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Short Communication

Basal metabolic regulatory responses and rhythmic activity of mammalian heart to aqueous kola nut extracts

Chukwu, L.O*, Odiete, W. O. and Briggs, L.S.

Aquatic Toxicology and Ecophysiology Laboratory, Department of Marine Sciences, University of Lagos, Akoka, Yaba, Lagos.

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Preliminary investigation on the effect of aqueous extracts of three species of kola nut; *Cola acuminata* (P. Beav), *C. nitida* subsp. *rubra* and *C. nitida* subsp. *alba* (Vent), on the rhythmic activity of mammalian heart and metabolic rate was carried out using male albino rats, *Rattus sp*. Low concentrations of kola nut extract stimulated the heart by increasing rate and force of contraction as well as metabolic rate. Higher concentrations reduced rate and amplitude of beat resulting, at still higher concentrations in heart failure.

Key words: Kolanut, extract, basal metabolic rate, mammalian heart

INTRODUCTION

In West Africa and the Sudan, especially among the muslim population, kola nut are popular masticatory (Russel, 1955). They are important in various social and religions customs and may also be used to counteract hunger and thirst. In Nigeria, for example, the rate consumption of kola nut especially by students is very high as the principal stimulant to keep awake and withstand fatigue (Purgeslove, 1977).

Investigations on the physiological or clinical effect of kola nuts in man or other mammals have not received much attention. The lack of this otherwise important information is probably because it is assumed that the effects of kola nuts will be similar to those of methylxanthines which are also present in them. Somorin (1973) reported that caffeine, theobromine and theophylione found in kola nuts are xanthine stimulants. The effects of the pure xanthines on various mammalian tissues are known (Ritchie, 1975). High concentrations of the pure xanthines in the body result in certain heart disorders. Continual and habitual chewing of kola nuts could lead to the accumulation of methylxanthines and bring about similar heart disorders. The results of this study suggest that the problem is worth investigating.

*Corresponding authors E-mail: obinnalcunilag@yahoo.com.

MATERIALS AND METHODS

Albino rats weighing between 70 and 110 kg obtained from the Animal House of the University of Lagos were used for this study. The rats were all males to avoid any physiological differences that might arise due to sex differences.

Preparations of kola nut extracts

The kola nuts used in the study were *Cola accuminata*, *C. nitida* subsp. *rubra* and *C. nitida* subsp. *alba*. 10 g of each kola were thoroughly ground using mortar and pestle in 50 ml of Ringer-Locke solution. The latter was prepared as described by Perry (1971). The mixture was allowed to stand at room temperature for about 24 h to allow more chemical substances in the homogenized kola to diffuse into the solution and then filtered. The clear brown filtrate was made up to 100 ml with Ringer-Locke solution and stored at –4°C while the heart of the rabbit was being prepared. Subsequently, any known aliquot from the concentrated extract represented a known weight of the kola nut extract.

Effect on rhythmic activity of mammalian heart

A rat heart was isolated and prepared for isotonic recording of its mechanical properties in the manner described by Perry (1971). The aorta was tied on to the cannula in a Langendorf perfusion chamber. The kola nut extracts were injected, with the aid of a hypodermic syringe, through the rubber cap of the cannula into the perfusion fluid. The extracts were added in increasing quantities of 0.2 ml each time. The temperature of the perfusion fluid was main tained throughout the period of investigation at 37°C.

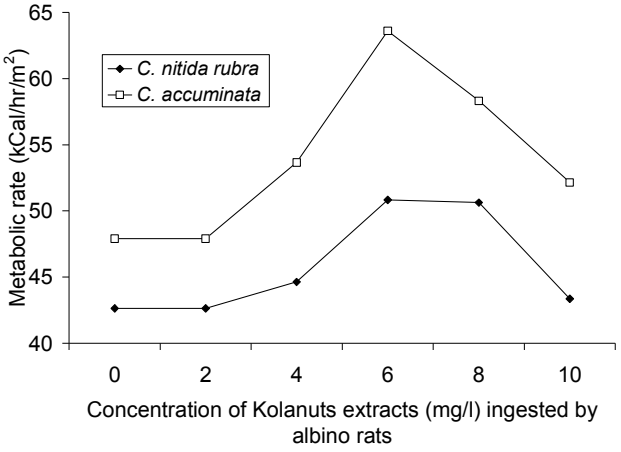

Figure 1. The effect of *C. accuminata* and *C. nitida rubra* extracts on the metabolic rate of male albino rats.

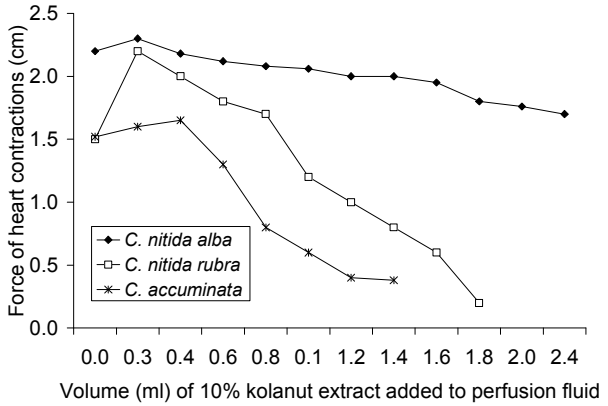

Figure 2. The effecct of *C. accuminata* and *C. nitida* extracts on the force of contraction of male albino rat heart,

Determination of metabolic rate

About sixteen of the albino rats supplied were randomly samplied and placed into four sets (or batches) each containing four rats. These animals were placed in different cages at ambient laboratory conditions (temperature: 27 ± 2°C; relative humidity 79 ± 2%). All the animals were fed on the usual rat marsh (obtained from the Animal House, University of Lagos), with adequate water supplies. In addition, to their normal diet, each set, containing four rats respectively was also fed on either of the kolanut extracts: the first batch of four rats were placed on *C. acuminata* extract, the second batch on *C. nitida rubra* extract, and the third batch were fed only the normal rat marsh and served as control. For each of the extracts, the calculated doses for animals of different body weights were diluted to the following range of concentrations: 2, 4, 8 and 10 mg/ml.

After recording their initial body weight, rats of the extract treated group were fed orally by tube feeding same concentration of extract once a week for five weeks. Each week, the test organisms were fed a higher dosage of extract. After about 15 min following the administration of the calculated dose of extract, the rate of oxygen consumption was determined, hence the metabolic rate was com puted after Eckert and Randall (1983). In addition, the metabolic rate of each of the rat in the batch was always determined a few minutes prior to the application of the extracts, at any given time the exercise was carried out.

The metabolic rate was computed using indirect calorimetry (Eckert and Randall, 1983) from oxygen consumption and heat production calculated as calories per square metre per hour. The rate of oxygen uptake by the animal was measured by a simple respirometer in which a glass container with a graduated pipette and Celsius centigrade thermometer are attached to a rubber bung. Carbon dioxide was absorbed by soda lime. The rate of oxygen uptake was measured by the rate of movement of a film of soap applied at the tip of the graduated pipette, while the soda lime absorbed the carbon dioxide.

Like most animals, rodents are frightened and aroused by sudden movements and sharp noise. Therefore, a calm and quiet atmosphere was maintained during the experiment. Moreso, readings were taken only when the rat was quiet, that is, not moving.

RESULTS

Effect of kola nut extract on metabolic rate

The various species of kola nuts were found to have profound effects on metabolic rate. As the concentration of the extracts was increased, the rate of metabolism also increased up to a certain limit. The increase in basal metabolic rate at high concentrations (8 – 10 mg/l) was smaller than that at lower concentrations.

At low concentrations of *C. nitida rubra* extract (≤4 mg/ml), the rate of metabolism increased slightly by about 4.81%. As the concentrations of the extract increased, further increase in metabolic rate was recorded. At very high concentrations (>8 mg/ml), the metabolic rate increased by 118.76%, and thereafter began to fall (Figure 1).

C. acuminata had similar effects to *C. nitida* rubra except that the magnitude of the variation in rate of metabolism was higher, for example at low concentration of say 4 mg/ml, the percentage increase in metabolism was 112.00% (Figure 1).

Effect of kola nut extract on rhythmic activity of heart

Low concentrations of the kola nut extracts increased the rate of beat and the force of contraction. *C. accuminata* was the most potent and increased the force of contraction by 40 - 60% and rate by 30 - 47%. *C. nitida rubra* increased the force by 13 - 20% and rate by 3%, while *C. nitida alba* increased the rate by 10 - 16% and force by 2%.

As the quantity of the kola nut extracts injected was increased there was corresponding decrease in both of contraction and rate (Figures 2 and 3). The force of heart contraction was always the first to be affected, its decrease occurring before that of the heart rate. At still higher concentrations the force of contraction became so

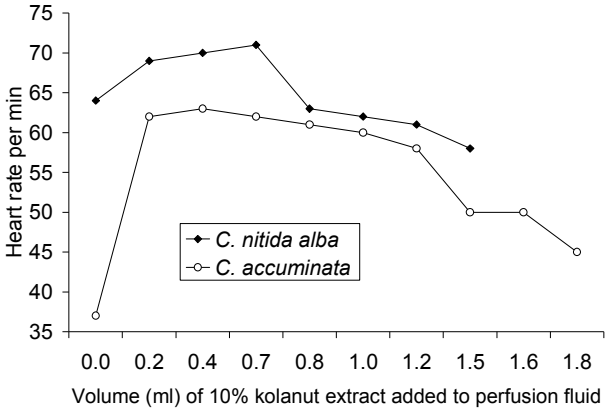

Figure 3. The effect of *C. accuminata* and *C. nitida* extracts on the rate of beat of male albino rats heart.

severely reduced that heart failure resulted. Prior to heart failure the rate was reduced by 60 - 70% and the force (amplitude) by 80 - 90%.

DISCUSSION

From the results of this study, it was found that the species of kola nut investigated were capable of increasing the rate of metabolism at low concentrations. The increase in basal metabolic rate at higher concentrations was smaller than at lower concentrations. The observed decrease is not due to decrease in rate of oxygen consumption. Possible explanation for this is that at higher dosages, the sensation of the extract makes the animal uncomfortable; hence, recording good readings became difficult.

The active chemical constituents of all the species of kola nut include caffeine, glucoside, theobromine and kolatin which are stimulants (Russel, 1955). It has been found that most of the physiological actions of kola are due to caffeine (Eijnatten, 1973.) because the effect of the kola nut extract is similar to that of caffeine, and the latter occur abundantly in kola nut.

The quantity of methylxanthines present in the kola nuts was not determined but Somorin (1973) found that *C. accuminata* contained 0.16l g caffeine per 100 g powdered kola nut. Assuming there was complete methyxanthine extraction then each 1 ml of the filtered kola nut extract should contain 2.35, 1.91 and 1.40 mg of the purines in *C. accuminata*, *C. nitida rubra* and *C. nitida alba*, respectively. The concentration of methylxanthines in the crude kola nut extracts used in this investigation should be far less than the amounts stated above.

The effects of the three species of kola nut decreased in the order *C. accuminata, C. nitida rubra* and *C. nitida alba*, corresponding to their xanthine contents. The re sults agree with those of other investigations on the effect of caffeine on vertebrate striated muscle (Ashley, 1971; Cohen, 1975; Ebashi, 1980). Low concentrations (1 - 5 mM) of caffeine cause theophylline potentiate contractions by causing the release of calcium by muscle sarcoplasmic reticulum (Eckert and Randall, 1983). Higher concentrations cause contracture and about 48 mM of caffeine was found to cause irreversible contracture in frog striated muscle (Huxley and Taylor, 1958).

The xanthines stimulate the mammalian myocardium directly (Eckert and Randall, 1983). In isolated mammalian heart both the rate of beat and force of contraction are increased by caffeine and theophylline (Hodgkin and Horowicz, 1957). In man low concentrations of caffeine cause small decreases in heart rate and higher concentrations produce tachycardia and arrhythmias (Tonomura, 1973; Ritchie, 1975). During this investigation the addition of 1 ml of 1% soluble caffeine (Nescafe) was found to increase both the rate of heartbeat and force of contraction (results not shown).

A fairly large kola nut weighs about 10 g and many habitual kola nut chewers take one or more of such nuts daily, so the possibility exists that contracture of the myocardium and heart disorders could result. A clinical investigation similar to that done for caffeine by Ebashi et al (1980) will certainly resolve this speculation.

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