International Journal of Biomedical and Health Sciences
Vol. 3, No. 4 December 31, 2007
Printed in Nigeria

0794-4748/2007 $12.00 + 0.00

http://www.asopah.org

IJBHS 2007084/3409

Histological studies of the effects of monosodium glutamate on the ovaries of adult Wistar rats

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(Received September 21, 2007)

ABSTRACT: The effect of monosodium glutamate (MSG) used as food additive on the ovaries of adult Wistar rat was investigated. Both adult male and female Wistar rats (n=24) of average weight of 185g were randomly assigned into three groups A, B and C of (n-8) in each group. The treatment groups (A and B) were given 3g and 6g of MSG thoroughly mixed with the grower's marsh, respectively on a daily basis. The control group © received equal amount of feeds (Grower's march) without MSG added for fourteen days. The grower's mash was obtained from Edo Feeds and Flour Mill Ltd, Ewu, Edo State and the rats were given water liberally. The rats were sacrificed on day fifteen of the experiment. The ovaries were carefully dissected out and quickly fixed in 10% formal saline for routine histological procedures. The histological findings in the treated groups showed evidence of cellular hypertrophy, degenerative and atrophic changes with the group that received 6g of MSG more severe. These findings indicate that MSG may have some deleterious effects on the Oocytes of the ovaries of adult Wistar rats at higher doses and by extension may contribute to the causes of female infertility. It is recommended that further studies aimed at corroborating these findings be carried out.

Key Words: Monosodium glutamate; Histology; Oocytes; Female infertility; Vacuolations; Ovaries; Wistar rats.

Introduction

Pathological processes frequently involve the body's normal responses to abnormal environmental influences. Such noxious external influences as pathogenic microorganisms, trauma, dietary deficiencies and hereditary factors acting alone or in a complex interaction with environmental factors, cause diseases[1]. Various environmental chemicals, industrial pollutants and food additives have been implicated as causing harmful effects[2]. Most food additives act either as preservatives, or enhancer of palatability. One such food additive is Monosodium glutamate (MSG) and it is sold in most open market stalls and stores in Nigeria as "Ajinomoto" marketed by West African Seasoning Company Limited; as "Vedan" or "White Maggi" marketed by Mac and Mei (Nig) Limited.

The safety or otherwise of this product's usage has generated much controversy locally and globally[3]. 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 excellent bleaching properties could be harmful or injurious to the stomach mucosa, 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[4]. The Food and Drug Administration (FDA) of the United States reports that Monosodium glutamate is safe and that it should be maintained on the "Generally Recognized as Safe" (GRAS)-list of foods. MSG is thus reportedly permitted to be a safe food additive that requires no specified daily intake, or an upper limit intake requirement. 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[4]. When MSG is added to food, it provides a flavoring function similar to the naturally occurring free glutamate: which differ from the four classic tastes of sweet, sour, salty and bitter.

The toxic effect of MSG was further corroborated by the work done on the testis, causing significant oligozoospermia and increase abnormal sperm morphology in a dose-dependent fashion in male Wistar rats[4]. It has also been established that MSG may be implicated in cases of male infertility as it causes testicular hemorrhage, degeneration and alteration of sperm cell population and morphology [5].

Through its stimulation of the orosensory receptors and by improving the palatability of meals, MSG influences the appetite positively, and induces weight gain[6]. Despite its taste stimulation and improved appetite enhancement, reports indicate that MSG is toxic to human and experimental animals[7].

In 1968, the first published report of an adverse reaction to Monosodium glutamate appeared in the New England Journal of Medicine where it was reported that Monosodium glutamate was neurotoxic; killing brain cells, causing retinal degeneration, endocrine disorder and also associated with a number of pathological conditions such as addiction, stroke, epilepsy, brain trauma, neuropathic pain, schizophrenia, anxiety, depression, degenerative disorders such as Parkinson's disease, Alzheimer's disease, Huntington's disease, and amyotrophic lateral sclerosis[8,9].

The Ovary is a paired, egg-producing reproductive organ found in female organisms. The Ovaries also functions in the production of various steroid and peptide hormones like estrogen and progesterone which sub serve many functions in the reproductive system[10].

This work is carried out to investigate some probable histological effects of MSG on the Ovary and its likely involvement in female infertility in Nigeria. About 15% of cases of female infertility investigation will show no abnormality. In these cases abnormalities are likely to be present but not detected by current methods[11].

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 grower's marsh 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 3g and 6g of MSG thoroughly mixed with the grower's marsh, respectively on a daily basis. The control group © received equal amount of feeds (Grower's march) without MSG added for fourteen days. The rats were sacrificed on the fifteenth day of the experiment. The Ovaries were quickly dissected and fixed in 10% formal saline for routine histological techniques. The 3g and 6g 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.

Histological Study

The tissue were dehydrated in an ascending grade of alcohol (ethanol), cleared in xylene and embedded in paraffin wax. Serial sections of 7 microns thick were obtained using a rotatory microtome. The deparaffinised sections were stained routinely with haematoxyline and eosin. Photomicrographs of the desired results were obtained using digital research photographic microscope in the University of Benin research laboratory.

Results

The Ovaries of the control group showed normal histological features, illustrating a well defined zonal granulosa surrounding the Oocyte and compact Theca folliculi and the presence of some primordial follicles (Fig. 1).

The Ovaries of the treated groups showed some cellular hypertrophy of the Theca folliculi, complete distortion/destruction of the basement membrane separating the Theca folliculi from the zona granulosa. Degenerative and atrophic changes were observed in the Oocyte and zona granulosa; these were more pronounced in those that received 6g of MSG. There were marked vacuolations appearing in the stroma cells (Figs. 2 and 3).

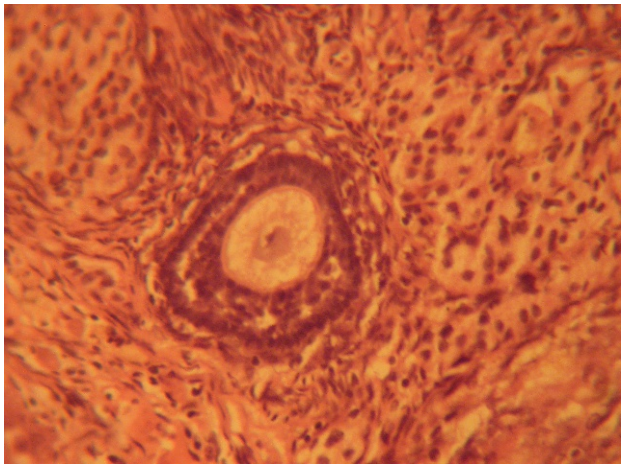

FIGURE: 1 Control section of the Ovary (Mag. x400).

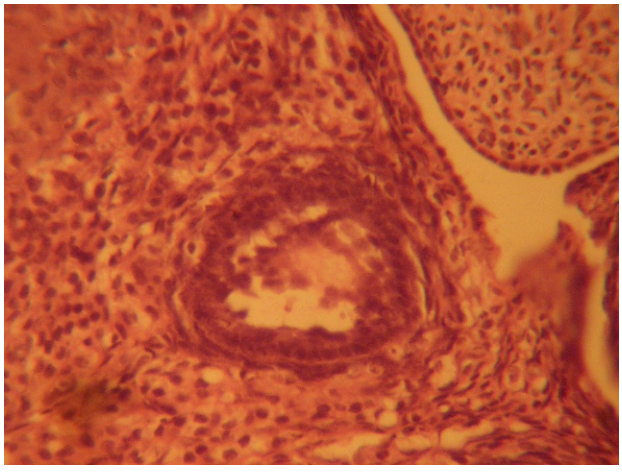

FIGURE: 2 Treatment section of the Ovary that received 3g MSG.(Mag. x400).

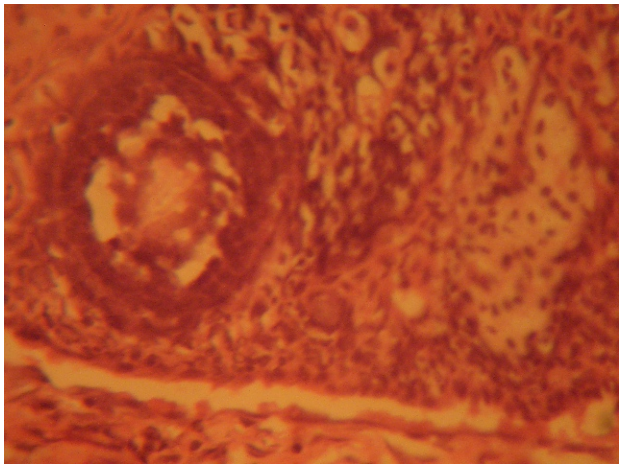

FIGURE: 3 Treatment section of the Ovary (6g MSG) (Mag. x400)

Discussion

The results of the haematoxyline and eosin staining (H & E) reactions showed some cellular hypertrophy of the Theca folliculi, complete distortion/destruction of the basement membrane separating the Theca folliculi from the zona granulosa. Degenerative and atrophic changes were observed in the Oocyte and zona granulosa; these were more pronounced in those that received 6g of MSG. There were marked vacuolations appearing in the stroma cell.

The increase in cellular hypertrophy of the Theca folliculi in the treatment groups as reported in this study may have been as a result of cellular proliferation caused by the improved intake of food which MSG influences[6=8].This corroborates the fact that MSG causes an increase in appetite and thereby leading to increase in weight and obesity[8]. The vacuolation probably indicates the presence of mucous. Degenerative and atrophic changes which were observed in the Oocyte and zona granulosa were more pronounced in the groups treated with higher dose (6g) of MSG.

It may be inferred from the present results that higher dose and prolonged administration of MSG resulted in degenerative and atrophic changes observed in the Ovaries. The actual mechanism by which MSG induced cellular degeneration observed in this experiment needs further investigation.

Degenerative changes have been reported to result in cell death, which is of two types, namely apoptotic and necrotic cell death. These two types differ morphologically and biochemically[12.] Pathological or accidental cell death is regarded as necrotic and could result from extrinsic insults to the cell such as osmotic, thermal, toxic and traumatic effects[13]. In this experiment MSG could have acted as toxins to the Oocyte and follicular cells of the Ovaries. The process of cellular necrosis involves disruption of membrane's structural and functional integrity which was also a landmark of this experiment. In cellular necrosis, the rate of progression depends on the severity of the environmental insults.

The greater the severity of insults, the more rapid the progression of neuronal injury[14].The principle holds true for toxicological insults to the brain and other organs[15]. It may be inferred from the present results that prolonged intake of MSG resulted in increase toxic effects on the Ovaries with that of higher dose more marked.

Conclusions and Recommendations

The results obtained in this study following the administration of 3g and 6g per day of MSG to adult Wistar rats caused some cellular hypertrophy of the Theca folliculi, complete distortion/destruction of the basement membrane separating the Theca folliculi from the zona granulosa. Degenerative and atrophic changes were observed in the Oocyte and zona granulosa; these were more pronounced in those that received 6g of MSG. There were marked vacuolations appearing in the stroma cell. It is recommended that further studies be carried out to corroborate these findings.

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