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Full Length Research

Nephrotoxic Nature of Potash (Kaun) in Wistar Rats

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The use of potash as food additive without a recourse to its adverse effect is on the increase in Nigeria. Therefore, this study is aimed at examining its nephrotoxicity on the kidney of Wistar rats. Potash was locally sourced in a market in Owerri, Nigeria. Thirty Wistar rats were acclimatized for seven days and divided into five groups of six each. Animals in group A were administered distilled water while those in groups B, C, D and E were administered 250, 500, 750 and 1000 mg/kg body weight of potash for 28-days via oral route of administration. At the end of 28 days of treatment, blood samples were collected *via* cardiac puncture. Hepatic indices were determined using standard methods. Elevation in creatinine and urea levels was observed when experimental animals were compared with those in control group. This elevation in urea concentration was insignificant at a low dose of 250 mg/kg but significant at higher doses of 500, 750 and 1000 mg/kg when compared to those in control group at $P<0.05$. Increase in creatinine concentration was only significant at the highest dose 1000 mg/kg when compared to those in control group at $P<0.05$. A significant increase was observed in the concentration of sodium following the administration of potash at all doses compared with those in control group at $P<0.05$. Similarly, a significant increase was observed in the level of potassium (except the group treated with 250 mg/kg) when compared with those in control group at $P<0.05$. Administration of potash had no significant effect on the concentration of bicarbonate of experimental animals when compared with those in the control group. Observation from this study showed that potash is nephrotoxic especially at high doses. Consequently, it is recommended that its consumption should be discouraged.

Keywords: Potash, Renal Indices, Nephrotoxicity, Wistar rats.

INTRODUCTION

Potash is any of various mined and manufactured salts that contain potassium in water-soluble form, the name derived from pot ash, refers to plant ashes soaked in water in a pot, the primary means of manufacturing the product before the industrial era (Davy, 2008). It is produced worldwide at amounts exceeding 30 million tonnes per year, mostly for use in fertilizers. Various types of fertilizer-potash constitute the single largest global industrial use of the element potassium. Potassium was first derived by electrolysis of caustic potash (potassium hydroxide), in 1807 (Knight, 1992). The old method of making potassium carbonate (K_2CO_3) was by collecting or producing wood ash (an occupation carried out by ash burners), leaching the ashes and then evaporating the resulting solution in large iron pots, leaving a white residue called pot ash (Dennis, 2006). Approximately 10% by weight of common wood ash can be recovered as pot ash. Later, potash became the term widely applied to naturally occurring potassium salts and the commercial product derived from them (WPI, 2000). Locally known as “kaun” or “Akanwu”, Potash is used commonly for culinary purposes. It is used for cooking pulses like beans, akidi (black Mexican beans), fiofio (cowpea beans etc. in order to tenderize the pulses so easily (Iweka et al., 2016). “Kaun” is also added in ewedu and okro soup (a Nigerian delicacy) during preparations in order to increase the greenness and texture of the vegetables (Okpala, 2015). No data exist about the quantity or dosage of potash consumed in the average daily meal of Nigerians.

Nephrotoxicity can be defined as the adverse effect of substances on renal function (Perazella, 2009). These substances can include molds and fungi, cancer therapeutics such as cisplatin, antibiotics such as aminoglycosides, metals such as mercury, arsenic and lead, and drugs of abuse such as cocaine. One indication of nephrotoxicity is a change in renal function as assessed by the glomerular filtration rate (GFR), blood urea nitrogen (BUN), serum creatinine (sCr), or bilirubin concentrations; however, nephrotoxicants can induce kidney damage without changing any established clinical marker of renal function. For example, studies have shown that proximal tubule necrosis in male Sprague Dawley rats exposed to gentamicin can be as high as 75% prior to any increases in BUN or sCr (Zhou et al., 2008). Several substances have been reported to adversely affect the renal integrity. This study is therefore designed to examine the likely effect of potash on the kidney.

MATERIALS AND METHODS

Experimental Design

Potash was locally sourced in a market in Owerri, Imo State, Nigeria and was carefully preserved to avoid contamination. Thirty (30) healthy male Wistar rats (*Rattus norvegicus*) weighing between 145 and 160 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 (NAS, 2011). They were randomly divided into five (5) groups of six (6) rats each. Animals in group A were administered distilled water while those in groups B, C, D and E were administered 250, 500, 750 and 1000 mg/kg body weight of potash for twenty-eight (28) days via oral route of administration. At the end of 28 days of treatment, animals were anaesthetized using diethyl ether and were sacrificed and blood samples were collected *via* cardiac puncture.

Determination of Renal Indices

Creatinine concentration was determined using Jaffe reaction described by Toora and Rejagopal (2002). Urea concentration was determined using a Randox Commercial Kit based on the methods of Fesus et al. (1983). The concentrations of sodium (Na), potassium (K) and bicarbonate (HCO_3^-) were determined using Biorex diagnostic kit according to the methods of Lorentz (1998).

Statistical Analysis

Results are expressed as mean ± standard deviation. The levels of homogeneity among the groups were assessed using One-way Analysis of

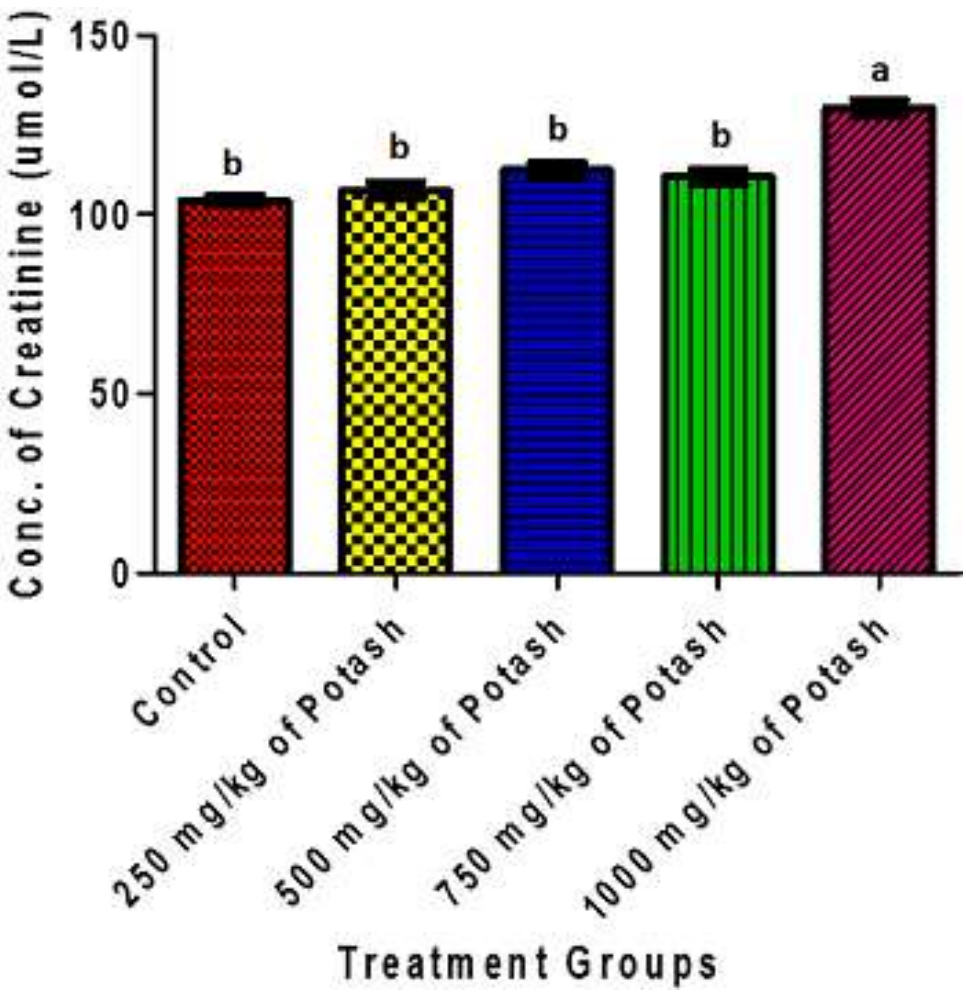

Figure 1. Effect of Potash on the Concentration of Creatinine of Animals after 28 days of Treatment.

Results are presented as mean ± SD with n = 6. Bars with different letters are significantly different at P<0.05

Variance (ANOVA) followed by Tukey's test. All analyses were done using Graph Pad Prism Software Version 6.00 and P values < 0.05 were considered statistically significant.

RESULTS

The effect of potash on renal indices of animals after 28 days of treatment is presented in Figures 1-5. Elevation in creatinine and urea levels was observed when experimental animals were compared with those in control group. This elevation in urea concentration was insignificant at a low dose of 250 mg/kg but significant at higher doses of 500, 750 and 1000 mg/kg when compared to those in control group at P<0.05 (Figure 2). Increase in creatinine concentration was only significant at the highest dose 1000 mg/kg when compared to those in control group at P<0.05 (Figure 1). A significant increase was observed in the concentration of sodium following the administration of potash at all doses compared with those in control group at P<0.05 as presented in Figure 3. Similarly, a significant increase was observed in the level of potassium (except the group treated with 250 mg/kg) when compared with those in control group at P<0.05 (Figure 4). Administration of potash had

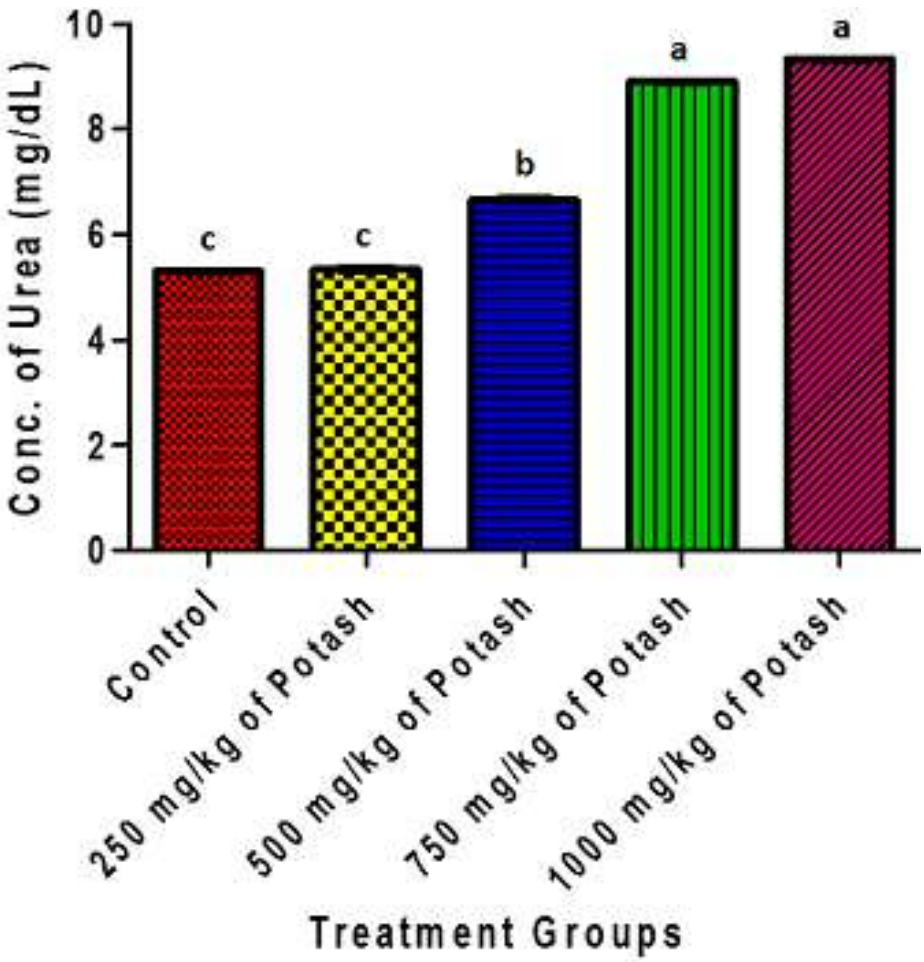

Figure 2. Effect of Potash on the Concentration of Urea of Animals after 28 days of Treatment.

Results are presented as mean ± SD with n = 6. Bars with different letters are significantly different at P<0.05

no significant effect on the concentration of bicarbonate of experimental animals when compared with those in the control group (Figure 5).

DISCUSSION

The kidneys have vital function in detoxification and excretion of metabolic wastes and xenobiotics (Airaodion et al., 2019a). Exposure to toxic chemicals causes alterations in some tissue enzyme activities. The kidneys control the excretion of urea, creatinine, and reabsorption of electrolytes into the blood. Defeat in activities of kidney will result in accumulation of electrolytes, urea, and creatinine in the biological fluid (Shittu et al., 2015; Ogbuagu et al., 2021). The results of renal indices of experimental animals sequel to exposure to potash are presented in Figures 1-5. Yohei et al. (2012), reported that the relationship between high renal restitive index (RI) and cardiovascular and renal outcomes is significant and persisted after multivariate Cox regression analysis, including traditional risk factors. The serum creatinine concentration is widely interpreted as a measure of the glomerular filtration rate (GFR) and it is used as an index of renal function in clinical practice (Airaodion et al., 2021). Glomerular filtration of creatinine, however, is only one of the variables that determine its concentration in serum. Alterations in

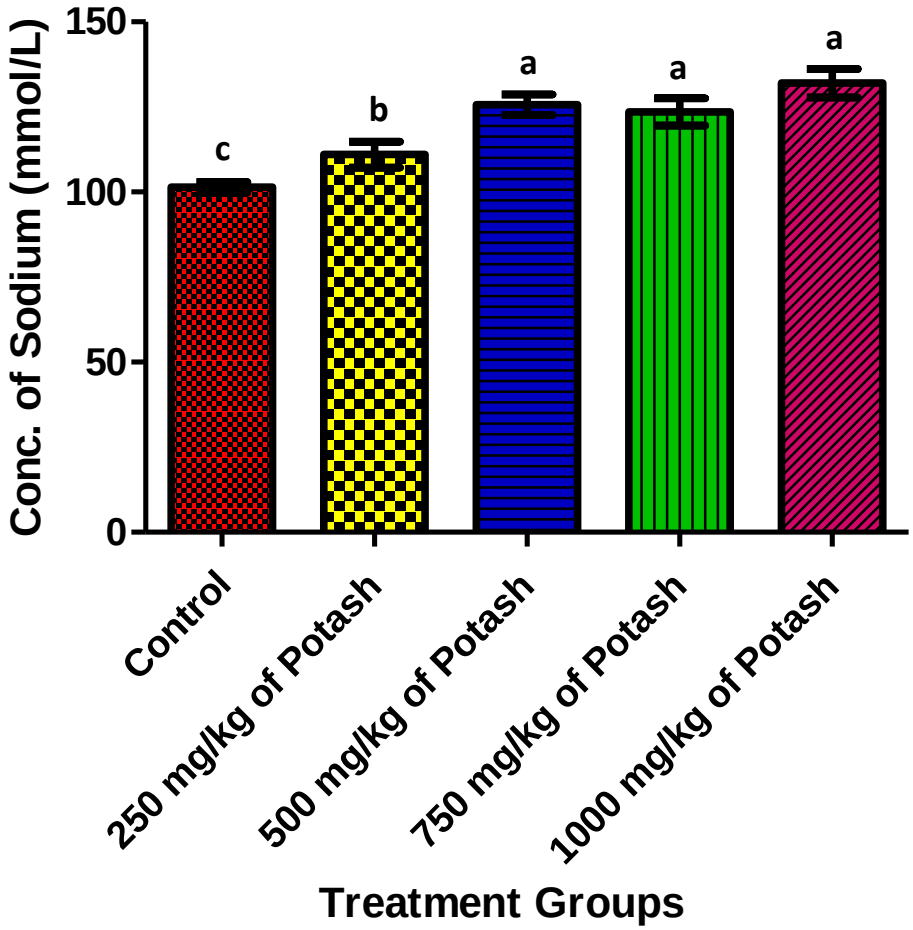

Figure 3. Effect of Potash on the Concentration of Sodium of Animals after 28 days of Treatment.

Results are presented as mean ± SD with n = 6. Bars with different letters are significantly different at P<0.05

renal handling and metabolism of creatinine and methodological interferences in its measurement may have a profound impact on the serum concentration of creatinine metabolism and is constant among individuals and over time, with the creatinine production rate being equal to the renal excretion rate (Airaodion et al., 2019b). In the theoretical situation where both criteria are satisfied, the serum creatinine is inversely proportional to the GFR, so that each halving of the GFR results in a doubling of the serum creatinine concentration (Kassirer, 2001). Secretion of creatinine was observed even in early studies of the clearance of exogenously administered creatinine (Kassirer, 2001). Mandell et al., (2003), reported that the exogenous creatinine clearance decreased as the concentration of creatinine in the blood was acutely increased10-fold by creatinine infusion. This decrease was thought to be due to saturation of the tubular secretory mechanism, because the inulin clearance was not affected by this exogenous increase of the creatinine concentration in the blood. Creatinine reabsorption during low rates of urine flow is thought to result from its passive back-diffusion from the lumen to the blood. Thus, when urine flow rate is very low, passive reabsorption of creatinine might result in a lower creatinine clearance and a higher concentration of serum creatinine than what one would expect solely on the basis of the Glomerular Filtration Rate (Airaodion et al., 2021; Miller et al., 2002). Dietary protein deficiency leads to negative nitrogen balance and

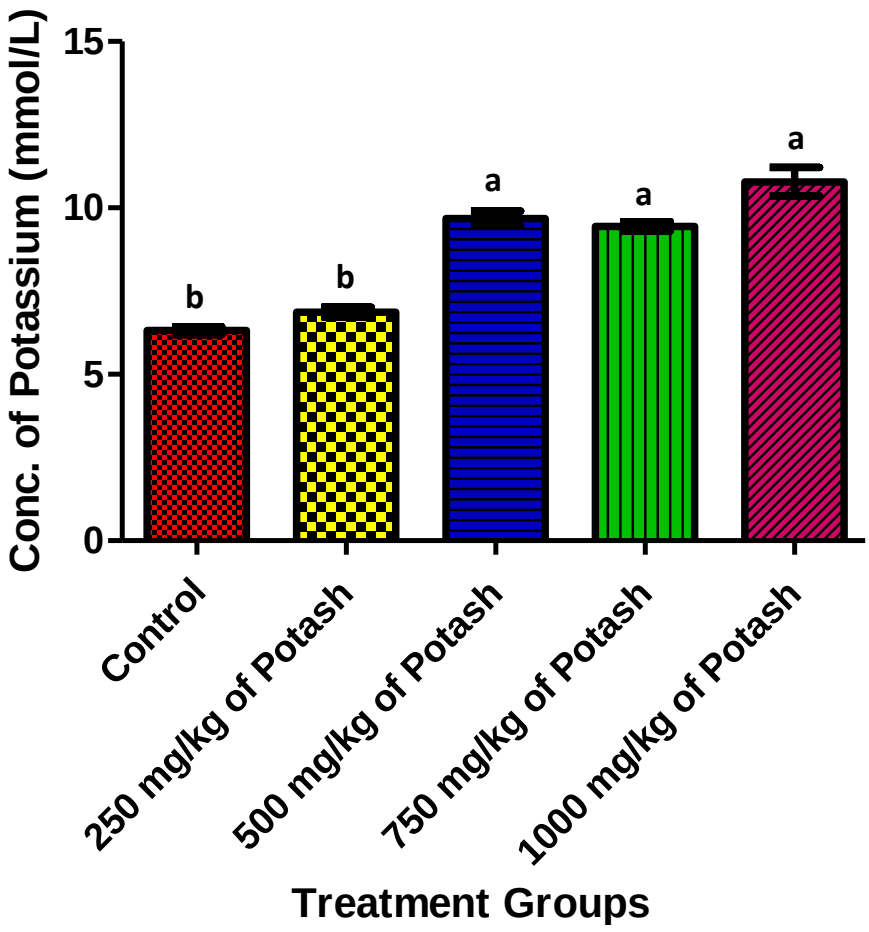

Figure 4. Effect of Potash on the Concentration of Potassium of Animals after 28 days of Treatment

Results are presented as mean ± SD with n = 6. Bars with different letters are significantly different at P<0.05

loss of muscle mass, thereby decreasing creatinine production. Less severe alterations in the diet, however, also may have important effects on the size of the creatine pool and creatinine excretion, which are independent of nitrogen balance and muscle mass. In this study, a dose-dependent increase was observed in the serum creatinine concentration in experimental animals when compared with that of the control animals. This increase was significant at the doses of 500, 750 and 1000 mg/kg body weight (Figure 1). The significant increase in creatinine content at these doses may be attributed to compromise of the renal functional capacity. The potash might have altered creatinine metabolism in favor of increased anabolism, decreased catabolism and decreased clearance (Airaodion et al., 2019b).

Serum urea and creatinine levels are an indication of kidney function both in man and in rodents (Airaodion et al., 2019b; Ogbuagu et al., 2021). In this study, a dose-dependent increase was observed in the serum urea concentration in experimental animals when compared with those of the control animals. This increase was only significant at the dosage of 750 mg/kg and 1000 mg/kg body weight respectively (Figure 2). The significant increase in urea content at these doses may be attributed to compromise of the renal functional capacity. The potash at these doses might have perturbed urea metabolism in favor of increase anabolism, decrease catabolism and decrease clearance.

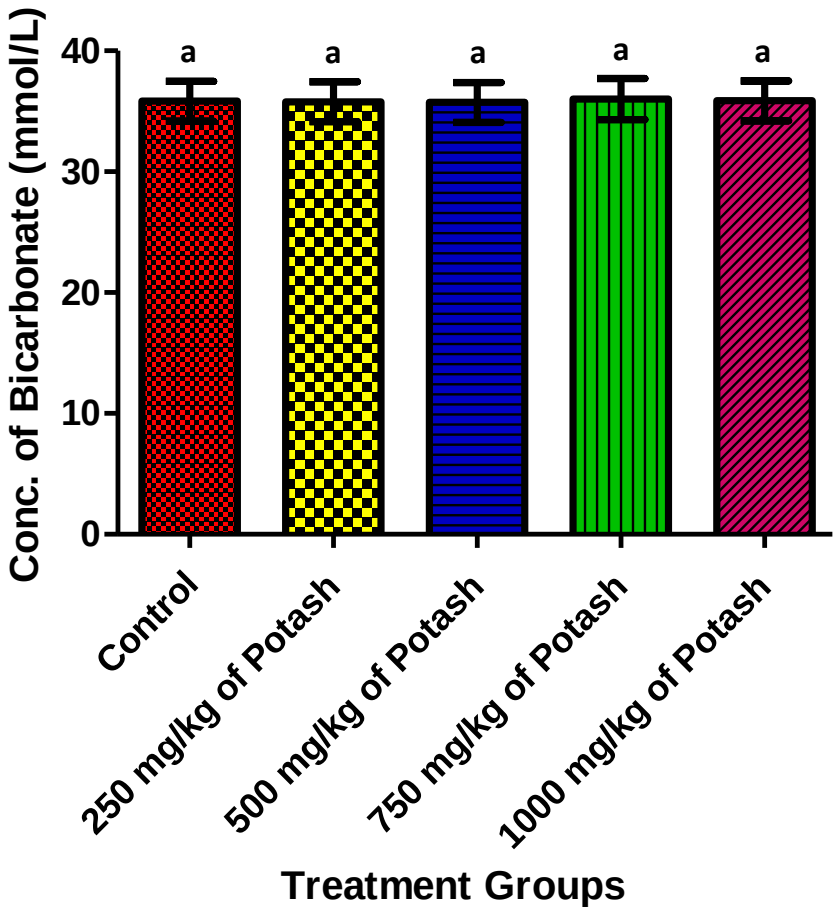

Figure 5. Effect of Potash on the Concentration of Bicarbonate of Animals after 28 days of Treatment

Results are presented as mean ± SD with n = 6. Bars with different letters are significantly different at P<0.05

The significant increase in the levels of sodium and potassium following treatment with potash in this present study (Figures 3 and 4) suggests that the normal excretion of these electrolytes by the kidney might have been adversely affected (Airaodion et al., 2019b; Ogbuagu et al., 2021). Potash was observed to have no significant effect on the concentration of bicarbonate (Figure 5).

CONCLUSION

Observation from this study showed that potash is nephrotoxic to rats especially at high doses. This does not automatically translate to same effect in human. However, its consumption at high dosage should be discouraged. And further study using human model is recommended.

CONFLICT OF INTERESTS

Authors wish to declare that no conflict of interests exist in this study and publication.

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