The Effects Of Monosodium Glutamate On The Open Field Locomotor Activities In Adult Wistar Rats

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Citation

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Abstract

The effects of Monosodium glutamate (MSG) commonly used as food additive, on the open field locomotors activities of adult Wistar rats were carefully studied. The rats of both sexes (n=24), average weight of 185g were randomly assigned into two treatments (n=16) and control (n=8) groups. The rats in the treatment groups received 0.04mg/kg and 0.08mg/kg of MSG thoroughly mixed with their feeds for fourteen days, while the control rats received equal amounts of feeds without MSG added. The rats were fed with growers' mash purchased from Edo Feeds and Flour Mill Ltd, Ewu, Edo State and were given water liberally. The rats were taken from their home cages and placed randomly into one of the four corners of the open field, facing the centre and allowed to explore the apparatus for 5minutes as the various behavioral scores were measured.
The findings indicates that there was a significant difference ($P<0.05$) in the frequencies of line crossing, walling, grooming and hinding between the two treatments and control groups.

INTRODUCTION

Most food additives act either as preservatives or enhancer of palatability. One of such food additive is monosodium glutamate (MSG) and it is sold in most open markets and stores in Nigeria as “Ajinomoto” marketed by West African Seasoning Company Limited. Various environmental chemicals, industrial pollutants and food additives have been implicated as causing harmful effects [1] .

The safety of MSG's usage has generated much controversy locally and globally [2] . In Nigeria, most communities and individuals often use MSG as a bleaching agent for the removal of stains from clothes. There is a growing apprehension that its bleaching properties could be harmful or injurious to the body, or worse still inducing terminal diseases in consumers when ingested as a flavor enhancer in food. Despite evidence of negative consumer response to MSG, reputable international organizations and nutritionist have continued to endorse MSG, reiterating that it has no adverse reactions in humans. Notably of such is the Directorate and Regulatory Affairs of Food and Drug Administration and Control (FDA&C) in Nigeria, now NAFDAC has also expressed the view that MSG is not injurious to health [3] .

MSG improves the palatability of meals and thus influences the appetite centre positively with it resultant increase in body weight [4] . Though MSG improves taste stimulation and enhances appetite, reports indicate that it is toxic to human and experimental animals [5] . MSG has a toxic effect on the testis by causing a significant oligozoospermia and increase abnormal sperm morphology in a dose-dependent fashion in male Wistar rats [6] . It has been implicated in male infertility by causing testicular hemorrhage, degeneration and alteration of sperm cell population and morphology [7] . It has been reported that MSG has neurotoxic effects resulting in brain cell damage, retinal degeneration, endocrine disorder and some pathological conditions such as addiction, stroke, epilepsy, brain trauma, neuropathic pain, schizophrenia, anxiety, depression, Parkinson's disease, Alzheimer's disease, Huntington's disease, and amyotrophic lateral sclerosis [8] . It cannot be stated that MSG is the cause of such varied conditions as epilepsy and Alzheimer's disease, although there may be concerns of its involvement in its etiology.

The open field test provides simultaneous measures of locomotion, exploration and anxiety [9] . Stretch attend postures are “risk-assessment” behaviors which indicate that the animal is hesitant to move from its present location to a new position and thus a high frequency of these postures indicates a higher level of anxiety [10] . Grooming behavior is a displacement response and is expected to be displayed in a novel environment in an open field test [11] . Grooming

behaviors should, therefore, decrease with repeated exposure to the testing apparatus. Bindra and Thompson argued that there is no significant correlation between fearfulness, urination and defecation as measured in the open field test; however they agreed that defecation and urination in a novel environment are signs of emotionality, which is not to be equated with fearfulness or timidity [12] . Repeated exposure to the open field apparatus result in time dependent changes in behaviours [13] . At first, when the apparatus is novel to the animals more fear-related behavior (such as stretch attends and activity in the corners and walls of the open field) are displayed. However with repeated traits more exploration and locomotor activity (such as rearing and line crosses as well as more central square activity) is observed. There are, however, strain differences in behavior after repeated testing in the open field. With repeated exposure, some strains show such increased activity while others show habituation and decreased activity levels and others show no change [14] . This present study was to elucidate the effect of monosodium glutamate on the open field locomotor activity in adult Wistar rats.

MATERIALS AND METHODS

ANIMALS: Twenty four (24) adult Wistar rats of both sexes with average weight of 185g were randomly assigned into three groups A, B and C of (n=8) in each group. Groups A and B of (n=16) serves as treatments groups while Group C (n=8) is the control. The rats were obtained and maintained in the Animal Holdings of the Department of Anatomy, School of Basic Medical Sciences, University of Benin, Benin city, Nigeria. They were fed with growers' mash obtained from Edo feed and flour mill limited, Ewu, Edo state) and given water liberally. The rats gained maximum acclimatization before actual commencement of the experiment. The Monosodium glutamate (3g/ sachet containing 99+% of MSG) was obtained from Kersmond grocery stores, Uselu, Benin City.

MONOSODIUM GLUTAMATE ADMINISTRATION: The rats in the treatment groups (A and B) were given 0.04mg/kg and 0.08mg/kg of MSG, thoroughly mixed with the growers' mash, respectively. The control © group received equal amount of feeds (growers' mash) without MSG added for fourteen days. The 0.04mg/kg and 0.08mg/kg MSG doses were chosen and extrapolated in this experiment based on the indiscriminate use here in Nigeria due to its palatability. The two doses were thoroughly mixed with fixed amount of feeds (550g) in each group, daily.

APPARATUS: The open field apparatus was constructed with plywood and measured 72 x 72cm with 36cm walls. The walls and floor were both white. Blue lines were drawn on the floor with a marker and were visible through the clear plexi-glass floor. The lines divided the floor into sixteen 18x18cm squares. A central square of equal size was drawn in the middle of the open field (18 x 18cm) [15] .

PROCEDURE: The maze was located in a test room and lit by a fluorescent lamp for background lighting. The open field maze was cleaned between each rat using 70% ethyl alcohol to avoid odor cues. The rats were carried to the test room in their home cages and tested one at a time for 5 minutes each. Rats were handled by the base of their tails at all times. Rats were taken from their home cages and placed randomly into one of the four corners of the open field facing the centre and allowed to explore the apparatus for 5minutes. After the 5minutes test, the rats were returned to their home cages and the open field was cleaned with 70% ethyl alcohol and permitted to dry between tests. To assess the process of habituation to the novelty of the arena, rats were exposed to the apparatus for 5minutes on two consecutive days.

The behavioral score measured in this experiment includes:

- Line crossing: Frequency with which the rats crossed one of the grid lines with all four paws
- Rearing: Frequency with which the rats stood on their hind legs in the maze
- Rearing against a wall: Frequency with which the rat stood on their hind legs against a wall of the open field.
- Grooming: Frequency and duration of time the animal spent licking or scratching itself while stationary.

STATISTICAL ANALYSIS: The value obtained from the control and treatments groups were recorded and compared statistically using the statistical package for social sciences (SPSS)

RESULTS

There were significant differences ($P<0.05$) in the frequencies of line crossing, walling, grooming and hinding between the animals in treated and control groups during the period of MSG administration (as shown in table I,II III ,IV and V below).

Figure 1

Table 1: The Mean Behavioral Scores of the animals in the Open Field Test

No of Days	Open Field Test	Group C Control (n=8)	Treatment A(n=8)	Treatment B(n=8)
-12	Line crossing	45.4 ± 15.9	85.0 ± 17.1	97.3 ± 19.1
	Walling	4.2 ± 3.5	15.5 ± 3.3	18.0 ± 2.4
	Hinding	5.2 ± 3.6	5.0 ± 2.9	6.8 ± 5.2
	Grooming	4.4 ± 2.6	5.8 ± 1.2	1.5 ± 1.7
-9	Line crossing	3.4 ± 14.4	33. 0 ± 14.8	85.0 ± 30.6
	Walling	4.2 ± 2.2	5.0 ± 3.2	10.2 ± 5.4
	Hinding	2.6 ± 3.3	2.4 ± 2.2	4.8 ± 3.9
	Grooming	7.4 ± 4.8	4.8 ± 1.6	4.6 ± 2.2
-6	Line crossing	36.6 ± 11.2	55.2 ± 12.5	66.8 ± 44.5
	Walling	3.4 ± 3.4	10.2 ± 6.3	8.0 ± 6.0
	Hinding	1.8 ± 1.1	1.2 ± 1.9	2.8 ± 2.3
	Grooming	7.6 ± 5.2	2.4 ± 2.1	4.2 ± 0.5
-3	Line crossing	16.4 ± 11.0	45.0 ± 13.2	70.2 ± 29.6
	Walling	1.8 ± 1.3	8.9 ± 0.8	13.6 ± 2.3
	Hinding	0.2 ± 0.5	0.2 ± 0.4	1.6 ± 2.3
	Grooming	4.0 ± 4.2	3.6 ± 1.2	4.0 ± 2.7
0	Line crossing	34.6 ± 13.8	43.4 ± 6.2	57.4 ± 21.7
	Walling	4.6 ± 3.8	8.4 ± 3.7	11.8 ± 6.1
	Hinding	2.0 ± 2.5	2.0 ± 2.5	1.2 ± 1.8
	Grooming	4.0 ± 2.6	5.0 ± 2.8	3.8 ± 1.9
3	Line crossing	17.0 ± 9.4	26.8 ± 18.3	48.3 ± 10.8
	Walling	1.6 ± 1.5	4.6 ± 4.0	6.7 ± 5.5
	Hinding	1.4 ± 1.7	0.6 ± 0.6	0.3 ± 0.6
	Grooming	5.4 ± 1.7	3.6 ± 2.0	4.0 ± 2.6
6	Line crossing	26.0 ± 5.7	31.7 ± 2.9	34.3 ± 23.9
	Walling	1.4 ± 1.5	4.0 ± 2.7	2.7 ± 2.1
	Hinding	1.6 ± 1.3	1.0 ± 1.0	2.3 ± 1.2
	Grooming	6.2 ± 5.2	4.0 ± 1.7	4.0 ± 1.7
9	Line crossing	30.0 ± 22.0	31.7 ± 13.3	41.7 ± 21.1
	Walling	3.5 ± 2.7	2.0 ± 2.0	5.7 ± 3.8
	Hinding	1.8 ± 1.5	1.0 ± 1.7	1.7 ± 2.1
	Grooming	6.8 ± 2.6	3.3 ± 2.5	4.3 ± 3.2
12	Line crossing	31.5 ± 17.3	53.7 ± 20.6	36.7 ± 10.1
	Walling	3.3 ± 3.3	7.7 ± 2.5	4.3 ± 3.1
	Hinding	1.8 ± 1.3	1.7 ± 1.2	0.3 ± 0.6
	Grooming	7.5 ± 4.2	3.7 ± 2.1	1.7 ± 1.2

Figure 2

Table 2: The symmetric measures test of the line crossing frequency in open field test between the control (subject) and treatment (experimental) groups of animals

		Value	Asymp. Std. Error(a)	Approx. T(b)	Approx. Sig.
Nominal by Nominal	Contingency Coefficient	.943			.230
Interval by Interval	Pearson's R	.696	.137	2.565	.037(c)
Ordinal by Ordinal	Spearman Correlation	.700	.205	2.593	.036(c)
N of Valid Cases		9			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

c. Based on normal approximation.

Figure 3

Table 3: The symmetric measures test of the walling frequency in open field test between the control (subject) and treatment (experimental) groups of animals

		Value	Asymp. Std. Error(a)	Approx. T(b)	Approx. Sig.
Nominal by Nominal	Contingency Coefficient	.943			.230
Interval by Interval	Pearson's R	.687	.196	2.503	.041(c)
Ordinal by Ordinal	Spearman Correlation	.667	.273	2.366	.050(c)
N of Valid Cases		9			

a Not assuming the null hypothesis.

b Using the asymptotic standard error assuming the null hypothesis.

c Based on normal approximation.

Figure 4

Table 4: The symmetric measures test of the grooming frequency in open field test between the control (subject) and treatment (experimental) groups of animals

		Value	Asymp. Std. Error(a)	Approx. T(b)	Approx. Sig.
Nominal by Nominal	Contingency Coefficient	.907			.227
Interval by Interval	Pearson's R	.331	.273	.929	.384(c)
Ordinal by Ordinal	Spearman Correlation	.564	.277	1.808	.114(c)
N of Valid Cases		9			

a Not assuming the null hypothesis.

b Using the asymptotic standard error assuming the null hypothesis.

c Based on normal approximation.

Figure 5

Table 5: The symmetric measures test of the hinding frequency in open field test between the control (subject) and treatment (experimental) groups of animals

		Value	Asymp. Std. Error(a)	Approx. T(b)	Approx. Sig.
Nominal by Nominal	Contingency Coefficient	.928			.222
Interval by Interval	Pearson's R	.970	.023	10.543	.000(c)
Ordinal by Ordinal	Spearman Correlation	.962	.049	9.346	.000(c)
N of Valid Cases		9			

a Not assuming the null hypothesis.

b Using the asymptotic standard error assuming the null hypothesis.

c Based on normal approximation.

DISCUSSION

The result of this experiment revealed that MSG consumption caused significant (P<0.05) changes in the behavioral scored of line crossing, grooming, walling and hinding frequencies. The result of the open field locomotor activities in this study is in consonance with the findings of some investigators that recorded suppression of exploration and locomotor activities following drug administration

The number of line crossing and the frequency of rearing (hinding and walling) are usually used as a measure of locomotor activity. Ataxia and other gait disturbances that have been implicated with such drug as the antibiotics, chloroquine and quinine [16] . A high frequency of these behaviors indicated increased locomotion and exploration activities. In line with this study, it has been reported that administration of central nervous stimulant such as strychnine, picotoxin, theosemicarbazide, nikethamide, caffeine and amphetamine to rats resulted in suppression of exploration and locomotion [17] .

Behavioral studies have shown that intracerebro-ventricular injection of glucagons diminished spontaneous locomotor activity in rats and mice, impaired exploratory activity and reduced amphetamine-induced hyperactivity. In this study, the significant changes between the control and treated animal in line crossing, walling, grooming and hinding frequencies may have been attributed to the effect of monosodium glutamate

toxicity in the treated rats. Several studies have shown that high doses of monosodium glutamate can produce neurotoxicity such as selective damage to brainstem centres in mice and rats [18,19,20,21] .

Effects of some central nervous system stimulants such as amphetamines, leptazol, picrotoxin, strychnine and nikethamide have been reported to significantly suppress the open field exploration and locomotor activity in mice treated with these drugs. The significant difference in the locomotor activity of the treated animal compared to the control in this experiment might be partly due to the neurotoxic effects of MSG on the neuronal cells of the brain.

Fear behaviors which include closed arm activity, stretch attends, grooming, freezing, defecation and urination, implies a greater level of emotionality or fear [22,12] . In this experiment, there was a significant difference in the grooming, walling and hinding frequencies which are signs of emotionality. It therefore suggest that the emotional status of the experimental animals may have been implicated since the neurons of the medial geniculate body and perhaps that of the limbic system may be affected by the monosodium glutamate and, it is probable that the significant value obtained in this experiment in the line crossing, walling, hinding and grooming may have been due to the neurotoxicity effects of monosodium glutamate on the brain cells of adult wistar rats.

CONCLUSION AND RECOMMENDATION

In conclusion, this study revealed that consumption of MSG affects the locomotor activities in the Adult wistar rats. The line crossing, walling, hinding and grooming of the locomotor activities of the treated group in the open field test were significantly affected as compared to the control group.

It is recommended that further studies aimed at corroborating this finding be carried out.

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