# REPRODUCTIVE PERFORMANCE OF MICE ADMINISTERED VARIED CONCENTRATIONS OF MONOSODIUM GLUTAMATE

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## ABSTRACT

The impact of varied concentrations of monosodium glutamate (MSG) - a food additive, on the reproductive performance of mice was evaluated using 96 mice -28 males and 68 females, divided into four groups (n = 7 males and 17 females per treatment). Group 1 received no MSG, group 2 received 1 mg, group 3 received 2 mg, and group 4 received 4 mg per gm body weight of 40% aqueous solution of MSG every 48 hrs for six weeks, constitutingtreatment groups A, B, C, and D. After the sixth week, 15 female mice selected from each treatment were randomly allotted to three male mice of corresponding treatment for multiple mating for 48 hrs. The female mice from each treatment group were monitored through gestation after confirmation of copulation using vaginal plug as an index of mating. The conception rate and gestation length increased while the mean live weight of pups decreased with increase in the concentrations of MSG administered. Compared with the weights of pups from the control, the weight of pups from mice in treatment groups B and C decreased by 10.66 and 26%, respectively. The conception rate and the average number of pups decreased significantly ($P<0.05$) at 2mg of MSG/g BW compared to the control and those administered 1mg of MSG/g BW. The gestation length increased significantly ($P<0.05$) at 2mg of MSG/g BW (treatment C). Dead pups were recorded from mice administered 2mg of MSG/g BW. The result also showed that female mice administered 4mg of MSG/g BW did not give birth. The study revealed that high levels of MSG had adverse effect on the reproductive processes in the laboratory animal. The consumption of MSG, though a flavour enhancer food additive, should be reconsidered taking into account its potential adverse effects on reproductive processes.

**Keywords:** Monosodium glutamate; food additive, mice, reproduction.

## INTRODUCTION

Monosodium glutamate (MSG)is a food additive, popularly used as "flavour enhancer". It is the sodium salt of the non-essential amino acid-glutamic acid, one of the most abundant amino acids found in nature (Obochi *et al.*, 2009). It is marketed under series of trade names such as A-One, Ajinomoto or Vedan and a popular condiment in West African dishes (Obaseiki *et al.*,2003).

In Nigeria, commercial launderers and individuals often use MSG as a bleaching agent for the removal of stains from cloths and other textile materials and this excellent bleaching property of MSG could be harmful to tissues and organ of the body when ingested as a flavor enhancer in food. However, National Agency for Food and Drug Administration and Control (NAFDAC), the Nigeria Federal Government Agency with the responsibility to check and control consumable substances has expressed the view that MSG is not injurious orharmful to health (Samuels, 1999).MSG is thus reportedly permitted as a safe food additive that needs no specified average daily intake or an upper limit intake requirement (Samuels, 1999). Although once associated with foods in Chinese restaurants, MSG is now used by most fast food chains and in many foodstuffs, particularly processed foods (Rhodes *et al.*, 1991). Because of its flavour enhancing properties, glutamate is often deliberately added to foods, either as the purified monosodium salt (MSG) or as hydrolysed protein usually on individual's taste preferences (Geha *et al.*, 2000). Despite its taste stimulation and improved appetite enhancement, reports indicate that MSG is toxic to human and experimental animals (Belluardo *et al.*, 1990). The toxic effect of MSG was reported in a study on male Wistar rat

testis, in which significant oligozoospermia and increase abnormal sperm morphology in a dose-dependent manner was observed (Onakewhor *et al.*, 1998). In addition, administration of MSGhas been implicated in cases of male infertility as it causes testicular haemorrhage, degeneration and alteration of sperm cell population and morphology (Oforofuo *et al.*, 1997).This study wastherefore designedto evaluate the effect of varying concentrations of MSG on reproductive performance of mice

## MATERIALS AND METHODS

The study was carried out in the Department of Animal and Environmental Biology Laboratory, AdekunleAjasin University, Akungba - Akoko, Ondo State, Nigeria.

Ninety-six mice comprising of 28 males and 68females weighing 24-33g procured from the mice colony of the University of Ibadan, Ibadan, Nigeriawere housed in plastic cages and randomly assigned into one of four treatment groups A, B, C and D (n = 7 males and 17 females per treatment) after a 2-week physiological adjustment period.The animals were fed *ad libitum* with commercially prepared pelletized grower feed containing 15% crude protein, 7% fat, 10% crude fiber, 1.0% calcium, 0.35% phosphorus and 2550 Kcal/kg of metabolisable energyand drinking water was also provided *ad libitum*.

The micein Group A received no MSG, but normal saline water, group B received 1 mg, group C received 2 mg, and group D received 4 mg per gm body weight of 40% aqueous solution of MSG, prior to feeding every 48 hrs for six weeks, using a rat gavage needle.After the sixth week, three female mice from each treatment were allotted to a male mice of corresponding treatment (i.e. a male mice in group A was assigned to three female mice in group A, a male mice in group B to three female mice in group B, with the same procedure forgroups C and D, respectively) for multiple mating for 48 hrs. The female mice from each treatment group were monitored through gestation after confirmation of sexual intercourse using vaginal plug as an index of mating.At parturition, conception rate, gestation length, number of pups, mean litter size, number of live pups per litter, and pup weights were determined.

The experimental design adopted for this research was Completely Randomized Design (CRD).Data obtained were analyzed by ANOVA procedure of SAS®. The treatment means were compared using the Duncan procedure of the same software and result given P values of $< 0.05$ were considered significantly different.

## RESULTS AND DISCUSSION

The effects of varied concentrations of MSG on the reproductive parameters of mice are shown in Table 1. The conception rate, gestation length and weight of pups were significantly ($P<0.05$) influenced by the treatment. The conception rate and gestation length increased while the mean live weight of pups decreased with increase in the concentrations of MSG administered. Compared with the weights of pups from the control, the weight of pups from mice in treatment groups B and C decreased by 10.66 and 26% respectively. The conception rate and the average number of pups decreased significantly ($P<0.05$) at 2mg of MSG/g BW compared to the control and those administered 1mg of MSG/g BW. The gestation length increased significantly ($P<0.05$) at 2mg of MSG/g BW (treatment C). Dead pups were recorded from mice administered 2mg of MSG/g BW. The result also showed that female mice administered 4mg of MSG/g BW did not give birth, even when two female mice showed signs of pregnancy after copulation.

Food additives have been used to keep the quality, texture, consistency, taste, colour, alkalinity or acidity of foods to make them more acceptable to the users. Their use has reached alarming proportions and humans are daily exposed to these chemical substances in foods without defining the exact and safe limits (Sharma and Deshmukh, 2015). The dose-dependent lowered conception rate and elongated gestation lengths observed in this study revealed that MSG potentially affects reproductive development.The significantly lowered conception rate and loss of fertility observed in mice in treatment groups C and D respectively might be a result of complex factors including the reported toxic effects of MSG on testis (Oforofuo *et al.*, 1997; Onakewhor, 1998; Nosseir *et al.*, 2012) and degeneration of the uterus (Mondal *et al.*, 2016) on one hand and the ability of MSG to cross the placentary

barrier (Sharma and Deshmukh, 2015) on the other hand, raising the possibility of transplacental poisoning, as reported by Toth *et al.* (1987).

The significant concentration-dependent decrease in the weights of pupsis in agreement with the report of Hermanussen *et al.* (2006) that observed lower weight at birthin rats administered a dose of 5g of MSG orallyon the 3rd week of gestation compared with the control.Similarly, Diemen and Trindade (2010) reported that the weight of off spring of Wistar rats administered 20% MSG seems lower than the group administered 10% and the control group. Al-Qudsi and Al-Jahdali (2012) reported that MSG treated chick embryos had symptoms of growth retardations such as reduced whole body weight and length, neck length and beak length which is in consensus with this work.According to Fernandez (2005), rats born to mothers that consumed MSG during pregnancy had reduced levelsof growth hormone. The dose-dependent decrease in the body weight of pups observed in this study might be as a result of the reduction of growth hormone in pregnant mice administered MSG. Leitner and Bartness (2008) and Hermanussen *et al.* (2006) also cited a decrease in growth hormone in rats as a result of ingestionof MSG which might be due to the ability of MSG to cross the placental barrier in rat.

Mondal *et al.* (2014) also reported that MSG suppresses the physiological functions of the organ systems by reducing the availability of oxygen in tissues through the inhibition of the production of red blood cells. Al-Qudsi and Al-Jahdali (2012), in their study concluded that, administration of MSG could result in inadequate amounts of blood reaching the embryo therefore limiting the amount of nutrients transferred from yolk to embryo, leading to growth retardation.

The dose-dependent decrease in the average number of pups of the mice administered MSG was similar to the observation Diemenand Trindade (2010), that the control group of female Wistar rats had the highest number of offspring compared to other groups that were giving 10 and 20% of MSG. Hence, the decrease in the number of pups of mice administered 2mg MSG/gm BW could be attributed to the higher concentrations of MSG.

The number of dead pups observed in mice administered 2mg of MSG/g BW might be due to the ability of MSG to cross the placental barrier in rat.Also, the ability of MSG to cross the placental barrier in rats, as reported by Sharma and Deshmukh (2015), might be responsible for the death of pups of mice administered higher concentrations of MSG. The placenta provides oxygen and nutrients to developing foetus and removes waste products from the foetus. A defect in the placenta would affect the foetus which could be attributed to the possible causes of resorption of foetus in mice administered 4mg MSG/gm body weight in the present study, suggesting the possibility of transplacental poisoning of human foetus after the consumption of glutamate-rich food by the mother.

Mice administered with 4mg of MSG/g BW were unable to give birth. This can either be caused by abortion or infertility which is in consensus with the report of Onakewhor (1998) that MSG may be linked in cases of male infertility as it causes testicular haemorrhage, degeneration and alteration of sperm cell population and morphology.

## CONCLUSION

This study has shown that MSG is capable of producing alterations reproductive processes. Hence MSG, though a flavour enhancer food additive, must be carefully used in food preparation due to its influence on reproductive processes resulting in alterations in conception rate, gestation length, weight of resulting pups and survival of foetus.

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**Table 1: Reproductive performance of mice administered varied concentrations of monosodium glutamate (Mean ± SEM)**

| Parameters | Group A (Control) | Group B (1mg/g BW) | Group C (1mg/g BW) | Group D (1mg/g BW) |
|---|---|---|---|---|
| Conception rate (%) | 66.67[a] | 70.50[a] | 20.00[b] | - |
| Gestation length (days) | 20.25±0.25[b] | 20.75±0.25[b] | 22.00±0.41[a] | - |
| Average No of pups | 7.33±0.04[b] | 8.00±0.05[a] | 6±0.15[c] | - |
| Weight of pups (g) | 1.50±0.03[a] | 1.34±0.04[a] | 1.11±0.07[b] | - |
| No of dead pups | 0 | 0 | 6 | - |

[ab]: Means on same row with different superscripts differ significantly (P<0.05).