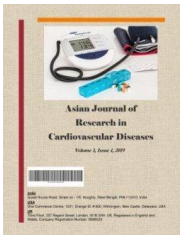

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Antihypertensive Potential of Coconut (*Cocos nucifera* L.) Water in Wistar Rats

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Authors' contributions

This work was carried out in collaboration among all authors. Author AIA conceptualized and designed the study and also wrote the manuscript. Author ACN managed the analyses of the study. Author KON managed the literature searches. Author JAE wrote the protocol while author AUM performed the statistical analysis. All authors read and approved the final manuscript.

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ABSTRACT

Background: Hypertension has become a common sickness in Nigeria especially among population above 50 years of age. It constitutes a major riskfactor for several cardiovascular diseases suchas atherosclerosis, heart failure, renal insufficiency, coronary artery disease and stroke.
Aim: This study was aimed at evaluating the antihypertensive potential of coconut water in Wistar rats.
Materials and Methods: Thirty Wistar rats were divided into three groups of ten each. Rats in groups 1 and 2 received aspecial prepared egg feed diet (24 egg yolkmixed with 1 kg of normal rat diet) while those in group 3 received normal feed diet and they served as the control group. Animals in group 2 were administered 3 mL/100 g bodyweight of undiluted coconut water simultaneously

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with the feeding. The animals were fed orally for 21 consecutive days and had access to drinking water *ad libitum*. Blood pressure of each of these groups was determined at day 0, 7, 14 and 21 respectively using standard methods.

Results: A significant increase was observed in the blood pressure of animals fed with egg formulated diet without coconut water treatment when compared with those fed with egg formulated diet and treated with coconut water and control group respectively at $P<0.05$. However, this effect was not significant when animals fed with egg formulated diet and treated with coconut water were compared with those in the control group.

Conclusion: The nonsignificant difference observed in the blood pressure of animals fed with egg yolk formulated-diet and treated simultaneously with coconut water when compared with those in the control group showed that coconut water possesses antihypertensive potential.

Keywords: Antihypertensive potential; blood pressure; coconut water; egg yolk.

1. INTRODUCTION

Hypertension is defined as the persistent elevation of systolic/diastolic blood pressure over 140/90 mmHg. It is a major risk factor for developing cardiovascular diseases [1]. Although no definite cause is apparent in the majority of hypertension cases (i.e. idiopathic hypertension), several underlying pathologies such as hyperactivity of the renin angiotensin system (RAS), inflammation, oxidative stress and impaired vascular relaxation, can contribute to its onset and long-term persistence [2,3]. Although various pharmaceutical drugs are available for the treatment of hypertension, management of hypertension often requires lifelong adherence to the medication and is associated with significant adverse side-effects [4]. Thus, there has been a growing interest in using alternative options, such as the adoption of a healthy lifestyle with restricted energy and dietary sodium intake, engagement in physical activities and stopping smoking, for prevention and management of hypertension [5,6].

Blood pressure is regulated through several mechanisms including modification of angiotensin-converting enzyme (ACE) activity and vascular function as well as changes in oxidative status [7]. Antioxidants may decrease blood pressure through decreasing oxidative stress in the body thus preserving the activity of nitric oxide synthase (NOS) as well as increasing nitric oxide (NO) bioavailability. Moreover, the potential interrelations between blood pressure and plasma lipids may contribute to increased coronary heart disease in hypertensive patients [8].

Coconut belongs to the family of *Arecaceae*, an important member of monocotyledons. It is botanically known as *Cocos nucifera* [9]. Around the world, coconut fruit products have been used in popular medicine for the treatment of various diseases, such as arthritis and diarrhea [10]. Studies carried out with the coconut husk fibre have proven its antiproliferative activity against lymphocytes [11] and also determined its analgesic and antioxidant activities [12]. In Nigeria, coconut is known by different names, viz: 'Agbon' in Yoruba, 'Aku-beke' in Ibo, 'Mosara' in Hausa and 'Ukpu' in Uzebba (Edo State).

Fig. 1. Coconut and its water [20]

Coconut water (CW), the liquid endosperm obtained from immature coconuts, in its natural form is a refreshing and nutritious beverage, widely consumed around the world due to its beneficial health properties [13]. Moreover, coconut water plays an important alternative role for oral rehydration and even for intravenous hydration of patients in remote regions [14] in addition to protecting against the induction of myocardial infarction [15]. Antioxidant activities of polyphenolics derived from plants have claimed beneficial health functions for retarding ageing and preventing cancer and cardiovascular diseases [16]. Moreover, the presence of ascorbic acid in the natural CW was correlated

with antioxidant properties [17]. A previous study confirmed the presence of caffeic acid in the coconut oil from the copra [18]. Chakraborty and Mitra [19], proved the existence of chlorogenic, caffeoylshikimic and dicaffeoylquinic acids, three caffeic acid derivatives, in the methanolic extract of young, mature and old coconut mesocarp. Airaodion et al. [20] have reported that the consumption of coconut water impacts positively on male fertility of Wistar rats. This present study is aimed at evaluating the antihypertensive potential of coconut water in Wistar rats.

2. MATERIALS AND METHODS

2.1 Collection of Coconut Water

Coconuts of 7 to 8 months of age were harvested from the coconut trees grown Apata area of Ibadan in Oyo State, Nigeria. The coconuts were dehusked, broken carefully and the liquid endosperm (coconut water) was collected and was used in the experiment.

2.2 Experimental Design and Animal Treatment

Thirty Wistar rats weighing between 200 and 220 g were used for the experiment. They were acclimatized for seven (7) days during which they were fed *ad libitum* with standard feed and drinking water and were housed in clean cages placed in well-ventilated housing conditions (under humid tropical conditions) throughout the experiment. All the animals received humane care according to the criteria outlined in the 'Guide for the Care and Use of Laboratory Animals' prepared by the National Academy of Science and published by the National Institute of Health. They were randomly divided into three groups of ten rats each. Animals in groups 1 and 2 received aspecially prepared egg feed diet (24 egg yolkmixed with 1 kg of normal rat diet) while those in group 3 received normal feed diet and they served as the control group. Animals in group 2 were administered 3mL/100g bodyweight of undiluted coconut water simultaneously with the feeding as recommended by Nnodim et al. [21]. The egg yolk formulated-diet has been reported to cause high blood pressure [22]. The animals were fed orally for 21 consecutive days and had access to drinking water *ad libitum*. Blood pressureof each of these groups wasdetermined at day 0, 7, 14 and 21 respectively.

2.3 Determination of Blood Pressure

Blood pressure was determined from the tails ofrats using non-invasive bloodpressure (NIBP) measuring apparatus (IN125, AD Instruments, Sydney, Australia) according to the method described by Airaodion et al. [22]. Each ratwas placed in NIBP restrainer and appropriatecuff with the sensor was then mounted on its tail andwarmed to about 33–35°C. The tail cuff (MLT125/R) was inflated to a pressure well above theexpected systolic blood pressure, i.e., 200 mmHg and slowly released during which the pulseswere recorded by using Power Lab dataacquisition system and a computer running LabChart 5.0 software (Ad Instruments, Sydney, Australia). Systolic blood pressure (SBP), Meanblood pressure (MBP) and heart rate weremeasured directly using pulse tracing whilediastolic blood pressure (DBP) was calculated from SBP and MBP as:

$$\text{DBP} = \frac{3\text{MBP}-\text{SBP}}{2}$$

2.4 Statistical Analysis

Data were subjected to analysis of variance using Graph Pad Prism. Results were presented as Mean ± standard deviation. One way analysis of variance (ANOVA) was used for comparison of the means followed by Tukey's (HSD) multiple comparison tests. Differences between means were considered to be significant at $p<0.05$.

3. RESULTS

The results of the effect of coconut water on blood pressure are presented in Figs. 2-5.

4. DISCUSSION

High blood pressure is a reliable indicator of premature death [23]. It is a risk factor for stroke, coronary heart disease and renal vascular disease. The control of blood pressure through diet has been the focal point of public health and mass media attention. The method in practice to control high blood pressure is "long-term" drug therapy. Drugs have side effects that can create more clinical problems than are solved [24,25]. That is why medical professionals worldwide are seeking non-drug treatment and preventative strategies.

The significant increase observed in the blood pressure of animals fed with egg feed diet without treatment with coconut water showed

that egg yolk caused high blood pressure [22]. This is in agreement with the report of Alamgeer et al. [26] who reported the antihypertensive activity of aqueous-methanol extract of *Berberis orthobotrys* Bien Ex Aitch in rats. Egg yolk has been reported to contain high cholesterol concentration [22,27]. Cholesterol rich diets have beenlinked to dyslipidemia which is considered amajor risk factor for hypertension [19,28]. This might be responsible for the sustained increase in blood pressure of animals fed with egg yolk diet without treatment with coconut water. This is also consistent with the reports of Airaodion et al. [22] and Spence et al. [27].

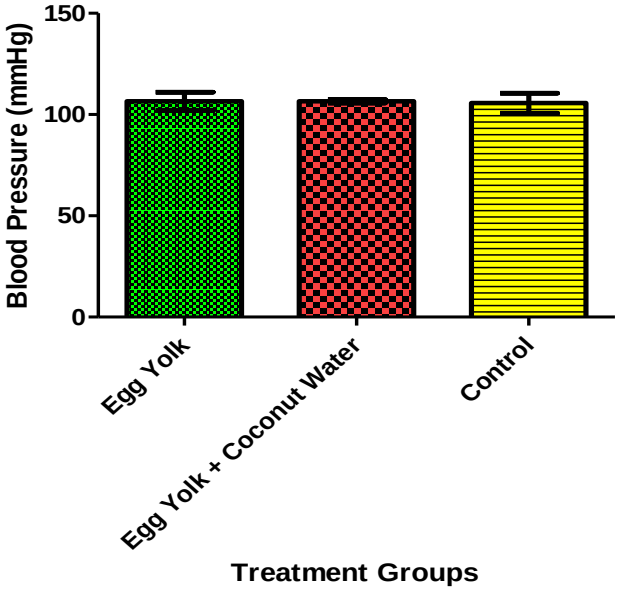

Fig. 2. Blood pressure of animals prior to treatment
Results are statistically significant at P<0.05

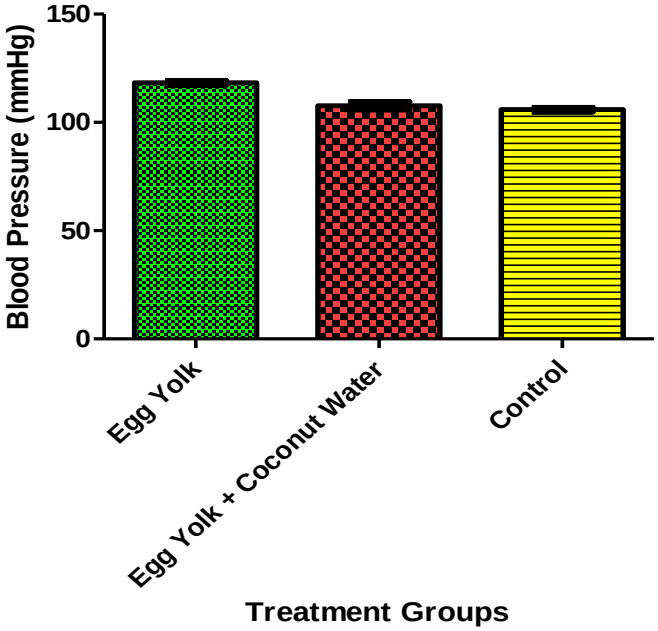

Fig. 3. Effect of coconut water on blood pressure of animals after 7 days of treatment
Results are statistically significant at P<0.05

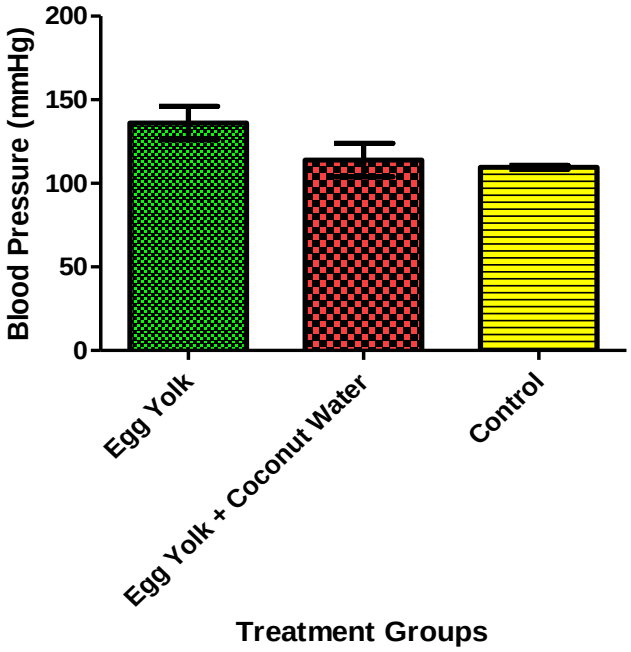

Fig. 4. Effect of coconut water on blood pressure of animals after 14 days of treatment
Results are statistically significant at P<0.05

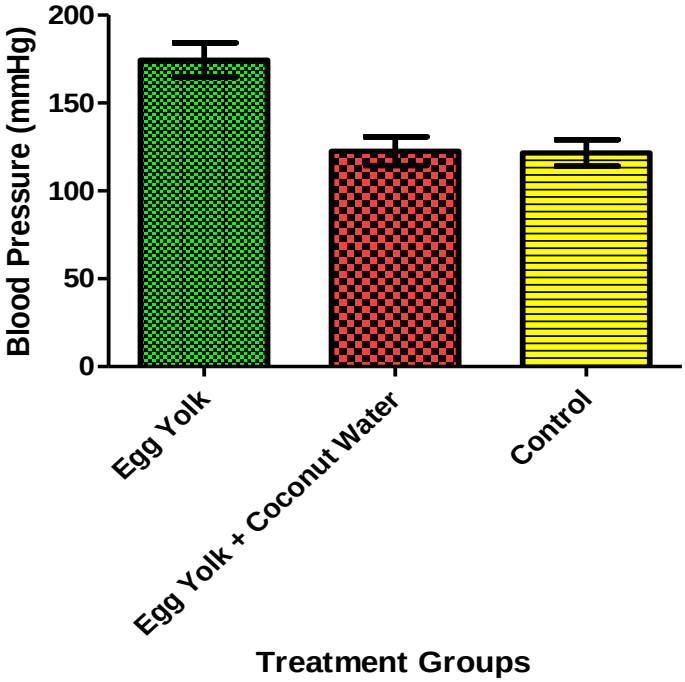

Fig. 5. Effect of coconut water on blood pressure of animals after 21 days of treatment
Results are statistically significant at P<0.05

It is interesting to note that the blood pressure of animals fed with egg yolk formulated diet and treated with coconut water is not significantly different from those of the control groups despite being fed with egg yolk formulated diet (Figs. 2-5). A significant decrease was observed in the blood pressure of animals fed with egg yolk formulated-diet and treated with coconut water when compared with those fed with the same diet but untreated with coconut water at

P<0.05. This is similar to the findings of Airaodion et al. [29] who treated animals with garlic juice. Coconut water has been reported to have enormous health benefits since it contains electrolyte, vitamins, sugar, protein, antioxidants, minerals, cytokinins and dietary fibre [20]. Actually, it is fat-free and has zero cholesterol. It has antiviral and antibacterial properties, helps to lose weight, very beneficial to a person with kidney stones due to its minerals, potassium and magnesium content [20]. The potassium causes vasodilatation and also improves the endothelial function. The magnesium has vasodilator property and also inhibits both the production of nitric oxide and contraction of vascular smooth muscle walls of arteries. Calcium and Vitamin C are also hypotensive. L-Arginine, a physiological substrate for the production of endothelium derived relaxing factor, nitric oxide (NO), which plays an important role in the regulation of vascular tone and homeostasis which is impaired in hypertension [30].

Potassium is the most important ion in the living cell, affecting almost every cellular function. Potassium is a fundamental factor in blood pressure regulation [31]. Increasing potassium intake has beneficial effects on human health. A high potassium diet lowers blood pressure in individuals with both raised blood pressure and average population blood pressure. Increasing potassium intake reduces cardiovascular disease mortality. This is mainly attributable to the blood pressure-lowering effect and may also be partial because of the direct effects of potassium on the cardiovascular system [32]. The antihypertensive potential of coconut water observed in this study might be due to its high content of potassium.

5. CONCLUSION

The nonsignificant difference observed in the blood pressure of animals fed with egg yolk formulated-diet and treated simultaneously with coconut water showed that coconut water possesses antihypertensive potential.

CONSENT

It is not applicable.

ETHICAL APPROVAL

Animal ethic Committee approval has been collected and preserved by the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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