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Effect of Lycopene on Selected Electrolytes in Sprague Dawley Rats Exposed to Dimethoate

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

Aim: This study was aimed at evaluating the effect of lycopene on some selected electrolytes in Sprague Dawley rats exposed to Dimethoate.
Experimental Design: A completely randomized experimental design using standard methods for analysis.
Location and Duration of Study: This study was carried out in the Department of Biology, Ignatius Ajuru University of Education Rumuolumeni, Port Harcourt, Rivers State, Nigeria. GPS 4^{o}48'14" N 6^{o}59'12" E. The study lasted for 28days.
Methodology: Thirty male rats were randomly selected into five (5) groups A-E (n=6/group). Groups B, C and D recieved 10,20 and 30 mg/kg/bw/day of dimethoate respectively co-administered 10mg/kg/bw of lycopene daily. Group E were administered 30mg/kg/bw/day of dimethoate without lycopene. All animals were allowed access to cool clean water and standard rat pellet ad libitum. Twenty-four hours to the termination of the experiment, feed was withdrawn from the animals. Blood samples for electrolytes analysis were collected through ocular puncture between the hours of 7:00am and 9:00am into plain sample tubes according to the approved protocol of blood collection techniques, while statistical analysis was carried out using one-way Analysis of Variance (ANOVA) and expressed as their respective units using SPSS 20 software.
Results: Result showed a significant (P=0.05) increase in the concentrations of sodium, calcium, potassium and bicarbonate with increase in the concurrent administration of lycopene. The highest concentration of all electrolytes was observed at the concentration of 30mg/kg/bw/day with

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coadministration of lycopene. Administration of lycopene at the concentration of 10mg/kg/bw appeared not to have any significant effect on production of electrolytes since all the electrolytes assessed increased with increased concentration of the pesticides. However, further work is required to make any conclusive statement with lycopene effect on electrolyte.

Keywords: Antioxidant; dimethoate; electrolytes; lycopene; pesticides.

1. INTRODUCTION

Environmental pollution resulting from indiscriminate use of pesticides at all levels has been a serious concern to researchers. Pesticides although toxic by design have numerous benefits including crop protection, preservation of food and prevention of vector-borne diseases. Their mode of action is by targeting systems or enzymes in the pests which may be identical to that found in humans and therefore, posing a risk to human health, environment fauna and ecosystem at large. According to [1], residual amounts of organochlorine organophosphate pesticides have been detected in soil, water reservoirs, vegetables, grains and other food products. Activation of cholinergic receptors by Organophosphate pesticides has been reported in experimental animals [2,3].

Oxidative stress caused by lipid peroxidation induced by dimethoate has also been found to be one of the molecular mechanisms involved in organophosphate toxicity. The toxicity of organophosphorus insecticides results in negative effects on many organs and systems such as the liver, kidney, nervous system, immune system and reproductive system [4,5,6,7]. Various studies conducted showed alteration in histology and antioxidant status of various organs e.g. liver, brain and testes of rats upon chronic exposure to dimethoate.[1,4,5,8,9]

Electrolytes are vital for the healthy functioning of the human body. They regulate nerve and muscle function, hydrate the body, balance blood acidity and pressure, and help rebuild damaged tissue. Fruits and vegetables are good sources of electrolytes. Common electrolytes include sodium, potassium, calcium, bicarbonate. The symptoms of an electrolyte imbalance can include twitching, weakness and if unchecked seizures and heart rhythm disturbances may occur.

Lycopene is a member of the carotenoid family, and the predominant source in the human diet comes from tomato and tomato-based products. The antioxidant capacity of tomato strongly depends on the content and bioavailability of lycopene in the fruit. There is strong correlation between lycopene content in tomatoes and antioxidant capacity [10].

Lycopene exhibits a high physical quenching rate of singlet oxygen, which is directly related to its antioxidant activity.

Researchers have reported that the consumption of tomatoes and tomato-based products in our daily diets affords many health benefits, particularly from the perspective of reducing the oxidative stress in its various forms [11,12]. [13] revealed the protective role of lycopene antioxidant on spermatogenesis and hormonal profile. Older adults are particularly at risk of decreased levels of antioxidant and electrolyte imbalance due to increased exposure pesticides. Therefore this study aimed at investigating the role of lycopene as an antioxidant against the risk of electrolyte imbalance.

2. MATERIALS AND METHODS

2.1 Experimental Location

The investigation was carried out in the Department of Biology, Ignatius Ajuru University of Education, Rumulumeni Port Harcourt, Rivers State Nigeria. GPS 4^{o}48'14" N 6^{o}59'12" E.

2.2 Animal Care and Management

Thirty adult male Sprague-Dawley rats weighing 245.23±18.71g were purchased from the animal house of the Department of Biochemistry, University of Port Harcourt, Rivers State, Nigeria. Animals were housed individually in plastic cages at room temperature and had access to commercial standard rodent Pellets and cool clean water *ad libitum.* The animals were acclimated for 14 days, before the commencement of the experiments. The experiments were conducted according to the institutional animal care protocols at the Rivers State University, Nigeria and followed approved

guidelines and ethical treatment of Laboratory animals.

2.3 Preparation Test Materials

Dimethoate was obtained from chemical company (Port Harcourt, Nigeria) with purity about 95%. Lycopene was ordered from Puritan's Pride Premium Incorporated Oakdale, New York, United States of America. Lycopene was dissolved in Olive at 10mg/animal /day.

2.4 Experimental Design

The thirty male rats were randomly assigned into five groups (A-E) of six male rats (n=6) each. Group A animals were not given dimethoate or lycopene and so served as the control. Groups B,C,D received oral gavage of 10mg/kg/bw/day, 20mg/kg/bw/day, 30mg/kg/bw/day of dimethoate for 28 days and were administered 10mg of Lycopene dissolved in olive concurrently while Group E were gavaged 30mg/kg/bw/day of the pesticide without Lycopene.

2.5 Blood Collection

Feed was withdraw from the animals 24hrs before the termination of the experiment. Rats were euthanized with ethyl ether in a desiccator. Blood was collected in plain sample bottles and allowed to clot. Thereafter, it was centrifuged at 1500g for 20 minutes. The serum was stored at 2-8^{o}C until required for electrolytes analysis. Analysis of sodium and potassium was with [14,15] respectively. Urea was assayed by colorimetric method of [16].

3. RESULTS

The effect of oral administration of dimethoate and lycopene on the concentration of serum sodium in male sprague Dawley rats is shown in Fig. 1. There was a non significant decrease in the level of sodium from 30mmol/l in the control to 28mmol/l in rats treated with 10mg/kg/bw/day of dimethoate coadministered lycopene. At 20mg/kg/bw/day, the concentration of sodium increased significantly from 28mmol/L to 40 mmol/L which remained stable even in rats treated with 30mg/kg of dimethoate and the lycopene. A further increase was observed from 40mmol/l to 42mmol/L at 30mg/kg/bw/day of dimethoate without the administration of lycopene.

The effect of oral administration of dimethoate and lycopene on the concentration of potassium in male sprague Dawley rats is shown in Fig. 2. There was no significance difference in the concentration of potassium observed in rats from the control group, and those treated with 10mg/kg/bw/day and 20mg/kg/bw/day of dimethoate. The value remained at 6.5mmol/L and thereafter increased to 8mmol/L in rats treated with 30mg/kg of dimethoate wih the coadministration of lycopene. A further increase occured from 8mmol/l to 11mmol/L in rats trated with 30mg/kg of Dimethoate without lycopene.

The effect of oral administration of dimethoate and lycopene on the concentration of Urea in male sprague Dawley rats is shown in Fig. 3. There was an increase in the concentration of urea from 2.3mmol/L, 3.9mmol/l and 4mmol/l in rats treated with 0m/kg/bw/day, 10mg/kg/bw/day and 20mg/kg/bw/day of dimethoate respectively. At 30mg/kg/bw/day with lycopene, the concentration of urea increased to 4.5mmol/L and remained almost at the same level in rats treated with 30mg/kg of dimethoate without lycopene.

The effect of oral administration of dimethoate and lycopene on the concentration of Bicarbonate in male sprague dawley rats is shown in Fig. 4. There was a consistent stepwise increase in the concentration of bicarbonate from 25mmol/l, 26mmol/l, 26.5mmol/l, 27.5mmol/l and 28mmol/l in rats treated with 0mg/kg/bw/day, 10mg/kg/bw/day, 20mg/kg/bw/day, 30mg/kg of dimethoate with lycopene and 30mg/kg/bw/day of dimethoate without lycopene respectively.

4. DISCUSSION AND CONCLUSION

Electrolyte balance in organisms is an important factor in fluid distribution, intra and extra cellular acid-basic equilibrium, maintaining osmotic pressure of the body fluids and normal neuromuscular irritability. These functions can be compromised with stress due to the toxicant effect on the physiology of the organism [17,18]. Electrolytes are known to also play pivotal roles in the regulation of reproductive functions in male. Plasma testosterone concentration has been reported to be correlated with concentrations of sodium (Na), potassium (K), Magnesium (Mg) in all male genital organs [19,20]. also electrolytes such as sodium, potassium,chloride and bicarbonate ions are among the parameters useful in the determination of kidney function. The elevation or depletion of the level of any may be an indicator for a kidney problem [21].

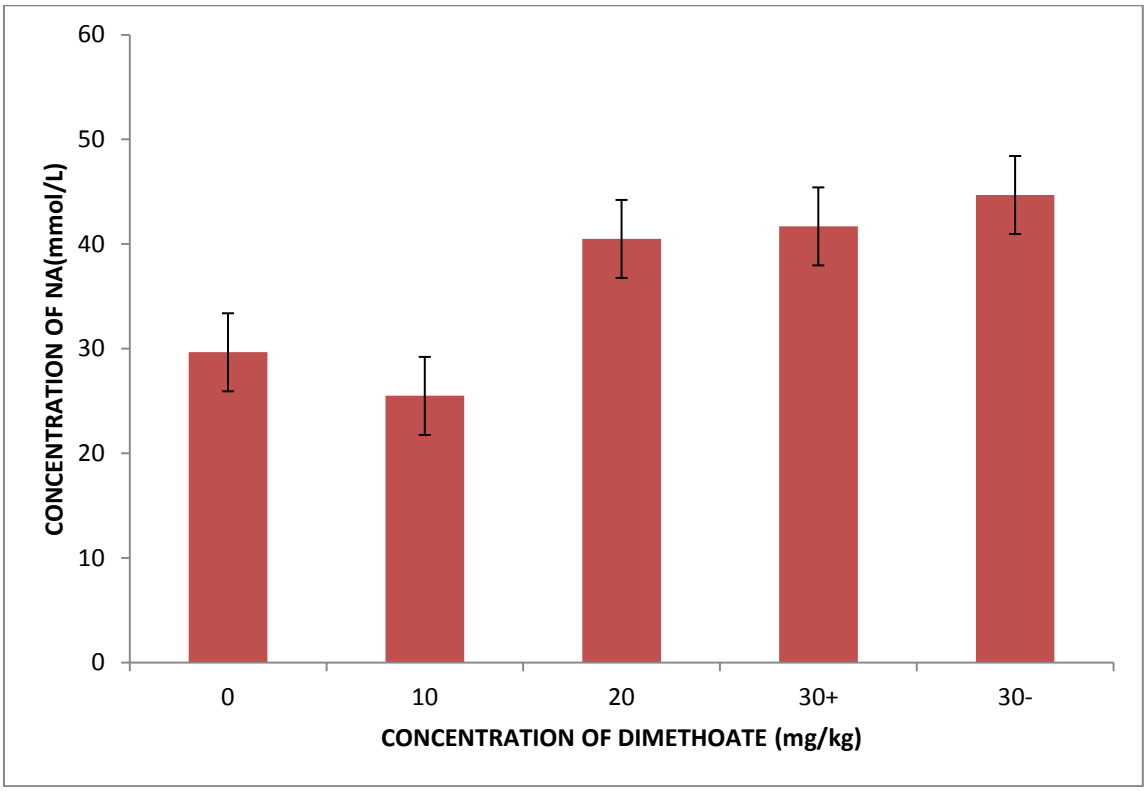

Fig. 1. Effect of Dimethoate on concentration of sodium in Sprague Dawley rats

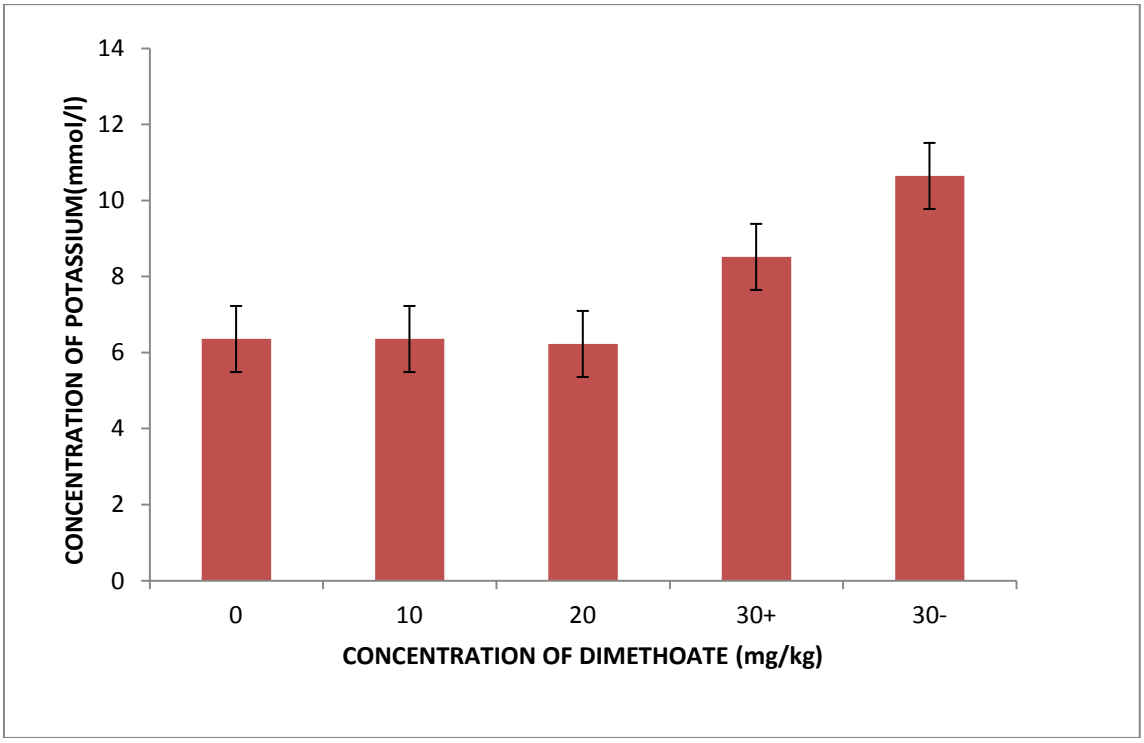

Fig. 2. Effect of Dimethoate on potassium in adult Sprague Dawley rats

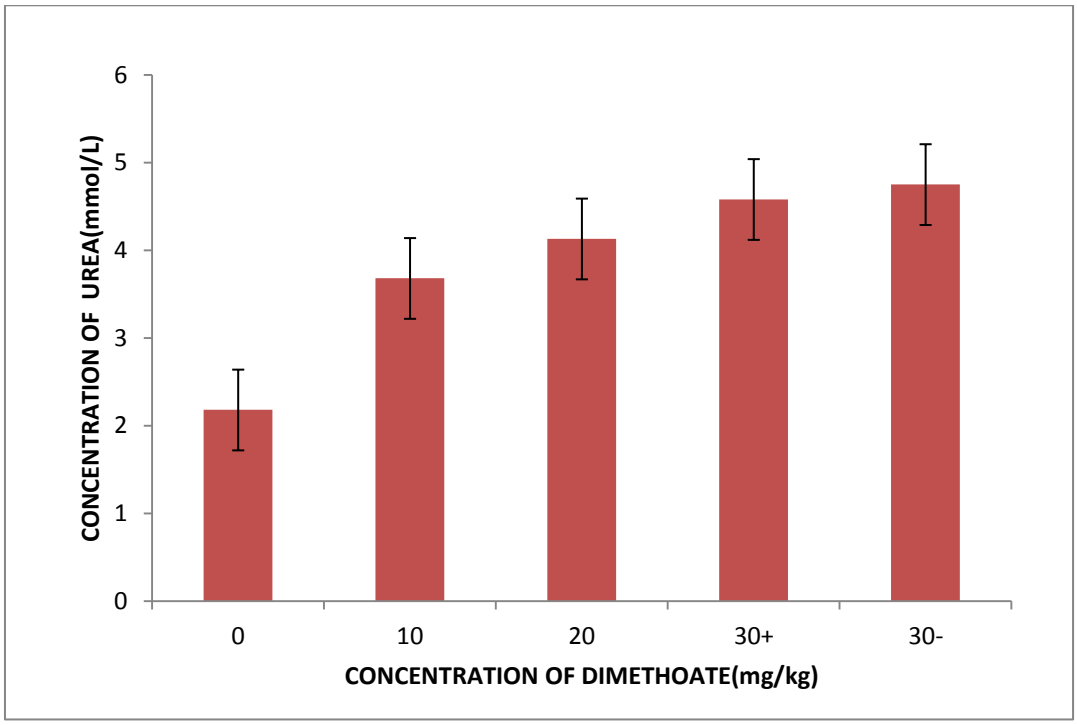

Fig. 3. Effect of Dimethoate on serum urea in Sprague Dawley rats

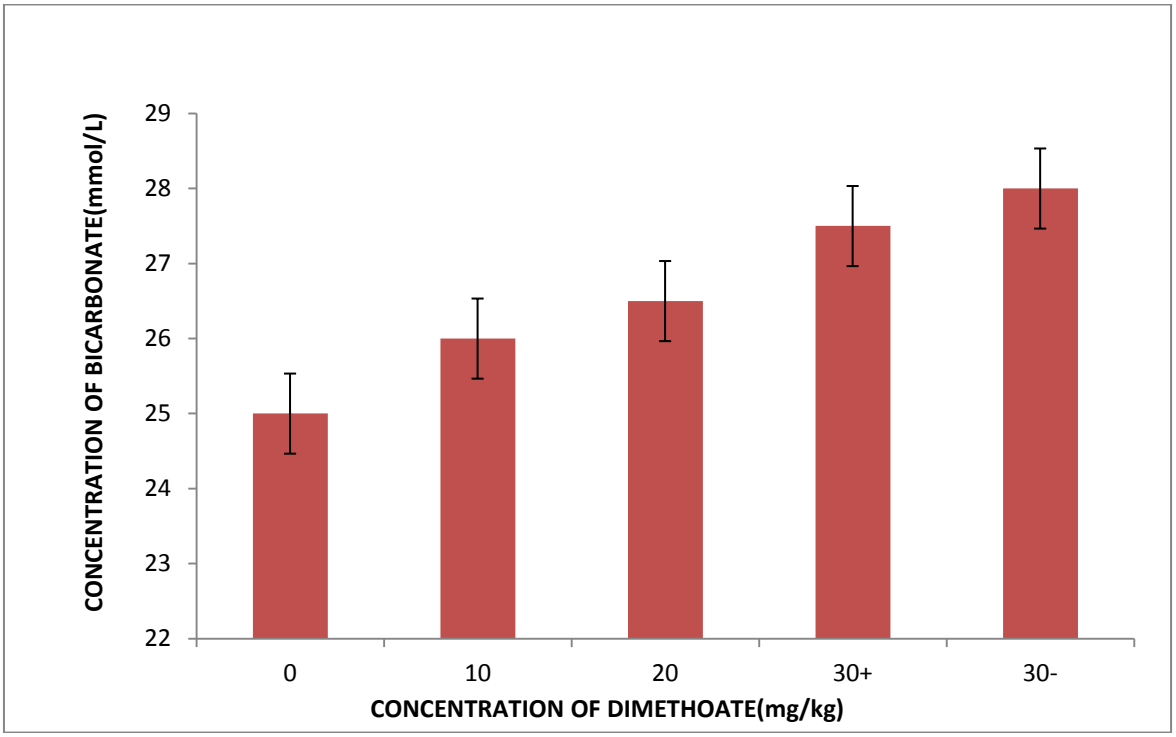

Fig. 4. Effect of Dimethoate on bicarbonate in Sprague Dawley rats

From this study, the concentration of sodium, calcium, potassium increased with increase in the concurrent administration of lycopene. The highest concentration of all electrolytes was observed at the concentration of 30mg/kg/bw with coadministration of lycopene. Sodium ion is a strategic extracellular fluid electrolyte that plays a role in many physiological processes such as

excitable tissues for depolarization [22]. A non-significant increase in serum sodium of animals treated with watermelon was reported [22].

Potassium is an essential intracellular mineral and important in maintaining fluid and electrolyte balance in the bodies of human and animals [22]. The significant increase of serum potassium level observed may be because lycopene contain higher amount of potassium.

Administration of lycopene at the concentration of 10mg/kg/bw appeared not to have any significant effect on production of electrolytes since all the electrolytes assessed increased with increased concentration of the pesticides. However, further work is required to make any conclusive statement with lycopene effect on electrolyte.

ETHICAL APPROVAL

The experiment was conducted according to the institutional animal care protocols at the Rivers State University Nkpolu-Oroworukwo, Port Harcourt, Rivers state, Nigeria and followed approved guidelines for the ethical treatment of experimental animals.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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