Urea (mmol L ⁻¹)	4.77 \pm 0.26 ^a	4.15 \pm 0.23 ^{ab}	2.88 \pm 0.07 ^c	3.97 \pm 0.58 ^b
Creatinine (μ mol L ⁻¹)	18.33 \pm 0.25 ^{ab}	17.33 \pm 1.31 ^a	18.77 \pm 1.25 ^{ab}	20.97 \pm 2.49 ^b

Results represent mean \pm standard deviation of group serum results obtained (n = 5). Mean in the same row, having different letters of the alphabet are statistically significant ($p < 0.05$)

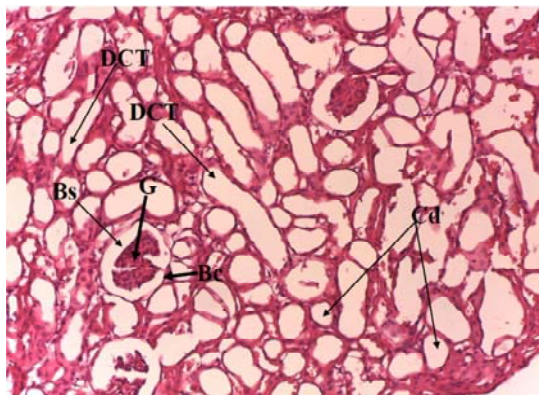


Fig. 1: Photomicrograph of kidney section from rat in group 1 (normal control) showing the normal histoarchitecture of the renal tissue

G: The normal glomerulus, Cd: collecting ducts, Bs: Bowman's space, Bc: Bowman's capsule and DCT: Distal convoluted tubule

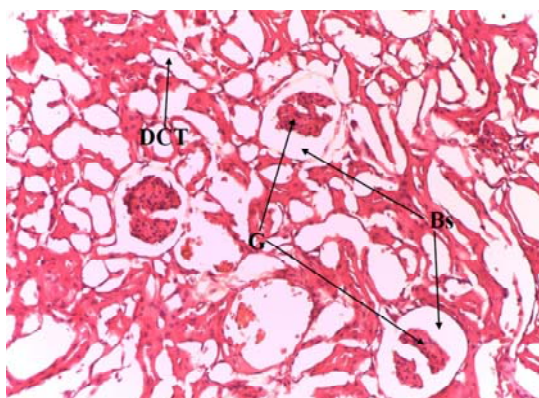


Fig. 2: Photomicrograph of kidney section from rat administered ethanolic extract of *Phoenix dactylifera* fruit (200 mg kg⁻¹ b.wt.) showing some mildly enlarged urinary spaces

Bs: Bowman's space and G: some normal glomeruli

creatinine level of the control animals. This shows that the extracts of *Phoenix dactylifera* fruit and *Cyperus esculentus* nut may not interfere negatively with creatinine elimination from the body system, an indication that they support kidney function. The result also shows that *Cocos nucifera* nut extract may interfere negatively with the process of creatinine clearance in the body if administered for the period of time used in this study.

The results of this study showed that urea was not retained in the test animals administered the ethanolic extracts of *Phoenix dactylifera* fruit, *Cyperus esculentus* nut and *Cocos nucifera* nut compared with the urea level of the control animals. Urea level was significantly lowered in the

groups administered the extracts of *Cyperus esculentus* nut and *Cocos nucifera* nut, but was less-significantly lowered in the animals administered *Dactylifera* fruit extract. Imo and Uhegbu¹¹ reported that renal diseases that reduce glomerular filtration may result to retention of urea. Ahmad and Gautam¹³ reported that increase in blood urea level result from inability of impaired kidney to filter urea up to the normal level. The evident reduction in the concentration of urea in all the test animals shows that urea was adequately excreted. Therefore, none of the three plant extracts showed negative interference with elimination of urea. This showed the three plant extracts supports proper glomeruli filtration rate. The Photomicrograph of kidney sections (Fig. 1-4) from rats administered the different plant extracts compared to the control support this biochemical result.

Sodium, potassium and chlorides increased less-significantly ($p > 0.05$) in all the test groups compared to the control. Sodium increased highest in group 2, potassium increased highest in group 3, while chlorides increased highest in group 4.

The balance of electrolytes in the blood could show the possibility of proper regulation of homeostasis. Electrolytes balance in the blood may be used in accessing the healthy functioning of the heart, liver and kidneys. Crook¹⁴ reported that abnormal level of serum electrolytes is believed to be indicative of impaired kidney function. Sodium is associated with blood pressure. A reduction in the level of sodium intake lowers the blood pressure. Chloride is an important electrolyte in the maintenance of the anion/cation balance between the extra-cellular and intra-cellular fluids. Chloride is important for the control of proper hydration, osmotic pressure and acid/base equilibrium¹⁰. Potassium is an electrolyte in the intra-cellular fluid and one of the protective electrolytes against hypertension¹⁵.

The results of this study (Table 2) showed that the level of serum sodium, potassium and chlorides were not significantly altered in all animals administered the ethanolic extracts of the plant materials. Mineral elements are essential for the proper functioning of human immune system and for sustaining life¹⁶. Impaired neuromuscular functions have been reported to result from potassium deficiency¹⁷. In this study, the level of all the selected electrolytes increased less-significantly in all the groups administered the three different plant extracts. The result showed that electrolytes balance or homeostasis may not be negatively altered by consumption of the plant materials. The increase observed in the levels of the electrolytes in animals administered the plant extracts and the mildly enlarged urinary spaces in some kidney tissues (Fig. 2, 3) supported the believe that the plant materials may possess diuretic properties.

Table 2: Concentrations of selected electrolytes (mmol L⁻¹) in rats administered ethanolic extracts of *Phoenix dactylifera* fruit, *Cyperus esculentus* nut and *Cocos nucifera* nut

Parameters	Group 1 (Normal control)	Group 2 (<i>Phoenix dactylifera</i> fruit 200 mg kg ⁻¹ b.wt.)	Group 3 (<i>Cyperus esculentus</i> nut 200 mg kg ⁻¹ b.wt.)	Group 4 (<i>Cocos nucifera</i> nut 200 mg kg ⁻¹ b.wt.)
Sodium	102.47±3.37 ^a	108.57±3.35 ^a	106.97±5.44 ^a	106.80±5.67 ^a
Potassium	9.84±1.25 ^a	10.83±2.37 ^a	11.02±0.53 ^a	10.73±0.91 ^a
Chlorides	78.37±4.91 ^a	82.90±3.06 ^a	82.17±4.59 ^a	83.13±4.35 ^a

Results represent mean ± standard deviation of group serum results obtained (n = 5). All mean in the same row are statistically non significant (p>0.05)

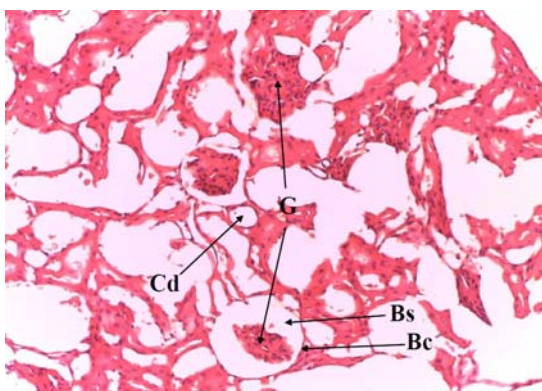


Fig. 3: Photomicrograph of kidney section from rat administered ethanolic extract of *Cyperus esculentus* nut (200 mg kg⁻¹ b.wt.) showing a mildly shrunken glomeruli (G) and a slightly increased urinary space (Bowman's space (Bs)). Normal collecting ducts (Cd) are evident

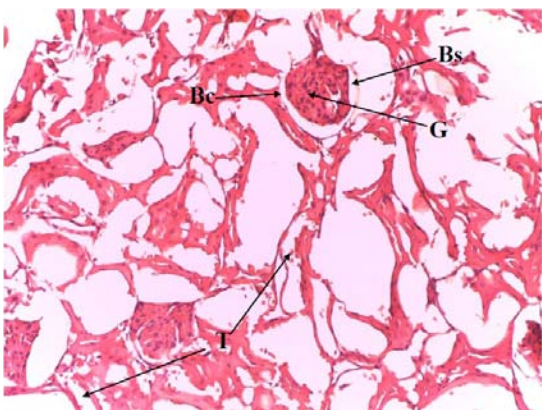


Fig. 4: Photomicrograph of kidney section from rat administered ethanolic extract of *Cocos nucifera* nut (200 mg kg⁻¹ b.wt.) showing an evidence of slightly enlarged glomerulus (G). Some tubules, Bowman's capsule and Bowman's space appeared normal

Saafi *et al.*¹⁸ in their research indicated that *in vivo* date palm fruit extract may be useful for the prevention of oxidative stress induced hepatotoxicity. The phenolics of date palm has been reported to have chemopreventive effects against

Dimethylbenz(A)Anthracene (DMBA)-induced mammary cancer¹⁹. This current study results showed that ethanolic extract of date palm may have renal-protective effect. In another study, a significant reduction in urea, creatinine, potassium and sodium following the administration of coconut water was reported by Nwangwa²⁰. It also reported that the renal cyto-architecture of diabetic rats showed a protective/regenerative effect following treatment with coconut water. This agrees with some of the findings of this current study, since there was no significant adverse effect of ethanolic extract of *Cocos nucifera* nut on kidney function of the male albino rats.

The current study is also in line with the report of Hassan²¹ who reported that the results of serum sodium and potassium concentrations showed non significant change in male albino rats that received tiger nut oil supplementation diet. The supplementation with this oil has benefits and safety. Oguwike *et al.*²² also reported that the consumption of tiger nut by male hypercholesterolemic subjects showed no adverse effects on Hb concentration, PCV, platelet count, WBC count and liver function. Olabiyi *et al.*²³ evaluated the enhancing effect of dietary supplementation of tiger nut on erectile function in normal male rats. The rats with supplemented diet containing tiger nut showed significantly increased sexual behavior, hormone levels and antioxidant activities. This reported antioxidant activity of tiger nut may contribute to the support of the kidney function of ethanolic extract of *Cyperus esculentus* nut exhibited in this current study.

CONCLUSION

The results of this study showed that the ethanolic extracts of *Phoenix dactylifera* fruit, *Cyperus esculentus* nut and *Cocos nucifera* nut have no apparent toxic effect on the selected kidney function indices of the experimental rats. The results also showed that the plant extracts may help reduce the retention of urea, thereby supporting kidney functions. The histoarchitectural states of the kidney sections supports the biochemical result showing no apparent toxic effects of the extracts. However, there were some evidence of mildly altered parts of the kidney tissues. The use of the three plant materials are encouraged in general nutrition.

SIGNIFICANCE STATEMENT

Phoenix dactylifera fruit, *Cyperus esculentus* nut and *Cocos nucifera* nut are widely consumed as food in many parts of the world and are also the major ingredients in the preparation of certain drinks such as the nutritious drink in Nigeria known as "Kunun aya." The investigation of the effects of ethanolic extracts of *Phoenix dactylifera* fruit, *Cyperus esculentus* nut and *Cocos nucifera* nut on selected indices of kidney function in male albino rats will reveal the possible selected biochemical and kidney histological effects of the different plant parts. It will also suggest if the regular use of the plant parts in nutrition may pose any adverse kidney effect in animal health system.

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