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Full Length Research Paper

Periwinkle (*Pachymelania aurita*) consumption induces *in vivo* electrolyte disorders

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ABSTRACT

Effects of aqueous periwinkle extract on plasma electrolytes were investigated in 20 albino rats for 28 days. Here, we found significant increase in sodium concentration in group 2, administered with cooked periwinkle extract, group 2 with uncooked extract group 3 and group 4 with cooked and uncooked extract as compared with control group ($P < 0.01$). Potassium concentration was significantly decreased in groups 2 ($P < 0.05$), 3 and 4 ($P < 0.01$) compared to group 1 ($P < 0.05$). There was a significant increase in chloride ion in groups 2, 3 and 4 compared to group 1 ($P < 0.05$). An increase in bicarbonate in groups 3 and 4 as compared to groups 1 and 2 ($P < 0.01$). Also, calcium concentration was significantly higher in group 3 compared to groups 1 and 2 ($P < 0.01$). Plasma pH was increased in groups 2 and 4 compared to groups 1 and 3 ($P < 0.05$). Acute toxicity (LD50) test showed higher mortality at an increased dosage (5000 mg/kg). Periwinkle extracts should, therefore, be consumed with caution due to its negative effects on electrolyte balance and plasma markers.

Keywords: Periwinkle, hypernatraemia, hyperchloremia, hypokalaemia, hypercalcaemia.

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INTRODUCTION

Sea foods provide reasonable sources of protein and minerals (Adebayo, 2011; Iboh et al., 2015). Most of the sea foods are consumed by man, as farm food or as plant fertilizers. Some varieties are also used for industrial purposes (Okon and Ausuji, 2007).

Periwinkles are soft body shell fish found mostly in brackish and littoral regions of the sea. They are gastropods of the phylum mollusca. There are two species of Periwinkles, *Tympanotosus Fuscatus* and *Pachymelania aurita* (Dambo, 1985). Periwinkles feed on the decaying organic matter and are edible (Buchanan, 1954).

In Nigeria and particularly in the South almost all the soup preparations require periwinkle, and in some native foods like Ekpang, Nkukwo or Asa prepared from water yam or cocoyam and cassava, it is indeed very delicious. It has been found to be useful for general health and brain development; it may also boost mental or brain lipid contents of Omega 6 fatty acids (lapsinkas 2001). Hence, found to reduce Alzheimer's disease-related dementia (Chuddler, 2009). Omega 6 fatty acids are associated with reduced cholesterol levels, arrhythmias and heart attack events (Peterson, 2009). It is also found to enhance reproduction, reduce rheumatoid arthritis and osteoarthritis symptoms. It's high mineral content (e.g. iodine) is necessary for thyroid gland growth and metabolism, while selenium content is associated with DNA protection (Fischer, 2006). Vitamin A and D contents from periwinkle may be beneficial for eye/skin health and for bones/teeth development (Amanda, 2004). Despite health benefits, there are health hazards associated with periwinkle consumption, such as accumulation of mercury overtime through bio-magnification and cross reactivity between such and radio active agent (Boehm et al., 2009). Thus, periwinkle may induce food poisoning to man and result in renal failure and/or liver damage (Toyin, 2015).

Blood electrolytes are essential for maintenance of

physiological conditions (Barret et al., 2013; Hall and Guyton, 2011). Specifically, sodium helps in maintaining acid base level and regulate total body water, and in maintaining blood volume and pH (Schauss, 1998). Also, sodium is involved in the generation of electrical signals. Hyponatraemia/hypernatraemia are associated with health risks, and may result in abnormal heart rhythm. Low potassium levels are also associated to affections in heart functioning (Kim et al., 2013).

Increase in chloride levels is associated with renal tubular acidosis, over treatment with saline solution. However, hypochloremia is associated with renal chronic pyelonephritis, vomiting and metabolic acidosis (Shahidid et al., 2012). Increased calcium levels, however, is associated with excitability and cardiac arrhythmias, while hypocalcaemia increases nerve and muscle excitability leading to tetany (Vivien et al., 2005).

MATERIALS AND METHODS

Animals/grouping

A total of twenty (20) male and female albino wister rats weighing 180 to 270 g were used for the study. They were kept in the Department of Pharmacology, University of Uyo, in a well ventilated animal house. Rats were randomly divided into four (4) groups of five (5) rats. They were fed with pellets and clean water. Rats were used for the experiment according to regulations of the institute of animal ethical committee (IAEC), and ethical standards from 1964 declarations of Hensinki were observed.

Preparation of aqueous periwinkle extract

Fresh 800 g of periwinkles were purchased from the major market in Uyo, Akwa Ibom State, Nigeria and divided into two groups 1 and 2. The edible part was removed by cracking the shell with stone. This served as the raw/uncooked samples (that is, group 1). Group 2 was cooked with shell and the edible part removed using needle, this served as the cooked sample. Both were dried in electric oven at 50°C for a day and weighed. The cooked ones weighed 282 g after drying, and the uncooked ones weighed 294 g. Dried periwinkles were blended separately. Cooked ones weighed 213 g after blending, and the uncooked ones weighed 222 g. 200 g of each blended cooked and uncooked periwinkles were dissolved separately in 600 ml of water and filtered after a day to obtain the filtrate (extract). The extract was concentrated in a water bath at 60°C. Plasma electrolytes were analysed using automated analyzing machine, VITROSDT- 6011. The data were statistically analysed using analysis of variance (ANOVA). Differences between groups were examined. Using least significant difference test values were reported as mean standard deviation with SPSS statistical package.

Acute toxicity test LD50

Methods from Lorke (1983) were used. 1 g of uncooked extract (that is, raw periwinkle) was dissolved in 100 ml of distilled water, making a stock solution of 100 mg/ml. A total of thirty (30) albino mice were used and divided into five (5) experimental and one (1) control groups (5 × 5 = 25; 5 other from control group). Intraperitoneal dosages of 5000, 4500, 4000, 3500 and 3000 mg/kg were administered. Animals were observed for 24 h for lethality. Those administered with 5000 mg/kg recorded 100% (100% lethal) death while groups with 4500, 4000, 3500 and 3000 mg/kg recorded no death (0% lethal). LD50 was then calculated using the following equation.

$LD50 = \sqrt{AB}$

Where A = Maximum dosage that produced zero (0%) mortality
B = Minimum dosage that kill the mice

$\therefore LD50 = AB = \sqrt{4500} \times \sqrt{5000}$

LD50 = 4743.42 mg/kg

Dosage/grouping of rats

Normal dose was 10% of LD50 (that is, 474.3 mg/kg). Doses were provided to each rat by their body weight, and administered orally using cannula by-passing the esophagus into the stomach (Jimmy and Udim, 2015). Group 1 received distilled water only. Group 2 rats were given cooked periwinkle extract, group 3 received cooked (raw) periwinkle extract and group 4 was provided with both uncooked and cooked periwinkle extracts. The extracts were given for 28 days.

RESULTS

Sodium

Results from electrolyte analysis showed a significant difference ($P < 0.05$) in sodium concentration as compared to control (Table 1, Figure 1). There was a significant increase ($P < 0.05$) in sodium concentration in cooked, uncooked and cook plus uncooked periwinkle groups (Table 1, Figure 1).

Potassium

Mean potassium concentration was significantly different ($P < 0.05$) from the control group. Potassium in group 2 was significantly different ($P < 0.05$) from group 1. Concentration of potassium in groups 3 and 4 was significantly lower ($P < 0.05$) than that of control (Table 1, Figure 2).

Chloride

Chloride concentrations in groups 2, 3 and 4 were significantly different from control (Table 1, Figure 3).

Carbonate

Bicarbonate concentration in cooked periwinkle was

Table 1. Electrolytes concentrations in control and experimental groups (mmol/L).

Groups	Na^+	K^+	Cl^-	HOC_3^-	Ica^{2+}	pH
Control Group 1	138.80 ± 0.97	6.82 ± 0.37	101.20 ± 1.07	21.00 ± 0.32	1.40 ± 0.02	7.54 ± 0.02
Cooked Group 2	145.20 ± 0.73	5.52 ± 0.45	105.40 ± 0.68	22.20 ± 0.80	1.41 ± 0.00	7.64 ± 0.02
Uncooked Group 3	143.20 ± 0.58	5.10 ± 0.32	104.40 ± 0.75	17.00 ± 0.32	1.49 ± 0.02	7.58 ± 0.02
Cooked + Uncooked Group 4	143.60 ± 0.68	5.30 ± 0.25	104.20 ± 0.37	16.60 ± 0.40	1.43 ± 0.01	7.64 ± 0.02

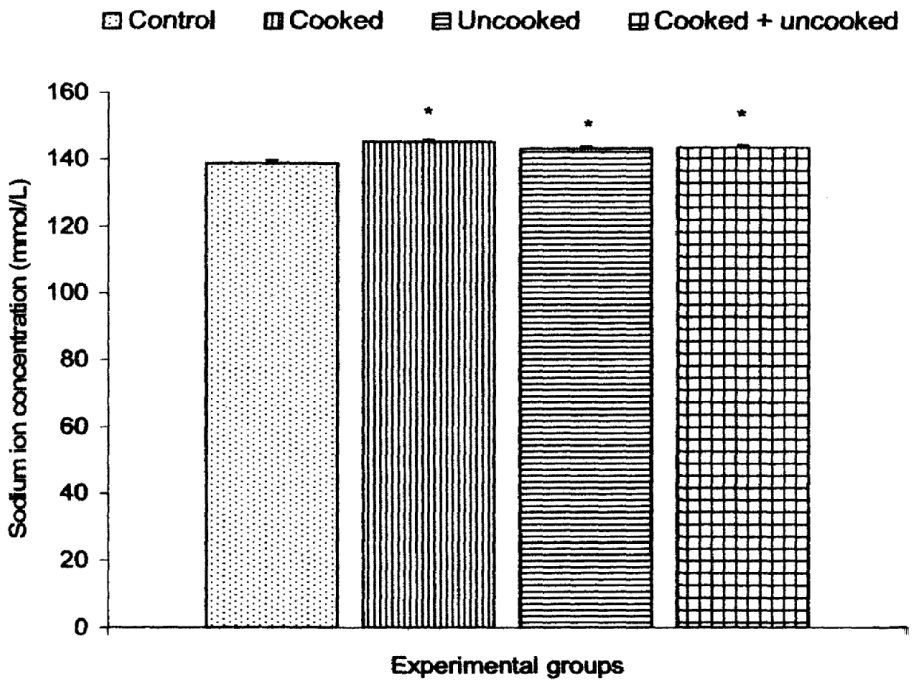

Figure 1. Comparison of sodium ion concentration in control, cooked and uncooked periwinkle extract fed groups. Values are expressed as mean ± SEM, n = 5. * = significantly different from control at $p < 0.05$.

significantly different ($P < 0.05$) from the control group. There was a significantly decrease in bicarbonate concentration in groups 3 and 4 compared to the groups 1 and 2 (Table 1, Figure 4).

Calcium

There was no significant difference in calcium concentration in group 2 compared to group 1. There was a significant increase ($P < 0.001$) in calcium concentration in group 3 when compared to groups 1 and 2. Concentrations of calcium in group 4 were decreased when compared to group 3, and was not different from groups 1 and 2 (Table 1, Figure 5).

Serum pH

There was a significant increase in serum pH in groups 2

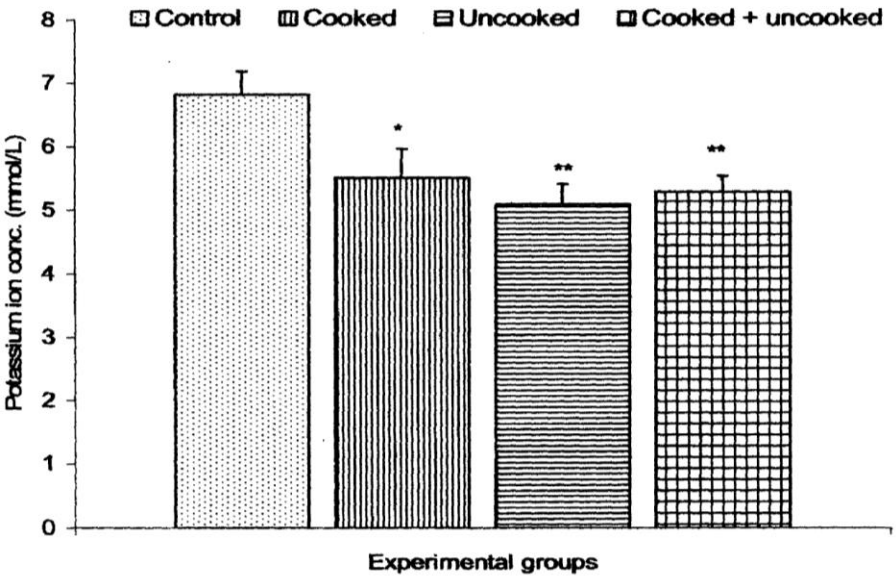

Figure 2. Comparison of potassium ion concentration in control, cooked and uncooked periwinkle extract fed groups. Values are expressed as mean ± SEM, n = 5. * = significantly different from control at $p < 0.05$. ** = significantly different from control at $p < 0.01$.

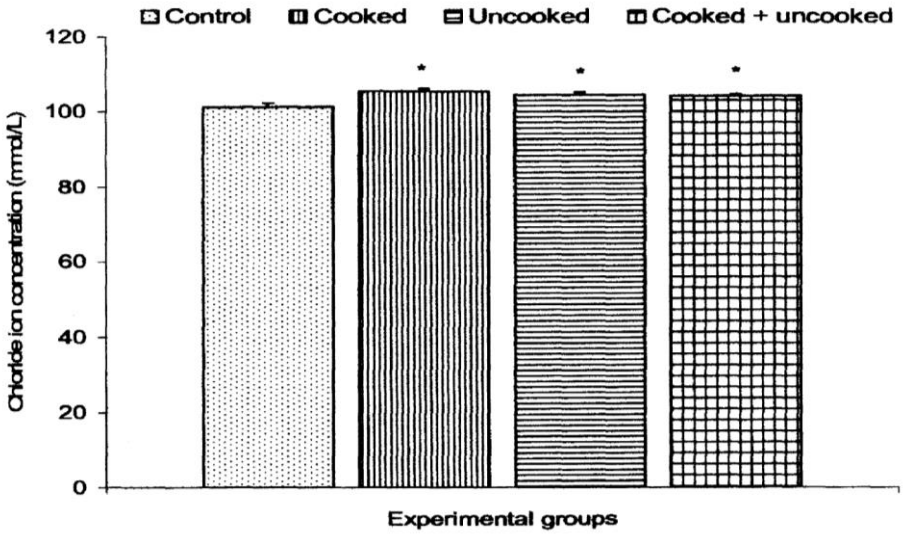

Figure 3. Comparison of chloride ion concentration in control, cooked and uncooked periwinkle extract fed groups. Values are expressed as mean ± SEM, n = 5. * = significantly different from control at $p < 0.05$.

and 4 when compared to control (Table 1, Figure 6).

DISCUSSION

Electrolyte analysis in the periwinkle showed fluctuations. For instance, sodium increase was observed in the cooked, uncooked and the cooked plus uncooked administered extracts. Increase of sodium may be result of the environment which periwinkles inhabit, as water is observed as a good source of ions (Adebaya, 2006). Control sodium concentrations were almost as in

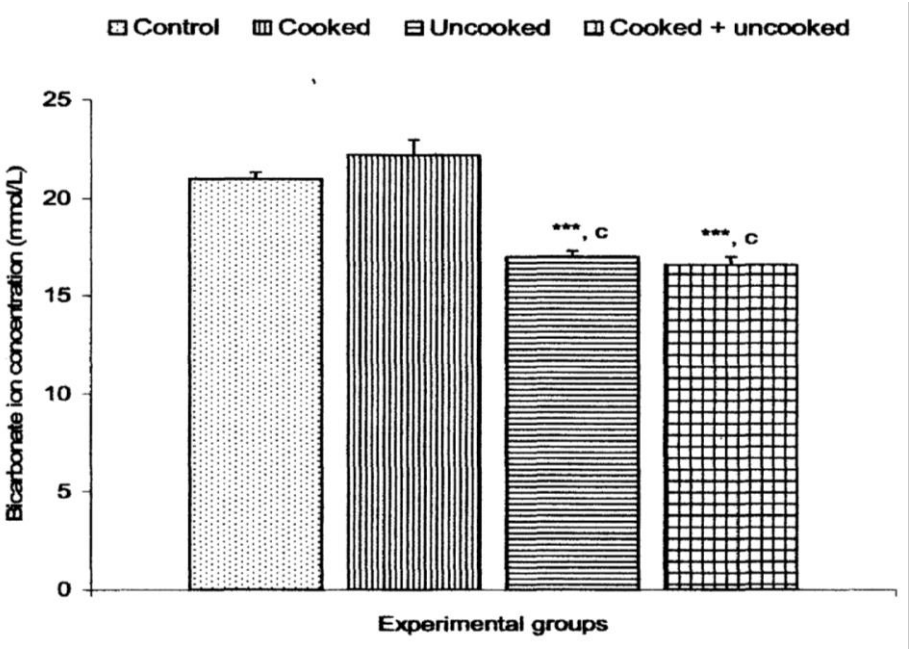

Figure 4. Comparison of bicarbonate ion level in control, cooked and uncooked periwinkle extract fed groups. Values are expressed as mean ± SEM, n = 5. *** = Significantly different from control at $p < 0.001$. c = $p < 0.001$ vs. cooked.

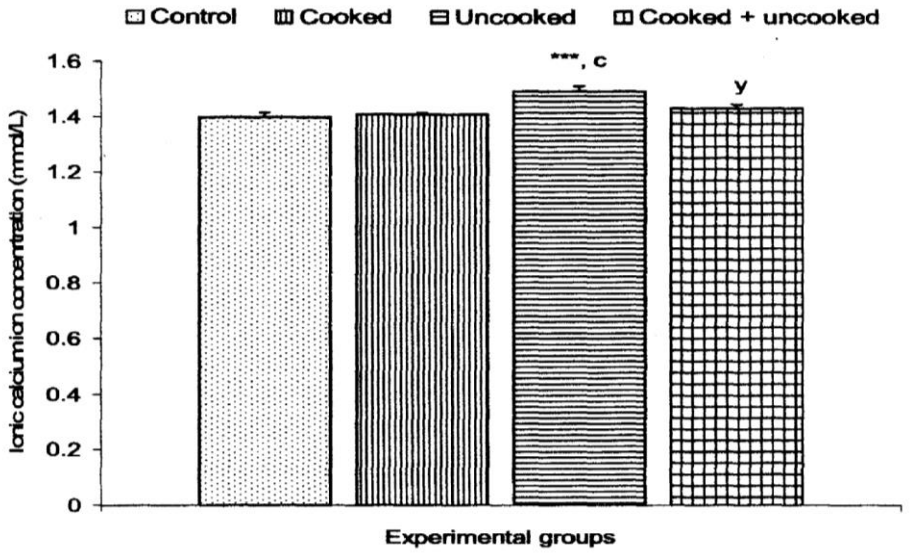

Figure 5. Comparison of ionic calcium ions concentrations in control, cooked and uncooked periwinkle extract fed groups. Values are expressed as mean ± SEM, n = 5. *** = significantly different from control at $p < 0.001$. c = significantly different from cooked at $p < 0.001$. y = significantly different from uncooked at $p < 0.01$.

humans, meaning that it is naturally endowed (Dambo, 1985). Increased sodium concentrations in periwinkle groups indicate hypernatraemia. It means that the electrical potential in neurons, brain and nerves will be overexcited. Sodium increases were observed from both uncooked and cooked periwinkle samples. This is because salt is often added in the cooking of periwinkle. This will certainly aggravate the hypernatraemia and the

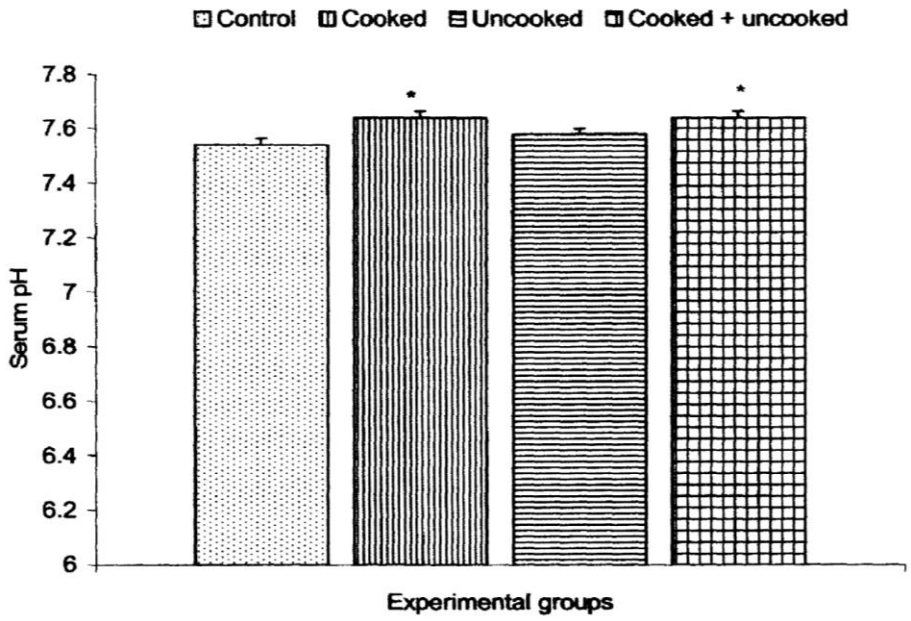

Figure 6. Comparison of serum pH levels in control, cooked and uncooked periwinkle extract fed groups. Values are expressed as mean ± SEM, n = 5. * = significantly different from control at $p < 0.05$.

high tendency of hypertension with increase sodium concentration and, in people with already altered plasma sodium concentrations, additional sodium may worsen their condition (Daven, 2011).

Potassium concentration in the cooked, uncooked and cooked plus uncooked was lower than in control animals. This would be beneficial to individuals under hyperkalaemia diets. Hyperkalaemia may lead to abnormal heart rhythm (Lawrence, 2008). However, the decrease in potassium in the extract may be due to increase in sodium ion as sodium and potassium are antagonistic and exchange in alternate pattern by their pump Na^+/K^+ pump along the cell membrane (Kaplan, 2002). On the other hand, periwinkle extract may have low potassium concentration and hence the ionic concentration may be dependent on the periwinkle composition.

Chloride ion concentration was higher in experimental groups, such as for sodium data. This could happen because sodium and chloride ions are often transported alongside (Barret et al., 2013). However, it could also mean high concentration of the chloride in the extract. Hyperchloremia has negative health implications as in renal tubular acidosis, decrease CO_2 content and renal failure (Fareed and Rory, 2015).

Bicarbonate concentration was higher in the cooked periwinkle extract than the uncooked plus cooked. Raised bicarbonate in the periwinkle may enhance healing of ulcer in man, since it neutralizes acidic food and also maintains acid base balance (Kim et al., 2013). Decrease in the cooked plus the uncooked indicate neutrality interaction with uncooked periwinkle bicarbonate, that is, non effect. Plasma ionic calcium was increased in the uncooked periwinkle compared to the cooked group. It means calcium must have been lost in cooking. This is of negative effect, as children, particularly babies, are often fed with periwinkle and it serves as alternative for fish in low income regions. Such variation may affect bone development. Low calcium concentrations may also increase nerve and muscle excitability resulting in tetany (Vivien et al., 2005).

Conclusion

Our study has shown that periwinkles have the potential of altering plasma electrolytes concentration, thus inducing electrolyte disorders and undesirable health effects.

RECOMMENDATIONS

Periwinkle consumption should be done with great caution though it contains protein, unsaturated and poly-unsaturated fatty acid minerals etc with great health benefits as other sea foods. Persons with low sodium, potassium and bicarbonate are encouraged to consume

periwinkles but should check their electrolytes levels often. Long-term cooking of periwinkle should be avoided as it eliminates calcium, which is very essential for growth, especially in young children.

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