

Effects of Monosodium glutamate on Electrolytes and some Biochemical parameters in Rats

ABSTRACT

The effect of monosodium glutamate (MSG) on serum electrolytes, urea and creatinine levels was evaluated in Albino rats. The rats were randomly divided into four (4) groups based on the proportion of MSG supplemented in their diets. Group A was fed with commercial chow (control) while groups B, C and D were placed on 0.5, 1.0 and 5.0% MSG supplemented diets respectively. The serum electrolytes, urea and creatinine were analyzed using TECO Diagnostic kits. The sodium and chloride concentrations in the experimental groups were not significantly ($p>0.05$) different from the control group. Group fed 5% MSG supplemented diet had the highest potassium concentration ($6.00\pm0.83\text{Mmol/L}$) while the group placed on 0.5% MSG supplemented diet had the lowest concentration ($4.68\pm0.16\text{Mmol/L}$). There was a significant ($p<0.05$) difference in the potassium ion concentration between the experimental groups and the control group. The urea concentration ranged from $6.28\pm0.10\text{mmol/L}$ to $7.13\pm0.36\text{Mmol/L}$ in the experimental groups whereas the creatinine concentration ranged from $1.38\pm0.48\text{mmol/L}$ to $1.4\pm0.11\text{Mmol/L}$. There was no significant ($p<0.05$) difference in both urea and creatinine concentrations in the experimental groups when compared to the control group. This work has shown that high supplementation of diet with MSG could induce hyperkalemia and hypopuremia in rats.

Key words: *Monosodium Glutamate (MSG), electrolytes, urea, creatinine, supplemented diet*

INTRODUCTION

Monosodium glutamate (MSG) is a chemical food additive used to enhance the flavor of many types of food. It contains about 78% glutamic acid, 22% sodium and water [1]. Glutamate is one of the most common amino acids in nature [2] and is the main component of many proteins and peptides of most tissues (plant and animal). It is a non-essential amino acid as it can be produced in the body independent of its availability in ingested foods [3].

MSG has a trade name; “Ajinomoto” which is marketed by West African Seasoning Company Limited. It is commonly referred to as “Vedan” or “White Maggi” and available in markets as well as open stores in Nigeria. Monosodium glutamate when added to food provides a taste referred to as “umami” which differ from the four classic tastes of sweet, sour, salt and bitter. As a food additive, monosodium glutamate is described and listed on food labels as a “Flavouring” or “Hydrolysed vegetable protein”. Through its stimulation of the sensory receptors and improving the palatability of meals, monosodium glutamate influences the appetite positively and induces weight gain [4].

Despite its taste stimulation and improved appetite enhancement, reports indicate that monosodium glutamate may be toxic to humans and experimental animals [5]. Several communities in Nigeria often

use monosodium glutamate as a bleaching agent for the removal of stains from clothes. There is a growing apprehension that its excellent bleaching properties could be harmful or injurious to the tissues, and organs of the body or worse still inducing terminal diseases in consumers when ingested as a flavour enhancer in food. In the sixties, the symptoms associated with MSG were referred to as “Chinese Restaurant Syndrome” which began 15 to 30 minutes after eating in certain Chinese restaurants, and lasted about 2 hours with no lasting effects. These symptoms ranged from burning sensation of different parts of the body, headache or numbness in the face to chest pain, nausea or vomiting, sweating, paresthesias, heart palpitations and tremors [1]. In recent years there have been much concern about possible adverse effect of MSG on human and animals and MSG is believed to cause neurotoxicity, impaired vision and endocrinal disorder in human subjects. It has also been associated with some pathological conditions such as schizophrenia, anxiety, Parkinson’s disease, epilepsy, stroke and Huntington’s disease [6].

Despite evidence of negative consumer response to MSG, reputable International organizations and nutritionists have continued to endorse monosodium glutamate and reiterated that monosodium glutamate has no adverse reactions in humans [7]. Recognized International organization such as the Food and Drug Administration (FDA) and also a regulatory food safety body in Nigeria; National Agency for Food and Drug Administration Control (NAFDAC) have reported that MSG be maintained on the “Generally Recognized as Safe” (GRAS) - list of foods [8].

The Kidney is a paired organ located in the posterior abdominal wall, whose major functions include the removal of toxic metabolites and waste products from the blood and regulation of the amount of fluid and electrolytes balance in the body. Kidney function tests include; urinalysis, measurement of serum urea, creatinine, sodium, potassium and serum bicarbonate levels [9, 10]. Although some reports are available on the adverse effects of direct administration of MSG in kidney function, there have been a dearth of information of the effect of diet supplemented with MSG on kidney functions in rats. This study therefore aimed at evaluating the changes in kidney function parameters in rats fed MSG supplemented diets.

Materials and method

Reagents

TECO diagnostics Kits (Anaheim, U.S.A.) were used for the determination of serum electrolytes, urea and creatinine. All the chemicals used were of analytical grade.

66 **Monosodium Glutamate**

67 Ajinomoto a brand of monosodium glutamate manufactured by Ajinomoto Co., Inc. Tokyo, Japan
68 marketed by West African seasoning company limited was purchased from the Ultra modern market in
69 Minna Niger State, Nigeria. It was stored and protected from direct sunlight.

70 **Experimental Animals**

71 Healthy Wistar albino rats weighing between 120-150g were obtained from animal house centre,
72 college of Health Science, Benue State University Makurdi, Nigeria. They were conveniently housed
73 in the Department of Biochemistry laboratory, Federal University of Technology, Minna, under
74 standard environmental conditions (Temperature $27\pm 2^{\circ}\text{C}$, 70% Relative humidity and 12hrs day
75 light/night cycle). The rats were allowed free access to commercial growers feed pellets (product of
76 Bendel Feeds and Flour Mills, Ewu, Edo State, Nigeria) and water *ad libitum*. They were then allowed
77 to acclimatize to the laboratory condition for two weeks before the commencement of the experiment.
78 The cages were cleaned regularly throughout the experimental period. Animals were catered for in
79 compliance with internationally accepted principle for humane handling and use of laboratory animal.

80 **Experimental Diets**

81 Three different levels of supplementation with MSG (0.5, 1.0 and 5.0%) diets were prepared by adding
82 5g, 10g and 50g of MSG to 995g, 990g and 950g of standard feed respectively. The feeds were
83 pelletized according to the method of Larry, [11].

84 **Experimental Design**

85 A total of twenty (20) rats were randomly divided into four groups (A-D) of five (5) rats each and were
86 fed MSG supplemented commercial diets for four weeks.

87 Group A: The rats were fed normal commercial feed pellet and served as the control group

88 Group B: Rats were fed 0.5% MSG supplemented diets.

89 Group C: Rats were fed with 1% MSG supplemented diets

90 Group D: Rats were fed with 5% MSG supplemented diets

91

92 **Blood and Serum collection**

93 After four weeks of feeding the rats with supplemented diets containing different proportion of
94 monosodium glutamate, the rats were anesthetized using cotton wool soaked in chloroform and blood
95 was collected by decapitation into clean lithium heparinized bottles. The blood thus collected was

96 allowed to stand for 10 minutes at ambient temperature to clot. Thereafter, the serum was separated by
97 centrifugation at 1000 rpm for 10 minutes.

98 **Determination of Serum Electrolytes**

99 TECO diagnostic kit was used for the determination of serum sodium ion concentration according to
100 the method of Maruna and Trinder [12], potassium ion [13] and chloride ion [14].

101 **Determination of Urea and Creatinine Levels in Rats**

102 Urea and creatinine were determined using TECO diagnostic kit according to the methods of
103 Alexander and Griffith, [15] and Wilding and Kennedy, [16] respectively.

104 **Statistical Analysis**

105 Data were subjected to Analysis of Variance (ANOVA) using the statistical package for Social Science
106 (SPSS) 16.0 window versions. Results were presented as Mean $\pm$ Standard Error of Mean. Means with
107 difference were separated using the Duncan Multiple Range Test and results were considered
108 significant at $p < 0.05$.

109 **Results**

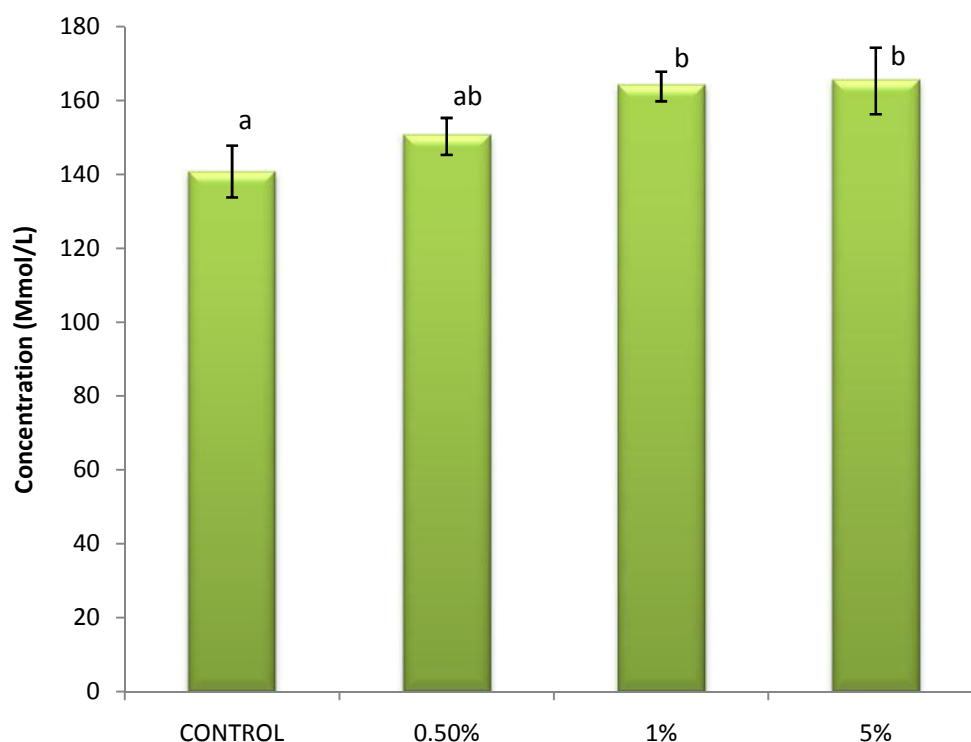
110 Figure 1 shows the effect of monosodium glutamate on serum sodium concentration of rats fed with
111 diets supplemented with MSG. In the experimental groups, there was a general increase in sodium ion
112 concentration with increased level of supplementation of MSG fed diet. However, there was no
113 significant difference ($p > 0.05$) in the concentration between the experimental groups and the control
114 group. The experimental groups supplemented with 5% MSG had the highest sodium ion concentration
115 (165.25 ± 9.14 Mmol/L) while the group placed on 0.5% MSG supplemented diet had the lowest sodium
116 concentration (140.75 ± 5.77 Mmol/L).

117 Figure 2 shows the effect of monosodium glutamate on serum potassium concentration of rats fed diet
118 supplemented with MSG. The potassium ion concentration ranged from 4.68 ± 0.16 mmol/L in the group
119 placed on 1.0% MSG supplemented diet to 6.00 ± 0.83 Mmol/L in the group supplemented with 5%
120 MSG. There was significant ($p < 0.05$) difference in the potassium ion concentration between the
121 control group and the experimental groups.

122 Rats placed on diet supplemented with 5% MSG, had the highest chloride ion concentration
123 (106.50 ± 6.89 mmol/L) while the groups placed on 0.5% and 1% MSG supplemented diet had similar
124 concentrations of 100.25 ± 8.23 Mmol/L and 100.25 ± 2.18 Mmol/L respectively. There was no

125 significant difference ($p>0.05$) in the chloride ion concentration between the control and experimental
126 groups (Figure 3).

127 The effects of monosodium glutamate on serum urea and creatinine levels are as shown in Figures 4
128 and 5 respectively. The urea concentration of rats placed on 0.5% MSG supplemented diet was
129 $6.28\pm0.10\text{mg/dL}$ while those fed with 1% and 5% supplemented diets were $6.53\pm0.66\text{ mg/dL}$ and
130 $7.13\pm0.36\text{mg/dL}$ respectively. The urea concentration of rats in the experimental groups were
131 significantly ($p<0.05$) lower than the control group. The creatinine concentration ranged from
132 $1.25\pm0.33\text{mg/dL}$ in group fed 1% MSG supplemented diet to $1.88\pm0.48\text{mg/dL}$ in rats placed on 5%
133 MSG supplemented diet. The creatinine concentration of rats in the experimental groups were not
134 significantly different ($p>0.05$) from those in the control group.

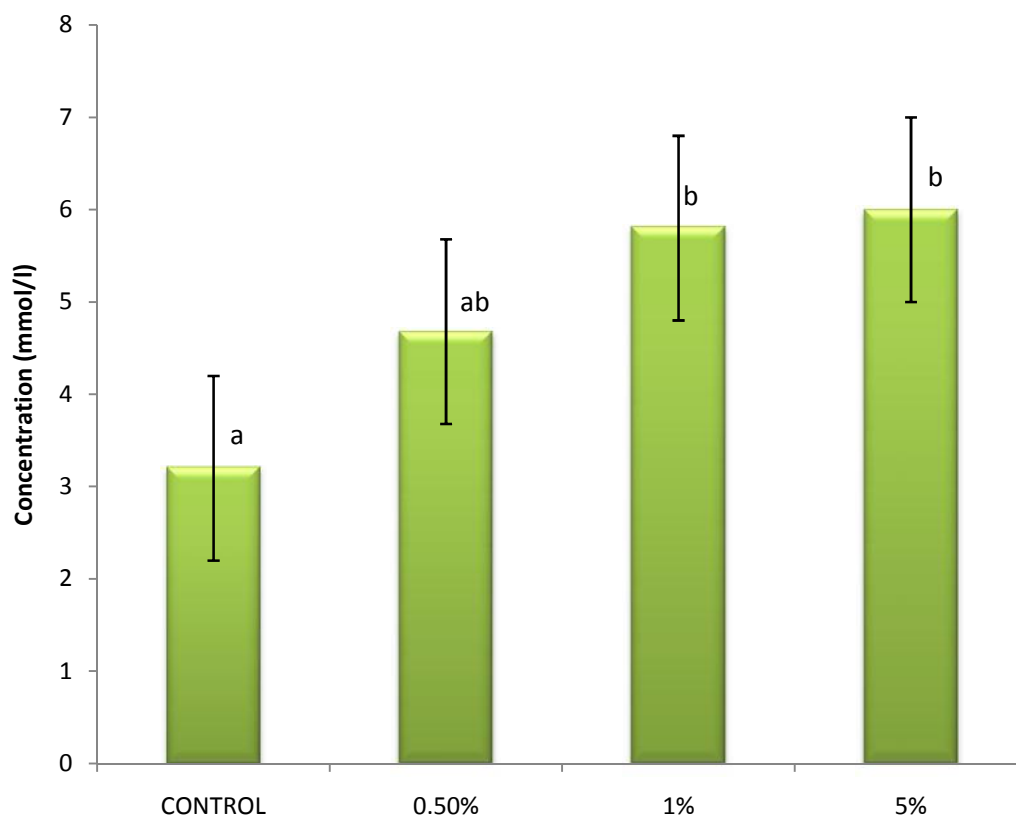


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136 **Figure 1: Serum sodium concentration (Mmol/L) in rats fed MSG supplemented diets**
137 *Values are Mean $\pm$ SEM (n=5). Bars with different alphabet are significantly ($p<0.05$) different from*
138 *Control group.*

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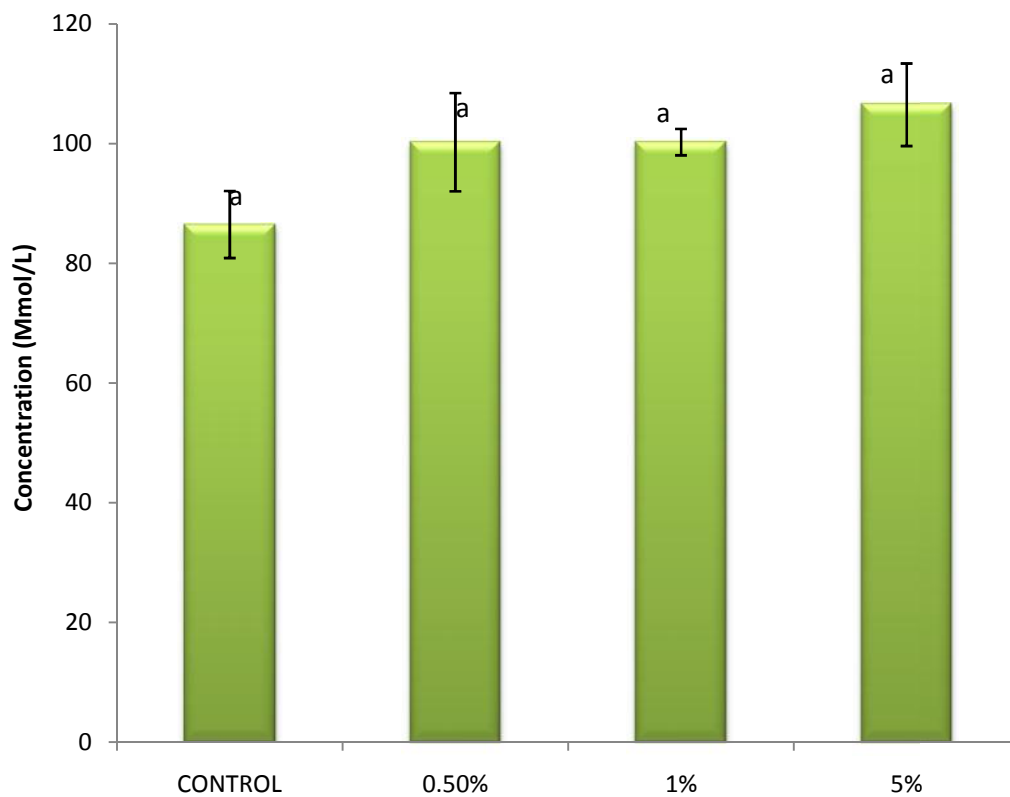
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142 **Figure 2: Serum potassium concentration (Mmol/L) in rats fed MSG supplemented die**
 143 Values are Mean±SEM (n=5). Bars with different alphabet are significantly (p<0.05) different from
 144 Control group.

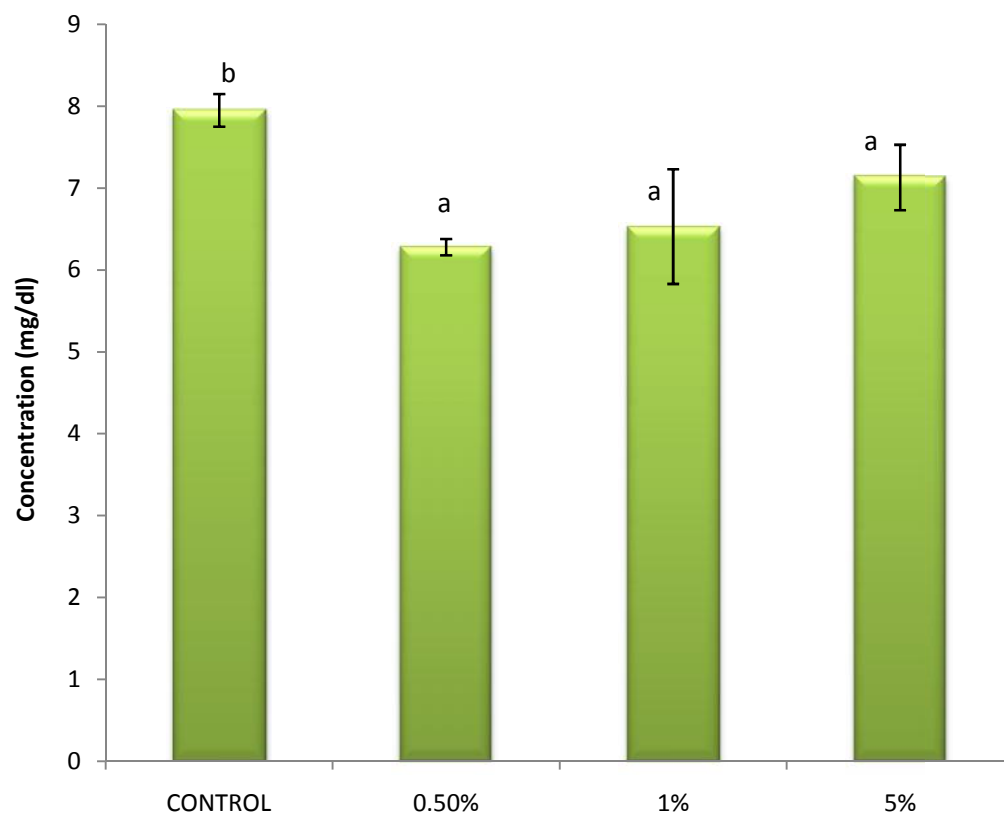
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147 **Figure 3: Serum chloride ion concentration (Mmol/L) in rats fed MSG supplemented diets**
 148 Values are Mean±SEM (n=5). Bars with different alphabet are significantly ($p<0.05$) different from
 149 Control group.

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151

152 **Figure 4: Serum urea concentration (mg/dl) in rats fed MSG supplemented diets**

153 Values are Mean±SEM (n=5). Bars with different alphabet are significantly ($p < 0.05$) different from
 154 Control group.

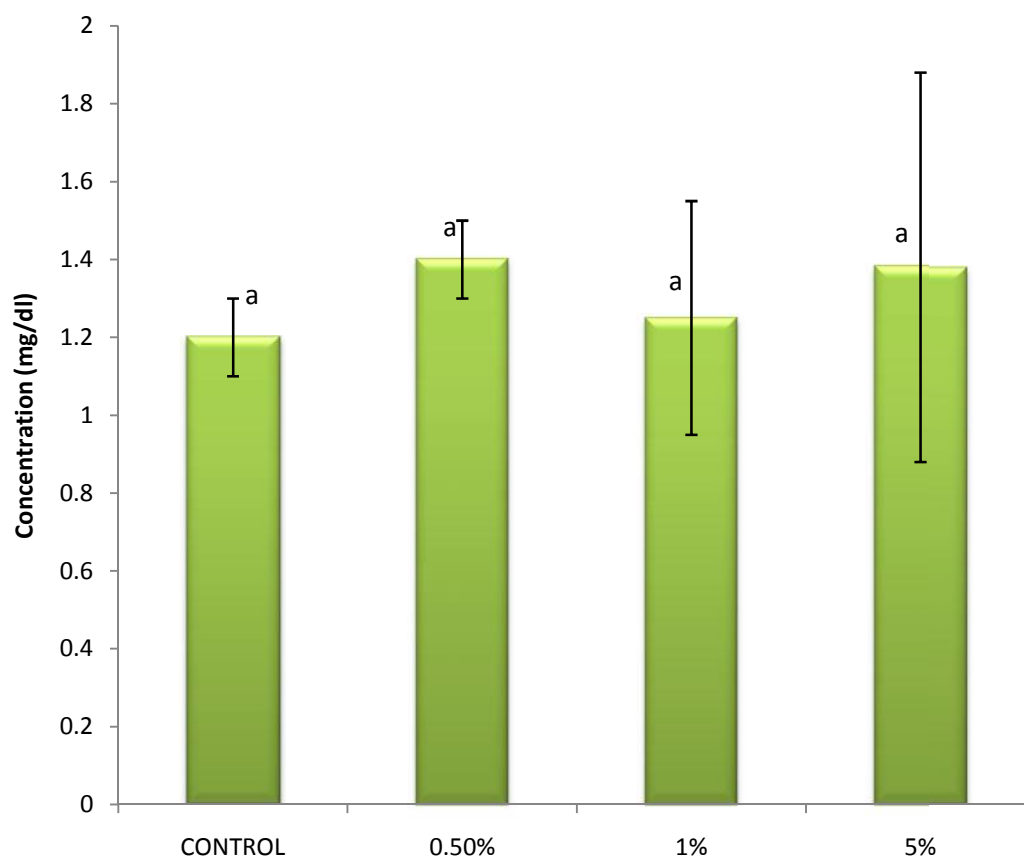


Figure 5: Serum creatinine concentration (mg/dl) in rats fed MSG supplemented diet
 Values are Mean±SEM (n=5). Bars with different alphabet are significantly ($p<0.05$) different from Control group.

DISCUSSION

Globally, dietary MSG has been consumed in large amount to induce preferences for foods [17]. Serum electrolytes are among the most commonly used laboratory tests for the assessment of a patient's diseased state.

The present study showed an increasing trend in the concentration of electrolytes with increasing MSG supplementation. Inuwa et al., [1] who evaluated the nephrotoxic and hepatotoxic effects of monosodium glutamate (MSG) consumption found similar increasing trend except with chloride ion (Figure 2). The non significant ($p>0.05$) change in the concentration of sodium and chlorine ions in the experimental groups also agrees with their findings.

169 The significant ($p<0.05$) increase in potassium level of the experimental groups (Figure 3) is consistent
 170 with findings of Ilegbedion et al., [4] who evaluated the effect of MSG on electrolyte balance and
 171 histology of gastroesophageal mucosa. The potassium ion concentration observed in experimental
 172 groups placed on 1% and 5% MSG supplemented diets was higher than the normal range 3.5 and 5.3
 173 mmol/L [18]. Values higher than this range may point at a condition referred to as hyperkalemia.
 174 Peterson and Levi, [19] reported that renal excretion is the major route of potassium elimination.
 175 William, et al., [20] reported that hyperkalemia may ensue when there is renal failure. Serum
 176 potassium is generally believed to rise above the normal limit only at the latter stage of chronic kidney
 177 disease (CKD) [21]. Eweka, [8] also reported the distortion of the cyto-architecture of the renal cortical
 178 structures and cellular necrosis associated with the kidney of rats administered MSG. Therefore, the
 179 concentration of potassium ion might have been elevated in the experimental groups possibly as a
 180 result of kidney dysfunction which may have resulted in poor excretion. Potassium homeostasis may
 181 also be altered by changes in acid-base balance, insulin, aldosterone and gastrointestinal and skin
 182 damages [19]. Moreso, according to He et al., [22], there are overwhelming evidences that laboratory
 183 animals exposed to MSG suffer neuroendocrine disorders. Ahmed and Wiesberg., [23] and Soliman,
 184 [24] had previously reported findings which explained that excess parathyroid hormone (PTH)
 185 increases basal levels of cytosolic calcium which affects the permeability of the cellular membrane to
 186 potassium thus decreasing extra renal disposal of potassium in chronic kidney disease.

187 Serum creatinine is a vital indicator of renal function [5, 8]. The concentration of serum creatinine in
 188 the experimental groups was not significantly ($p>0.05$) different from the control (Figure 5). The
 189 findings was not in agreement with that reported by Manal and Nawal, [5] who observed a significant
 190 rise in creatinine concentration and reported that administration of MSG may be attributed to alteration
 191 of the renal functional capacity. Inuwa et al., [1] also reported a significant elevation of creatinine level
 192 and suggested that MSG might have either interfered with creatinine metabolism leading to increased
 193 synthesis or the tissues might have compromised all or part of its functional capacity of tubular
 194 excretion [25]. The contrast observed might have resulted from either the concentration of MSG
 195 administered or the route of administration to the experimental animals.

196 Serum urea level significantly decreased in the experimental groups (Figure 4) and this agrees with the
 197 result obtained in the study of Manal and Nawal, [5]. It also agrees with the study of Egbonu et al.,
 198 [26] who reported a significant ($p<0.05$) reduction in urea concentration although was not in agreement
 199 with the work of Thomas et al., [27] who reported the protective effect of *Piper longum* Linn. on MSG

induced oxidative stress in rats. The significant reduction in serum urea concentration throughout the experimental groups might have resulted from impairment of the urea cycle (a down regulation of the urea synthesis) or increased excretion through the urine, probably as a result of MSG-induced toxicity.

Conclusion

Although the consumption of MSG has been controversial, yet, this study indicated that administration of MSG supplemented diets may elevate the level of potassium ion and decrease urea level resulting to hyperkalemia and hypouremia respectively.

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