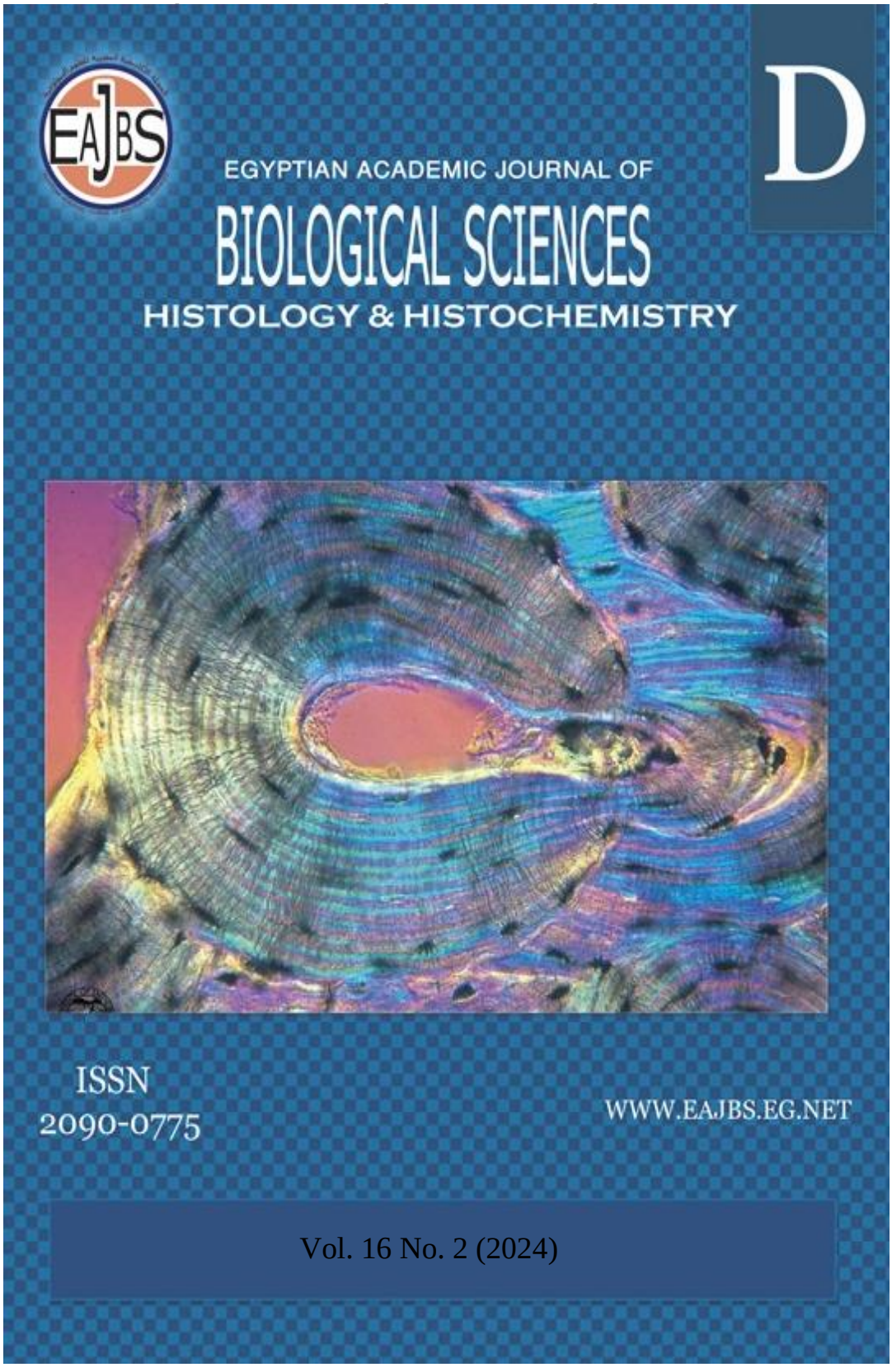

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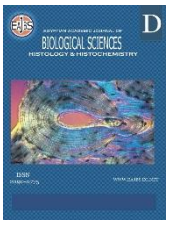

The Effects of Wheat Germ Oil as an Ameliorative Agent Versus Monosodium Glutamate on the Submandibular Salivary Gland of the Adult Albino Rat

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ABSTRACT

Background: One of the most popular taste enhancers in the world is monosodium glutamate (MSG). Wheat germ oil (WGO) exhibits antioxidant activity. The salivary glands play a crucial function in maintaining oral health and protecting teeth from caries. **Aim of the work:** to assess the concomitant use of WGO with MSG to ameliorate its destructive effects on submandibular glands. **Material and Methods:** Four groups of forty adult male albino rats were selected at random. Group I (negative control): received distilled water. Group II (positive control): received wheat germ oil (WGO) orally at 1.5 ml/Kg body weight once daily for eight weeks. Group III (monosodium glutamate treated group): received orally 15 mg/kg body weight of MSG once daily for 8 weeks. Group IV (monosodium glutamate and wheat germ oil treated group): received 15 mg/kg body weight of MSG once daily for 8 weeks in concomitant administration of wheat germ oil with a dose of 1.5 ml/Kg body weight. The rats were sacrificed, and the two submandibular salivary glands were extracted, and processed for light microscopic and ultrastructural study. **Results**: MSG induced destructive changes in the submandibular gland; disturbed architecture, vacuoles in acinar cells, and small and deeply stained nuclei. Vacuolated striated and convoluted ducts and blood vessels exhibited congestion, dilatation and extravasation. WGO administration in concomitant with MSG results in restoration of normal appearance apart from vacuolization and congested, extravasated blood vessels. **Conclusion:** MSG has a destructive effect on the structure of the submandibular gland and concomitant usage of WGO can ameliorate these effects.

INTRODUCTION

One of the most popular taste enhancers in the world is monosodium glutamate (MSG) due to its unique taste. It is a sodium salt of glutamic acid, which is produced when water ionizes it, releasing free sodium ions and glutamic acid. The last thirty years have seen a significant surge in MSG consumption (Kayode *et al.*, 2023).

Cheese, fermented soy products, yeast extracts, and tomatoes all contain MSG. It is absorbed in the small intestine of the human body, where it binds to TAS1R1-TAS1R3 receptors and stimulates the release of intracellular calcium, which excites the brain's taste center and produces an umami flavor of monosodium glutamate (Yang *et al.*, 2023). Although it is considered a safe food additive with no recommended daily dosage, its over-consumption has been related to pathological events in different body tissues and organs. MSG has neurological, cardiovascular and hepato-toxic impacts on excessive usage.

MSG disrupts the enzymatic activities of testosterone, gonadotropin-releasing hormone, luteinizing hormone (LH), and cholesterol levels in the serum, as well as the male accessory reproductive organs such as the prostate glands and epididymis. Male reproductive hormones were disturbed, sperm motility and count were decreased, and sperm morphology was altered by prolonged exposure to MSG. Additionally, changes have been found in the testes' histological structure (David *et al.,* 2024).

Exposure to MSG plays a primary role in the development and progression of metabolic disorders such as obesity, which leads to hypertension, diabetes mellitus and cancer initiation. One of the main ingredients in MSG and a significant contributor to hypertension and elevated blood pressure is dietary salt. Because MSG enhances the flavor of tobacco, smokers who consume large amounts of it run a higher risk of developing cancer. Depending on the amount ingested, MSG can have both beneficial and bad consequences. Despite debate regarding the safety of MSG and its potential to cause and worsen metabolic problems, its use is nonetheless widespread worldwide (Kayode *et al.*, 2023).

MSG has negative consequences on the human body, such as immunological disorders, cancer, metabolic syndrome, neurotoxicity, renal problems, cardiovascular disease, infertility, and underdevelopment of the fetus (Yang *et al.*, 2023).

High dosages of MSG consumed over an extended period cause oxidative stress by producing reactive oxygen species (ROS), which cause cytotoxicity in several bodily tissues. Degenerative changes in parotid gland acini and ducts were detected on Oral administration of MSG in albino rats. Acinar cells showed signs of atrophy and degeneration as vacuolation of cytoplasm, pyknotic or apoptotic nuclei. The striated secretory duct exhibited a dilation in the lumen and loss of its basal striations. MSG induced marked degenerative effects on parotid glands of albino rats (Abdel Rahman *et al.,*2023).MSG has also destructive apoptotic changes at acini and ducts of the submandibular salivary gland. Nuclear alterations and vacuolated cytoplasm were seen in the atypical organization of the mucous and serous acini (Imam& Salam, 2019).

A by-product of milling wheat, wheat germ (WG) is rich in bioactive substances. Wheat germ extracts (WGEs), which include a number of bioactive components, show antioxidant action. WGEs' bioactive components lower plasma lipid and oxidation levels. Thus, WG can be extracted using a variety of solvents and methods to be used as a natural antioxidant and nutraceutical (Liaqat *et al.,*2021). Wheat germ oil (WGO) possesses important functional and physiological characteristics and has been demonstrated to be a rich source of several essential dietary components (Siraj, 2022).

After infusing calendula flowers into WGO, a wide range of biological activities, including anti-oxidative activity and cell proliferation, are maintained. Through in-vitro research, the phytochemical content and biological impact of the infused oil on living cells are monitored. In comparison to non-infused cells, the cells infused with WGO exhibited significantly greater biological activity (cytotoxicity, wound healing, radioprotective activity, and cell-based antioxidant activity). As a nutritional supplement and in cosmetic items with chemotherapeutic effects, the produced formulation including WGO is seen to be a promising element (Gumus, *et al.,*2015).

WGO is a potentially useful component that has strong antioxidant qualities that can boost the body's natural antioxidant defense system. Developed hepatoprotective medication, caffeine in

a water-in-oil (W/O) emulsion with WGO stabilized by magnesium oxide nanoparticles (MgO NPs). Measuring inflammatory indicators, and oxidative stress parameters, and conducting a histological examination demonstrated the produced drug's strong hepatoprotective impact (Elmotasem *et al.,* 2018).

The salivary glands secrete saliva, which plays a crucial function in keeping Oral health, and protecting teeth from caries by sugar dilution, providing a buffering medium, a balance between demineralization and remineralization besides its antimicrobial role. Thus, any disturbance in the salivary gland structure will alter its secretion and lead to the development of caries and bacterial plaque accumulation as well as the development of periodontal illnesses disrupting the health of the mouth (Matczuk *et al.,*2016).

When combined, therapeutic herbs and nutritional supplements may be able to alleviate the negative effects of MSG (Yang *et al.,* 2023). So, in this research, we aimed to assess the impact of the concomitant use of wheat germ oil (WGO) with MSG to ameliorate its destructive effects on submandibular salivary glands in albino rats.

MATERIALS AND METHODS

Chemicals:

MSG was obtained in the form of powder Purity 99% NT product, CAS Number 142-47-2 by ALPHA CHEM Company in Egypt. The product is packed in the form of crystals that dissolve easily in water. WGO was purchased from Sedico Pharmaceutical Co., 6 October City, Egypt, was cleaned carefully to remove contaminates, collected and stored in an airtight container in a freezer (–20˚C) until it was further used.

Animals:

The present study was performed on forty adult (aged three months) male albino rats weighing (200-220) g each. These animals were acquired from the Assiut University Faculty of Medicine's Animal House and subjected to optimal care as food and water were added to adlibtum, exposed to 12 h dark/light cycle, kept at optimal temperature (25 ± 5) ºC and put in clean wooden ventilated cages. For adaptation, the animals were transported to their environment two weeks before the onset of the experiment. The experiment was conducted with ethics approval (local approval number: 04-2024-300448) and in compliance with the guidelines of the Faculty of Medicine of Assiut's Scientific Research Ethics Committee that adhere to the National Institute of Health's Guidelines for the Care and Use of Laboratory Animals.

Experimental Design:

In this study, the albino rats were split into four groups at random, with ten rats in each group.

Group I (negative control): distilled water was given to the rats in this group.

Group II (positive control): rats in this group received wheat germ oil (WGO) orally with a dose of 1.5 ml/Kg body weight once daily for eight weeks (Radi, *et al.,*2021).

Group III (monosodium glutamate treated group): The rats of this group received orally 15 mg/kg body weight of MSG once daily for 8 weeks (Imam& Salam, 2019).

Group IV (monosodium glutamate and wheat germ oil treated group): The rats of this group received 15 mg/kg body weight of MSG once daily for 8 weeks in concomitant with administration of wheat germ oil with a dose of 1.5 ml/Kg body weight (Radi, *et al.,*2021) and (Imam& Salam, 2019).

By the end of the eight weeks, the albino rats from all groups were anesthetized by phenobarbital (50 mg/kg) intraperitoneally, sacrificed, their chest walls were opened and intracardiac perfusion started immediately with an injection of 10% neutral-buffered formalin into the left ventricle, the perfusion continued until the output from the right atrium became clear, then dissection was performed, and the two submandibular salivary glands were extracted. The right one was processed

for light microscopic study while the left one was processed for ultrastructural study.

Light Microscopic Study:

The extracted right submandibular glands were cut into smaller pieces, fixed immediately in formalin 10% for 24-48 hours depending on the specimens' size, dehydrated in increasing alcohol grades and cleared in xylene. Finally, the specimens were embedded in paraffin and cut sagittally at 5-micron thickness and stained with hematoxylin and eosin staining. The stained slides will be photographed and examined by the optical microscope (OLYMPUS CX31-Japan) at the Department of Human Anatomy and Embryology, Faculty of Medicine, Assiut University for demonstration of the general histological structure.

Ultrastructural Study:

The extracted left-sided submandibular salivary glands were trimmed into very small pieces about (1x1 mm), immediately fixed in cold glutaraldehyde (4%) solution for twenty-four hours and washed four times in phosphate buffer with PH'7.2 (20 minutes for each wash), then the specimens were post-fixed in1% Osmium tetroxide for 2h. After that, another four washes in phosphate buffer were performed (20 minutes for each wash), and the specimens were dehydrated in ascending grades of alcohol and embedded in an Epon Araldite mixture. Semithin sections (0.5 micron) and ultrathin sections (50 nm in thickness) were obtained by the ultra-microtome. The semithin sections were stained with Toluidine blue and the ultrathin sections will be stained with lead citrate and uranyl acetate (Wyffels, 2021). The ultrathin sections will be photographed by the transmission electron microscope (Joel-JEM-100 CXII, Joel; Tokyo, Japan) at Assiut University Electron Microscopic Unit.

Immunohistochemical Study:

A caspase-3 immunohistochemical analysis was performed to assess the level of apoptosis. The previously prepared paraffin-embedded slices that had been treated in formalin (5 μm in thickness) were placed on slides that were electrically charged. Submandibular gland sections were treated with phosphate-buffered saline for five minutes, followed by an overnight incubation at 4°C with an antibody to caspase-3 at a dilution of 1:200 (In vitro gen; Sweden AB; Stockholm Sweden). After that, the sections were treated and incubated for one hour at room temperature with a secondary goat-anti-rabbit antibody (1:500) (In vitro gen; Molecular Probes; Eugene, Oregon, USA). Following a 15-minute incubation period in 3,3-diaminobenzidine, the slides were dehydrated, counter-stained with Mayer's haematoxylin, and mounted using dibutyl phthalate in xylene (DPX) (Shamel, *et al.*,2024).

Morphometric and Statistical Studies:

The acini's cell count will be measured in each of the various study groups. A CX41 optical microscope (Olympus, Center Valley, USA) with an Olympus U-CMAD3 digital camera interfaced to a computer will be utilized to view the stained sections at magnification x 400 area 17184.85Mm2. The data that is obtained will be shown as mean ± standard deviation (SD). The ANOVA test will be used to assess the researched groups' statistical significance. A p-value of less than 0.05 will be considered statistically significant.

RESULTS

A-Light Microscopic Results:

Examination of hematoxylin &eosin-stained sections in the control group revealed the normal histological architecture of the submandibular salivary gland; formed of a number of lobules separated by thin connective tissue septa with large excretory duct surrounded by blood vessels in between the lobules. Each lobule contained serous acini, and intercalated, striated and convoluted granular ducts (Fig. 1a). The acinar secretory cells showed a pyramidal shape and round basal

basophilic nuclei, intercalated ducts appeared lined with low cuboidal cells, while striated ducts lined with columnar cells with oval nuclei, regarding convoluted granular ducts, appeared lined with high columnar cells with characteristic acidophilic cytoplasm. The large excretory duct in between the lobules has a stratified lining (Fig. 2a&b). On examination of the monosodium glutamate (MSG) treated group the gland appeared with disturbed architecture, vacuoles in most of the secretory acinar cells, and nuclei appeared small and deeply stained. The striated and convoluted ducts appeared vacuolated with areas of cellular loss and blood vessels exhibited congestion, dilatation and extravasation of red blood corpuscles (Figs.1b, 2c&d). Examination of monosodium glutamate (MSG) +WGO treated group) showing; restoration of normal appearance like control apart from acinar cell vacuolization and congested, extravasated blood vessels (Figs.1c&2e).

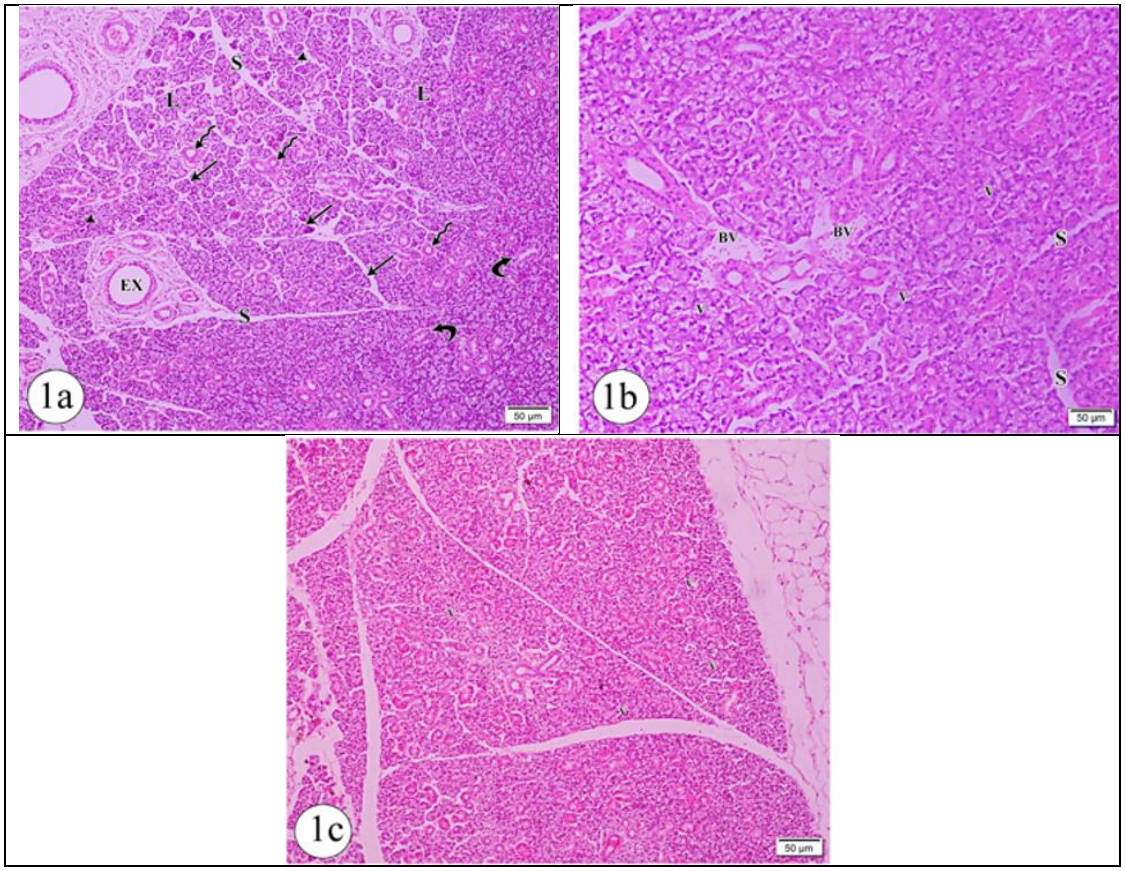


Fig.1(a): Photomicrographs of hematoxylin and eosin-stained submandibular gland sections of adult albino rat control(1a), MSG treated (1b), and MSG +WGO treated group(1c) showing. (1a): the normal histological architecture the gland formed of number of lobules (L) separated by thin connective tissue septa (S)with a large excretory duct (EX) surrounded by blood vessels in between the lobules. Each lobule contained serous acini (arrow), intercalated (arrowhead), striated (wavy arrow) and convoluted granular (curved arrow) ducts. (1b): showing disturbed gland architecture with wide connective tissue septa (S) and vacuoles in most of acini (V) and extravasation of red blood corpuscles (BV). (1c) showing the normal histological architecture appeared as the control group apart from some vacuoles (V)in acini.

(H&E × 200, Scale bar = 50 µm)

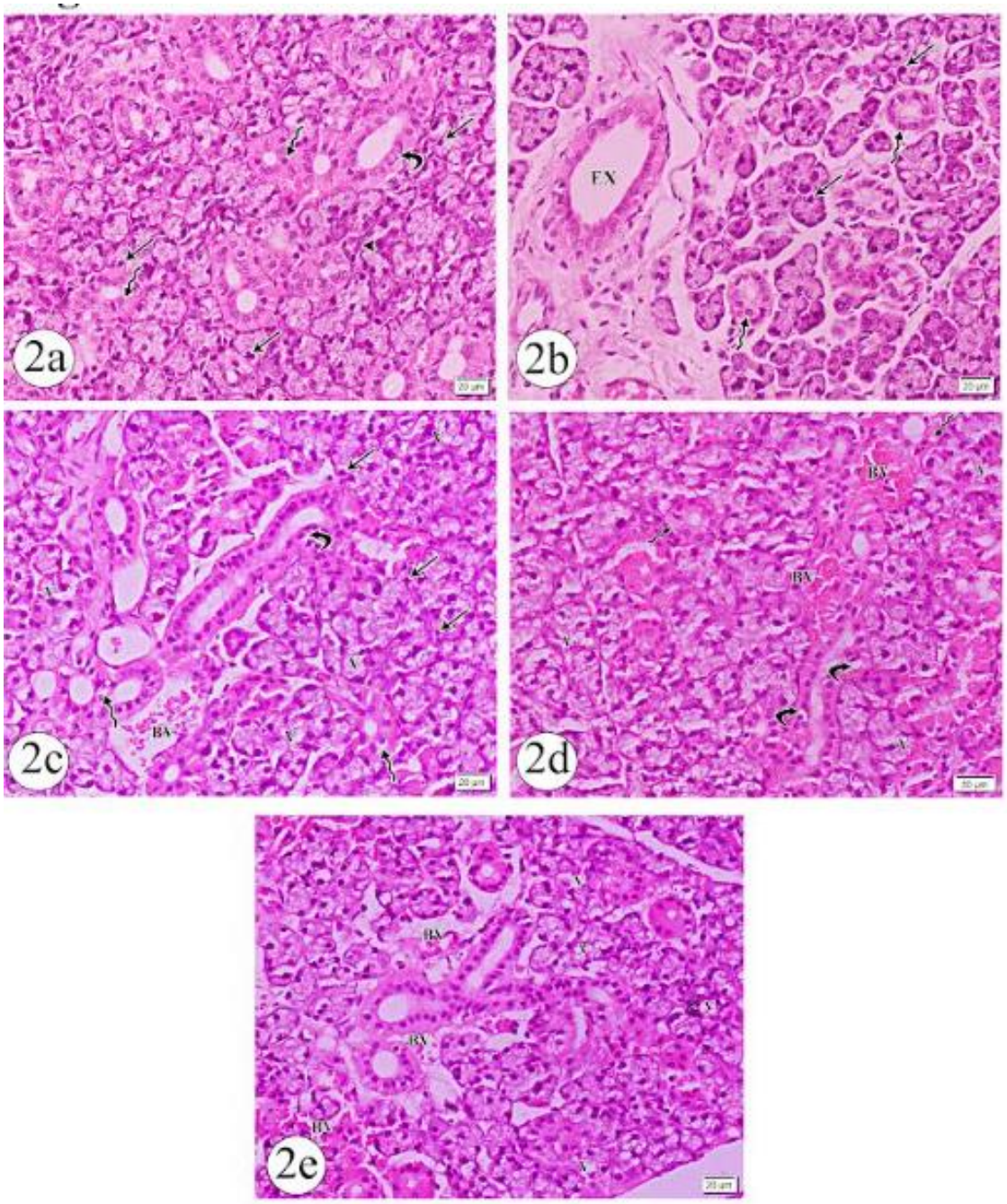


Fig 2: Photomicrographs of hematoxylin and eosin-stained submandibular gland sections of adult albino rat control(2a&b), MSG treated (2c&d), and MSG +WGO treated group(2e) showing:(2a&b); the acinar cells with characteristics deeply stained cytoplasm and rounded basophilic nuclei(arrow),intercalated duct lined with low cuboidal cells (arrow head),striated ducts lined with columnar cells with oval nuclei (wavy arrow),convoluted granular duct with characteristic acidophilic cytoplasm (curved arrow)and large excretory duct in between the lobules with its stratified lining (EX).(2c&d):showing; extensive vacuolization in acinar cells (V) some nuclei appeared small and deeply stained(arrow),striated ducts exhibited vacuolization (wavy arrow),granular convoluted duct showed vacuolization and tissue loss in some areas (curved arrow)and blood vessels appeared dilated, congested with extravasation in some areas(BV).(2e)showing; appearance similar to control apart from acinar cell vacuolization (V) and congested ,extravasated blood vessels (BV).

(H&E × 400, Scale bar = 20 µm)

Sirius Red Staining:

Fine collagen fibers were seen in the control group's Sirius-red stained sections around the blood vessels, acini, and spaces between lobules as well as in proximity to the ducts (Fig. 3a). Dense collagen fibers encircling acini, intralobular ducts, and blood vessels were seen in the MSG-treated group (Fig. 3b). Acini, ducts, and blood vessels were surrounded by a moderate number of collagen fibers in the MSG+WGO treated group (Fig. 3c).

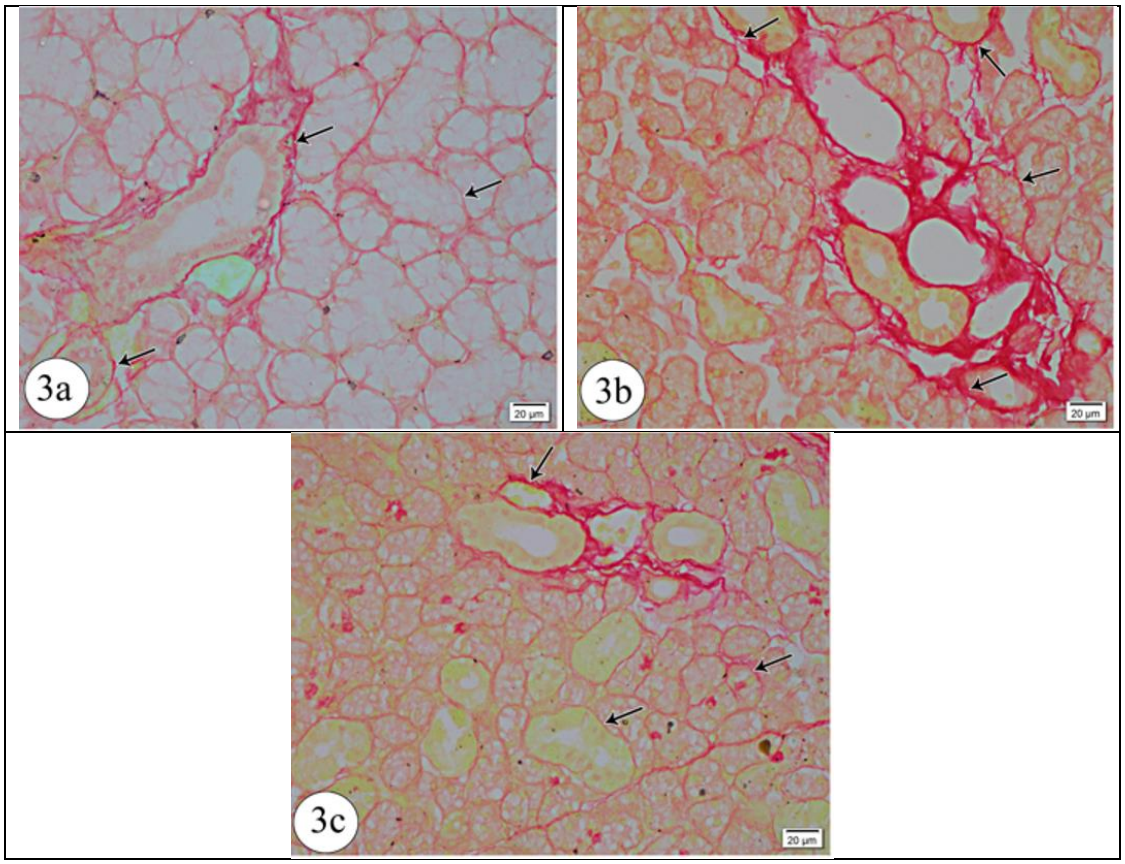


Fig.3: Photomicrographs of Sirius red stained sections in the submandibular gland in the control group (3a), MSG treated group (3b) and MSG+WGO treated group (3c) showing Fig. 3a: Fine collagen fibers (arrow) surrounding acini, the intralobular ducts and blood vessels. Fig. 3b: Intense collagen deposition (arrow) surrounding acini and intralobular ducts and their surrounding blood vessels. Fig. 3c: Moderate amount of collagen fibers (arrow) surrounding ducts, acini and blood vessels (BV).

(Sirius red X400 Scale bar = 20 µm)

Toluidine Blue Stained Semithin Sections:

An examination of semithin sections in the control group revealed the normal architecture of acinar secretory cells with basal round nuclei, and pale-stained secretory granules filling the cytoplasm surrounded by myoepithelial cells. The striated duct was also apparent with characteristics of basal striation, columnar lining, pale-stained secretory granules and wide lumen (Fig.4a). The MSG-treated group showed disorganized acinar cells, upward displaced, deformed nuclei in some cells, striated duct exhibited accumulation of secretory granules, disturbed lining epithelium and some vacuoles (Fig.4b). In the MSG+WGO treated group the secretory acinar cells and striated duct appeared as control apart from some vacuoles (Fig.4c).

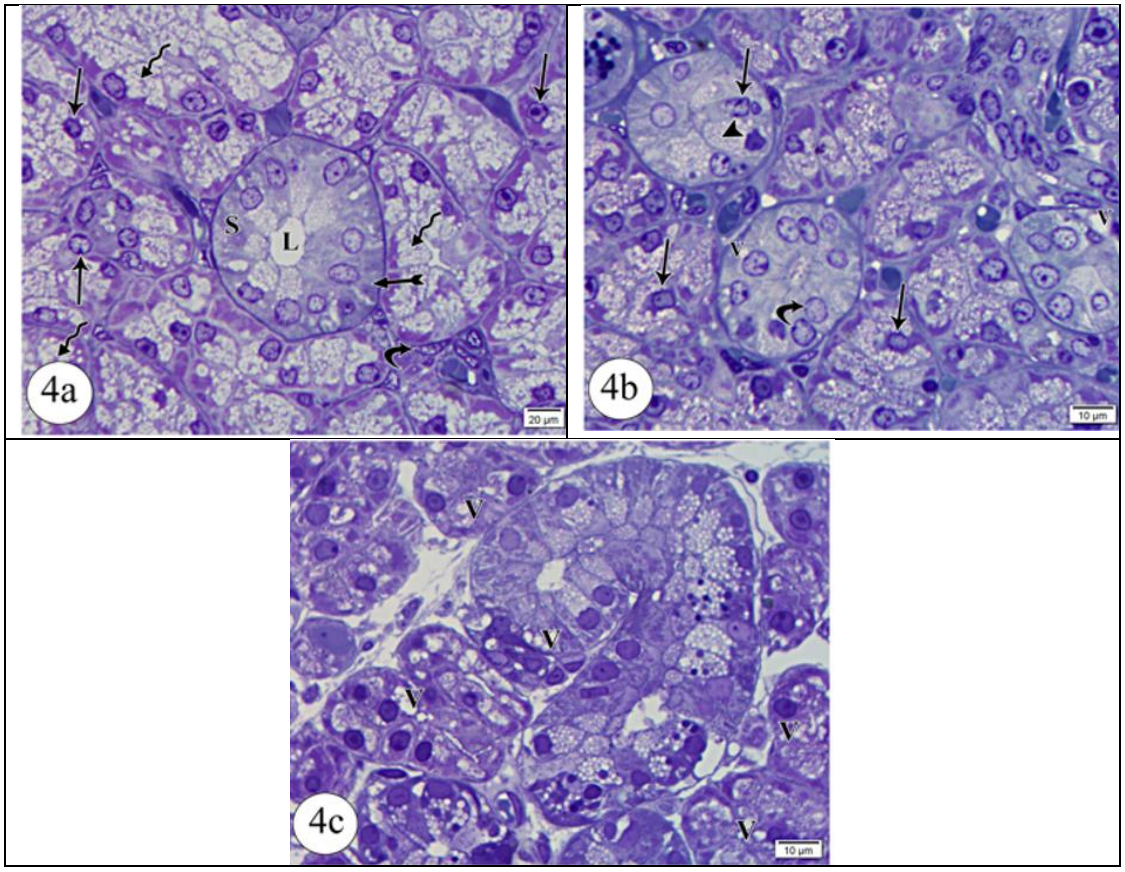


Fig.4: Photomicrographs of toluidine blue stained semithin sections in the submandibular gland in the control group (4a), MSG treated group (4b) and MSG+WGO treated group (4c) showing;(Fig. 4a):the acinar secretory cells with basal round nucleus (arrow),pale stained secretory granules filling the cytoplasm (wavy arrow) and surrounded by myoepithelial cells (curved arrow).The striated duct was also apparent (S) with characteristics basal striation (tailed arrow)and wide lumen (L). (Fig. 4b): showing disorganized acinar cells, upward displaced, deformed nuclei in some cells (arrow), striated duct exhibited accumulation of secretory granules (arrowhead), disturbed lining epithelium (curved arrow) and some vacuoles (V). (Fig. 4c): showing; the secretory acinar cells and striated duct appeared as control apart from some vacuoles (V). **(Toluidine blue X1000 Scale bar = 10 µm)**

B-Immunohistochemical Results:

On examination of the control group, a weak immunological response to caspase 3 was detected, as seen by the extremely mild brown coloring of the duct mainly (Fig.5a). The MSG-treated group had a strong positive immunoreaction to caspase-3, mostly manifested as a dark brown coloring around the acini and intralobular ducts (Fig.5b). The group treated with MSG plus WGO exhibited a moderately good response to caspase 3, primarily exhibiting a light brown coloration in the intralobular ducts (Fig.5c).

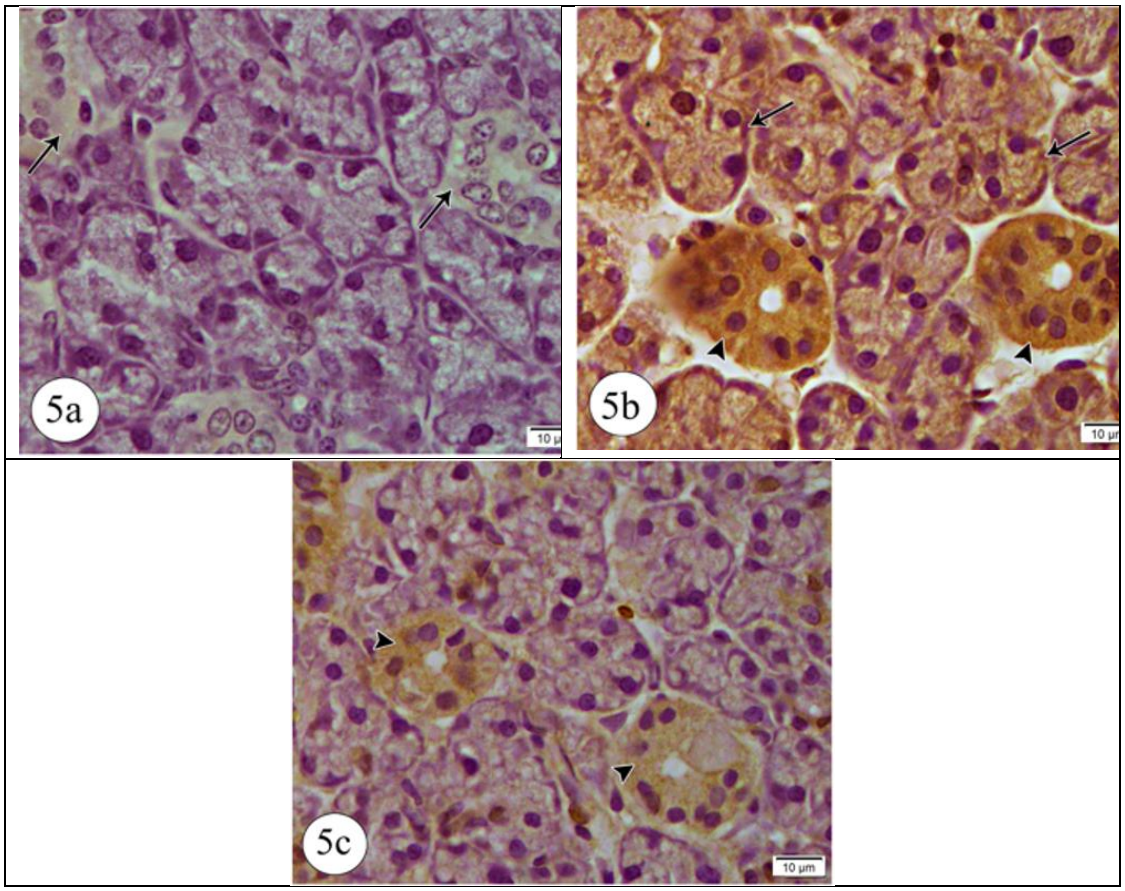


Fig.5: Photomicrographs of the submandibular gland in adult male albino rats exhibiting Caspase-3 immune-reactivity. (5a) The control group demonstrates a weak immunological response to caspase 3, as seen by the extremely mild brown coloring the duct mainly (arrow). (5b) The MSG-treated group had a strong positive immunoreaction to caspase-3, mostly manifested as a dark brown coloring around the acini (arrow) and intralobular ducts (arrowhead). (5c) The group treated with MSG plus WGO exhibited a moderately good response to caspase 3, primarily exhibiting a light brown coloration in the intralobular ducts (arrowheads). **(Caspase-3 immunostaining, X1000)**

C-Ultrastructural Results:

In the control group, normal ultrastructure of acinar cells was apparent with characteristic rounded basal euchromatic nucleus with well-demarcated nuclear membrane, most of the cytoplasm occupied by electron-lucent secretory granules, many closely backed parallel well-developed rough endoplasmic reticulum present in the basal cytoplasm and intact mitochondria were detected in the perinuclear region (Fig.6a). The striated duct showed normal lining with regular wide lumen, characteristics oval basal nucleus, abundant numerous mitochondria incorporated within the basal cell membrane infoldings, in addition to apical electron-lucent vesicles in apical part of cytoplasm (Fig.7a&b). The ultrastructural examination of MSG-treated acinar cells revealed fused abundant secretory granules compressing the nuclei with loss of their round appearance. The nuclei appeared heterochromatic with clumps of chromatin. The rough endoplasmic reticulum appeared dilated with the loss of its basal location. Some vacuoles were detected in the cytoplasm. Ballooned mitochondria and electron-dense bodies were also apparent in the cytoplasm (Fig.6b&c). The striated duct lining showed extensive vacuolization of cytoplasm, destructed less abundant mitochondria as compared to control, and the nuclei appeared rarified with loss of normal chromatin distribution,

accumulation of lipid droplets and electron-dense bodies (Fig.7c&d). Examination of ultrathin sections in MSG+WGO acinar-treated group revealed electron lucent secretory granules, and a rounded basal nucleus but the nucleus lost its euchromatic appearance, the cytoplasm contained a large number of well-developed, closely packed rough endoplasmic reticulum, and present in the basal cytoplasm, perinuclear intact mitochondria were detected but some vacuoles and electron-dense bodies were apparent in cytoplasm. The lining of the striated duct appeared normal as a control group apart from some vacuoles in the cytoplasm (Fig.6d&7e, F).

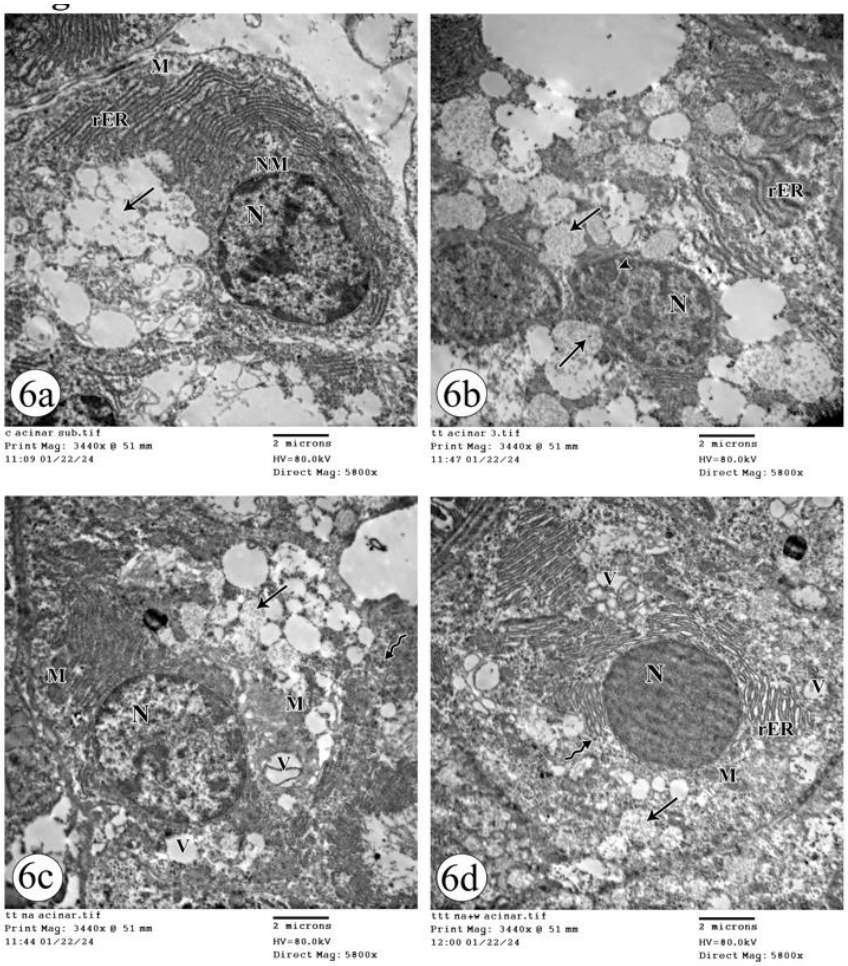


Fig.6: electron micrographs of ultrathin sections in acinar cells of submandibular gland in control(6a), MSG (6b&c) treated and MSG+WGO (6d) treated groups. [6a] showing normal ultrastructure of acinar cells with characteristic rounded basal euchromatic nucleus (N) with well demarcated nuclear membrane (NM), most of cytoplasm occupied by electron lucent secretory granules (arrow), a large number of closely backed parrel well developed rough endoplasmic reticulum (rER)present in the basal cytoplasm and intact mitochondria (M) detected in perinuclear region. [6b&c]: showing fused abundant secretory granules (arrow) compressing the nuclei (N) with loss of its round appearance. The nuclei appeared heterochromatic with clumps of chromatin(arrowhead). The rough endoplasmic reticulum (rER)appeared dilated with loss of its basal location. Some vacuoles (V) were detected in cytoplasm. Ballooned mitochondria (M) and electron dense bodies (wavy arrow) were also apparent in cytoplasm. [6d]: showing electron lucent secretory granules (arrow), rounded basal nucleus (N)but the nucleus lost its euchromatic appearance, the cytoplasm contained large number of well-developed, closely packed rough endoplasmic reticulum (rER), and present in the basal cytoplasm, perinuclear intact mitochondria(M) was detected but some vacuoles (V) and electron dense bodies (wavy arrow) were apparent in cytoplasm. **(TEM, X3600, 5800)**

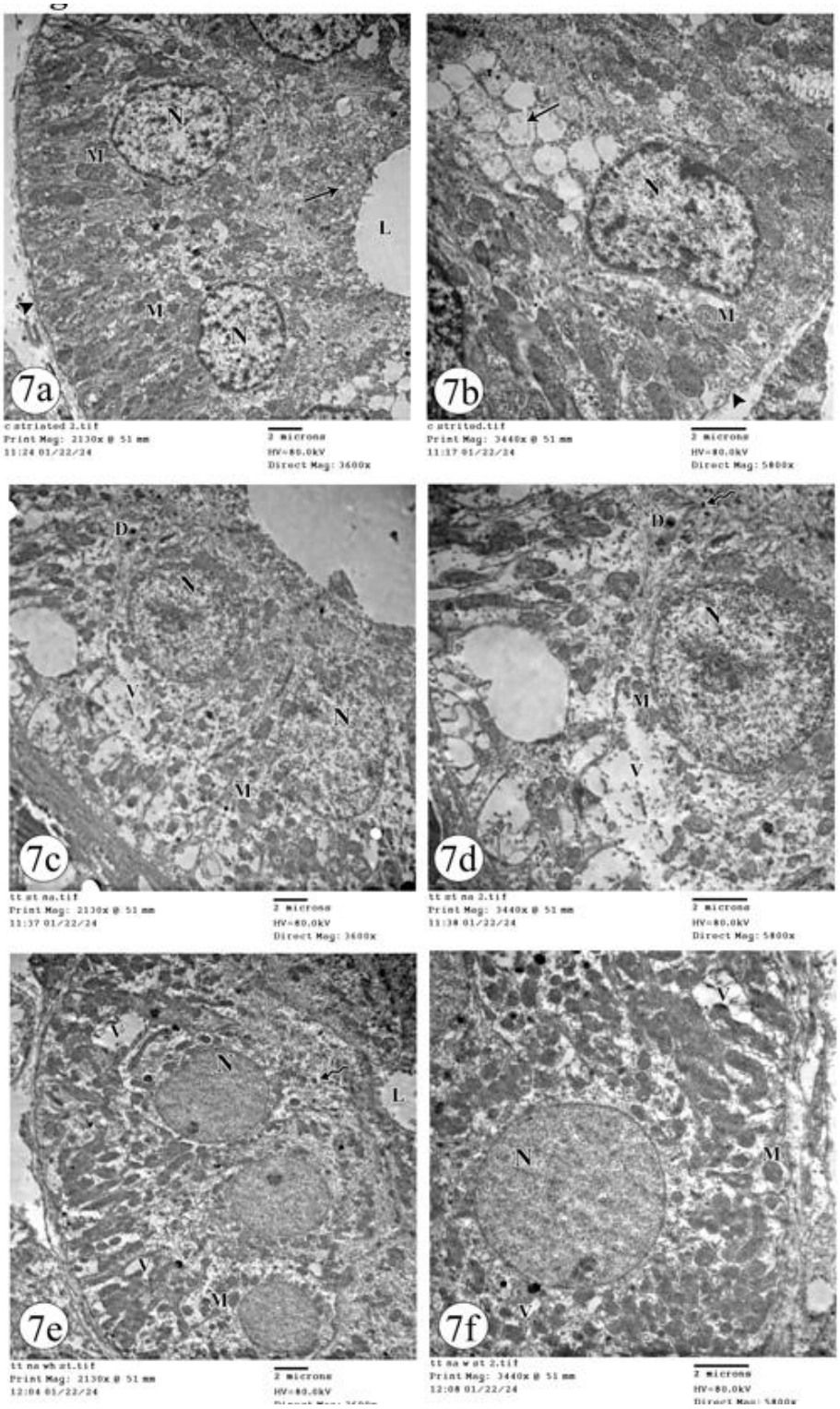


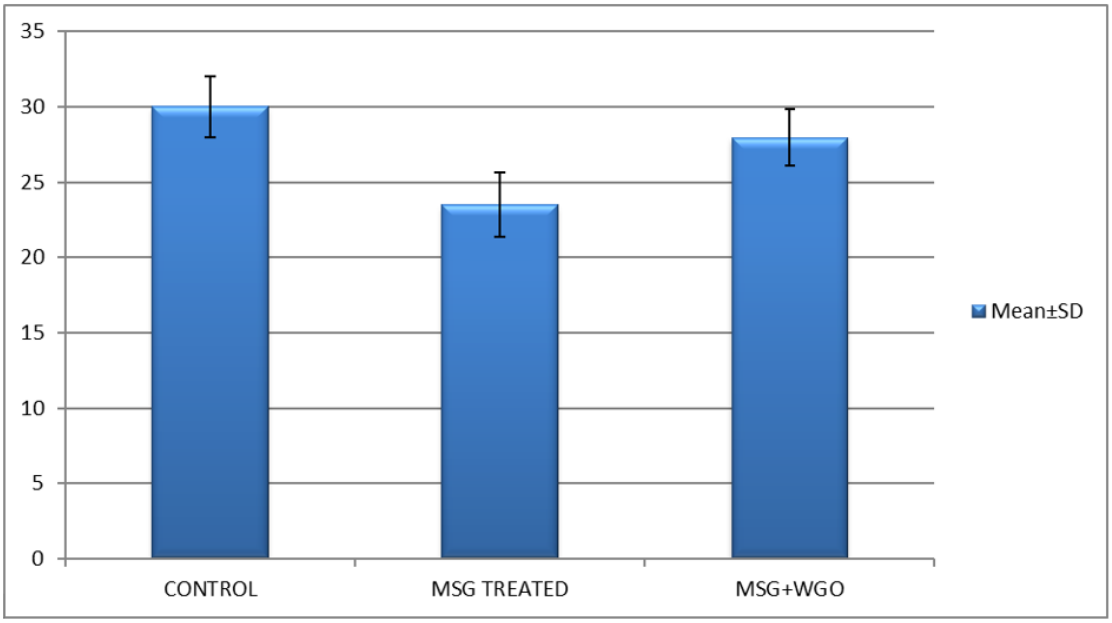
Fig.7: electron micrographs of ultrathin sections in striated duct of submandibular gland in control(7a&b), MSG (7c&d) treated and MSG+WGO (7e&f) treated groups. [7a&b]: showing; the normal lining of striated duct with regular wide lumen (L), characteristics oval basal nucleus(N), abundant numerous mitochondria(M) incorporated within the basal cell membrane infoldings (arrowhead), in addition to apical electron lucent vesicles(arrow) in apical part of cytoplasm. [7c&d] 7d a higher magnification of 7c showing; extensive vacuolization of cytoplasm(V), destructed less abundant mitochondria(M) as compared to control, the nuclei appeared rarified(N) with loss of normal chromatin distribution, accumulation of lipid droplet(D) and electron dense bodies (wavy arrow). [7e&f] 7f a higher magnification of 7e showing; the lining of striated duct appeared normal as control group apart from some vacuoles in cytoplasm (V). **(TEM, X3600, 5800)**

D-Morphometric Results:

The MSG-treated group exhibited a statistically significant decrease in acinar cell count as compared to the control group and (MSG+WGO) treated group was seen (Table 1 and Histogram 1).

Table 1: showing Number of cells (presented as mean ±SD) in the acini of submandibular salivary gland of adult albino rats of control, monosodium glutamate (MSG) treated and wheat germ oil (WGO) +MSG treated groups.

Group	CONTROL	MSG TREATED	MSG+WGO	P-value
Mean±SD	30.00±2.000	23.50±2.139	27.93±1.870	0.000



Histogram 1. Showing number of cells (presented as mean ±SD) in the acini of submandibular salivary gland of adult albino rats of control, monosodium glutamate (MSG) treated and wheat germ oil (WGO) +MSG treated groups**.**

DISCUSSION

Across the world, monosodium glutamate, or MSG, is used to improve the flavor of food. On the other hand, it adversely affects several organs in both humans and experimental animals (Imam& Salam, 2019). Since its discovery, MSG consumption has not been clearly linked to any negative health consequences on humans; yet, in recent years, MSG use has generated a great deal of debate. The deleterious consequences of MSG consumption, including general weakness, heart palpitations, and temporary numbness in the limbs, were originally documented in 1968 in the New England Journal of Medicine, where the condition was dubbed "Chinese Restaurant Syndrome. Furthermore, Results from animal studies suggested that MSG may be responsible for obesity, neurotoxicity, non-alcoholic fatty liver disease (NAFLD), and other conditions. Consequently, the safety of MSG remains a contentious issue that calls for a thorough examination of its impacts on health (Yang *et al.*, 2023).

According to Soliman, 2011, the ability of MSG to generate reactive oxygen species (ROS) and decrease the activity of antioxidant enzymes like superoxide dismutase activity (SOD) and glutathione metabolizing enzymes like

glutathione reductase and glutathione peroxidase led to its harmful effects. (Soliman,2011).

Pregnant animals' mothers who supplemented their diet with 1.125% MSG saw an increase in serum levels of high-density lipoprotein cholesterol, low-density lipoprotein cholesterol, total cholesterol, and triglycerides, as well as liver degeneration in their kittens. The kittens also developed insulin resistance (Collison *et al.*,2012). The obesity of offspring resulting from high-dose MSG ingestion during pregnancy in rodents can also cause dyslipidemia, hyperglycemia, hyperinsulinemia, and altered leptin signaling (Miranda *et al.*,2017). It's yet unclear if these consequences would manifest in people. Because MSG is a common flavor enhancer and increases food palatability, which in turn increases food intake, it has been documented to cause metabolic syndrome. Yet, MSG may disrupt the action of leptin, a hormone that tells the brain when an appetite is satisfied, hence reducing hunger (Shi *et al.*,2010).

Because WGO contains a wide variety of phytochemicals, it has many positive effects on nutrition and health. Numerous research investigated WGO's antioxidant capabilities, encouraging nutritional experts to investigate its nutraceutical features (Siraj, 2022). WGO demonstrates its antioxidant capacity by forming compounds with reduced metals and free radicals. According to several animal studies, administering WGO raises the levels of tocopherol and other bioactive substances in the heart, kidneys, liver, brain, and spleen, among other organs, and protects against oxidative stress (Field, *et al.,* 2008).

WGO is a useful food addition for preventing pesticide poisoning. WGO (1.5 mL/kg.bw/day) was tested experimentally for its antioxidant properties against oxidative stress and pesticide poisoning. The delivery of pesticides had a negative effect, although WGO improved the situation as indicated by oxidative stress indicators. Given the presence of bioactive ingredients, like, Vitamin E, phytosterols, and unsaturated fatty acids (Karabacak *et al.*,2011).

In the present study, the light microscopic examination of the MSG-treated group of HX&E-stained sections revealed the disturbed architecture of the submandibular salivary gland, vacuoles in most acinar cells, and nuclei appeared small and deeply stained. The striated and convoluted ducts appeared vacuolated with areas of cellular loss and blood vessels exhibited congestion, dilatation and extravasation of red blood corpuscles. Concomitant administration of WGO largely improves these deleterious effects. These results came in accordance with, Imam &Salam, (2019) who stated that MSG administration in rats revealed deleterious effects as some serous acini developed ill-defined borders, lost their typical organization, and had nuclear alterations that included big, hyperchromatic, pleomorphic, and occasionally pyknotic nuclei. The cell boundaries of the dilated striated and intercalated ducts were not clearly delineated. Moreover, there were larger blood vessels next to the striated ducts and in between the acini that were engorged with red blood cells (Imam& Salam, 2019).

In this experiment, examination of toluidine blue stained semithin section in MSG treated group showed disorganized acinar cells, upward displaced, deformed nuclei in some cells, striated duct exhibited accumulation of secretory granules, disturbed lining epithelium and some vacuoles. Concomitant administration of WGO largely improves these effects. These results agreed with Kumar *et al.* (2022) who reported that the salivary gland is impacted by monosodium glutamate, a presentation ingredient used in Chinese and fast meals as an artificial flavoring. Due to changes in taste pathways and sensation, MSG causes an increase in sodium ions in the salivary glands, which in turn increases salivary output. The daily recommended amount of MSG is 0.55 grams. Monosodium glutamate

toxicity results from increased absorption of monosodium glutamate. MSG damages ocular tissue and is a direct cause of diabetes, obesity, and epilepsy (triggering) cases. Its use ought to be avoided and reserved for the next generation (kumar *et al.* 2022).

According to Farombi& Onyema (2006), mitochondrial damage brought on by MSG is the cause of the cytoplasmic vacuolation observed in these studies. MSG increased the production of O2 and O2-free radicals, which in turn increased lipid peroxidation and served as a critical messenger for many clinical illnesses by increasing cytosolic-free calcium, which in turn increased membrane permeability and cell swelling. To keep ATP levels up, glycolysis was done, which caused lactic acid to be produced and the intracellular pH to decrease. This resulted in the failure of sodium-potassium ATPase, which in turn caused damage to cell membranes, lysosomes, and mitochondria (Farombi & Onyema 2006).

Regarding the found nuclear pleomorphism, these results were somewhat related to AL-Mosaibih, 2013, who reported that hepatocyte nuclei showed pyknosis and pleomorphism in a study employing rat liver cells administered with 30 mg/kg body weight of MSG. Furthermore, in line with Khalaf and Arafat's (2015) study, which examined the effects of different MSG dosages on the thyroid gland's morphometric and histological changes, including the formation of numerous pyknotic nuclei in both follicular and interfollicular cells and follicular hyperplasia in some follicles. According to Aisha, (2013), this pyknosis of the cell nuclei may be a sign of the cells' decreased functional effectiveness (Al-Mosaibih,2013), (Khalaf, & Arafat,2015) and (Aisha, 2013).

Furthermore, the histological data demonstrated a loss of normal glandular architecture, which was more pronounced in the group that received MSG treatment. This was in line with the findings of Dixit (2013), who reported a similar result in the kidney, and Kumbhare *et al.,* (2015), who reported cyto-architectural alteration in the liver of adult rats treated with MSG. Furthermore, Rani *et al.,* (2013) showed that the thyroid of the MSG-treated group had similar results, with some follicles appearing deformed, triangular, and rectangular in shape (Kumbhare *et al.,*2015), (Dixit, *et al.,*2013) and (Rani *et al.,* 2013)

Concurrently, the MSG-treated group's inflammatory cell infiltration in connective tissue was consistent with research by Kumbhare et al. (2015), which reported that leucocytes migrated chemotaxis-wise, or toward the site of inflammation, in response to any harmful agents that the body tissue encountered. Moreover, Aisha (2013) observed dilated, congested intertubular blood vessels of the testis in MSG-treated animals, which was consistent with the dilated and congested blood vessels seen in the MSG-treated group. Prostaglandin synthesis is known to be involved in blood flow regulation, which may account for the constriction of blood vessels as reported by Oladipo (2015). Furthermore, in line with Eweka *et al.,* (2011), who reported that oral MSG in adult rats resulted in liver architecture modification, hemolysis of RBCS in the central vein, hemorrhagic necrosis in the centrilobular, and other effects (Kumbhare *et al.,*2015), (Aisha, 2013), (Oladipo *et al.,* 2015) and (Eweka *et al.,* 2011).

In our study examination of Sirius red-stained sections in the MSG-treated group showed dense collagen fibers encircling acini, intralobular ducts, and blood vessels and this came in accordance with, Dosuky, *et al.* (2018) who stated that hepatic fibrosis by collagen fiber deposition; this was consistent with earlier research that found rats treated with MSG produced an area of hepatic necrosis and fibrosis (Ortiz *et al.,*2006) and (Onyema *et al.,*2006). Additionally, after treating rats with MSG Egbuonu *et al.* (2008).

documented biliary proliferation and peribiliary fibrosis. Additionally, oxidative stress may contribute to the progression of hepatic fibrosis and degeneration, according to a study done by Yaqub *et al.* (2008).

In this study examination of ultrastructural electron micrographs of MSG treated group showed acinar cells with fused abundant secretory granules compressing the nuclei with loss of their round appearance. The nuclei appeared heterochromatic with clumps of chromatin. The rough endoplasmic reticulum appeared dilated with the loss of its basal location. Some vacuoles were detected in the cytoplasm. Ballooned mitochondria and electron-dense bodies were also apparent in the cytoplasm. Moreover, the striated duct lining showed extensive vacuolization of cytoplasm, destructed less abundant mitochondria, rarified nuclei with loss of normal chromatin distribution, and accumulation of lipid droplets and electron-dense bodies. Concomitant administration of WGO greatly improved most of these changes.

Our findings corroborated those of Imam& Salam, (2019) who revealed that the ultrastructural results of their investigation showed indications of cell damage, such as a wide perinuclear membrane, dilated rough endoplasmic reticulum (RER), irregular nuclei with heterochromatin clumping and margination, degenerated mitochondria, and poorly defined secretory granules.

Additionally, in line with the findings of Khalaf & Arafat (2015), They noticed that follicular cells exhibited irregular hyperchromatic nuclei, noticeable RER dilatation, and enlarged lysosomes with patches of short or missing apical microvilli after applying doses of 3 g/kg bw and 6 g/kg bw of MSG daily for a month, respectively (Khalaf, & Arafat,2015).

Furthermore, the cytoplasmic organelles, including lysosomes, the Golgi apparatus, mitochondria, and rough endoplasmic reticulum, were destroyed, according to our electron microscope results. These might result from MSG's cytotoxic effects. According to Thomas, (1988) who clarified that the Golgi apparatus is in charge of packaging the hydrolytic enzymes involved in the creation of secretary products. Science says that when the Golgi apparatus is destroyed, lysosomes are destroyed as well, which increases the secretion of hydrolytic enzymes that may be the cause of the cytoplasmic organelles' demise. This contradicts the findings of Onaolapo, *et al.,* (2013) who found that groups of rats administered MSG/SD did not exhibit any morphologic signs of liver or kidney damage, even in the presence of biochemical disturbances.

In this experiment, our immunohistochemical findings showed a strong positive immunoreaction to caspase-3, in MSG treated group. The group treated with MSG plus WGO exhibited a moderately good response to caspase 3. Our findings were in line with those of Shredah &Nagy, (2017) who examined the effects of two different doses of MSG on the sublingual salivary gland using histology and immunohistochemistry, concluding that the changes were degenerative.

The current study's histomorphometric and immunohistochemistry findings agreed with the histology findings. Caspase 3 was used as an apoptotic marker in immunohistochemistry to show apoptotic cell death. This was in line with the findings of Eweka, & Adjene. (2007) showed that monosodium glutamate (MSG) caused neuronal cell death and suggested that neurotoxins may cause the apoptotic death pathway in brain cells.

In fact, the treatment of monosodium glutamate (MSG) in mice was found to greatly increase the rate of thymocyte programmed cell death (Pavlovic *et al.,* 2007). They proposed that oxidative stress caused by monosodium glutamate (MSG) significantly raises thymocyte levels of malondialdehyde (MDA) and xanthine oxidase (XO) activity. These substances accumulated and caused an

uncontrollably high intracellular calcium concentration, which through a number of processes aids in cell death (Narayanan *et al.*2010).

WGO regulates the increased ROS generation in mammals and lessens DNA oxidative damage. Wheat germ oil is rich in essential fatty acids, such as oleic, linoleic, and alpha-linolenic acids, which support lipid peroxidation by stimulating the tocopherol-mediated redox system and preventing the synthesis of eicosanoid (Alessandri, *et al.*,2011). Carotenoids, which are also included in WGO, contribute to this antioxidant impact (Mahmoud *et al.* 2016). Apart from its antioxidant properties, WGO was shown in a previous study to have anti-apoptotic properties as well, as it was able to decrease the expression of pro-apoptotic genes in rats exposed to radiation (Mohamed& Ahmed 2014).

In accordance with our study, Elevated transforming growth factor beta-1 (TGF-β1), reduced gastric immunoreactivity of NF-kB, and elevated synthesis and production of Nrf2, heme oxygenase-1 (HO-1), and antioxidants were linked to WGO. In summary, WGO-modified genes are associated with oxidative stress, inflammation, and apoptotic/antiapoptotic pathways to lessen the degree of ethanol-induced stomach injury (El-shafey *et al.* |2022).

Conclusion

MSG has destructive and damaging effects on histology and ultrastructure of the submandibular salivary gland and concomitant usage of WGO can greatly ameliorate most of these effects.

Declarations:

Ethics Approval and Consent to Participate: Ethical approval was obtained from the Ethical Committee of the Faculty of Medicine, Assiut University, Egypt.

Consent to participate from participants is not applicable as it is an animal experimental study

Conflict of Interest: The authors declare that they have no conflict of interest.

Author contribution: Each author took part in the design of the study, contributed to data collection, and participated in writing the manuscript. The manuscript is neither being published nor being considered for publication elsewhere until a decision is reached by this journal.The authors declared no conflict of interest.

Data availability statement: The collection of data developed and/or assessed throughout the present work is available through the corresponding author upon reasonable request.

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REFERENCES

Abdel Rahman,SM, S.A Younis; A.A ElSawa; and N. M Khalil (2023). Effect of monosodium glutamate and vitamin c on rat parotid gland. *Alexandria Dental Journal;* 48(1); 80-85.DOI: 10.21608.

Aisha, Danlami. (2013). Monosodium glutamate-induced testicular lesions in rats (histological study). *Middle East Fertility Society Journal;* 19(4): 274-280.

Alessandri, Jean-Marc & Extier, Audrey & Kais, Hadeel & Harbeby, Emilie & Lallemand, Marie-Sylvie & Linard, Alain & Lavialle, Monique & Guesnet, Philippe. (2011). Influence of gender on DHA synthesis: The response of rat liver to low dietary α-linolenic acid evidence higher ω3 Δ4-desaturation index in females. *European Journal of Nutrition,* 51. 199-209. 10.1007/s00394-011-0208-1.

Al-Mosaibih, M.A. (2013). Effects of Monosodium glutamate and acrylamide on the liver tissue of

adult Wistar rats. *Life Science Journal,* 10. 35-42.

Collison KS, Zaidi MZ, Saleh SM, Makhoul NJ, Inglis A, Burrows J, Araujo JA, Al-Mohanna FA (2012). Nutrigenomics of hepatic steatosis in a feline model: effect of monosodium glutamate, fructose, and Trans-fat feeding. *Genes and Nutrition,* 2012 Apr;7(2):265-80. doi: 10.1007/s12263-011-0261-7. Epub 2011 Dec 6. PMID: 22144172; PMCID: PMC3316754.

David Tolulope OLUWOLE, Oladipupo` Samuel EBIWONJUMI, Lydia Oluwatoyin AJAYI, Olubunmi Dupe ALABI, Victor AMOS, Grace AKANBI, Wale Johnson ADEYEMI, Ayodeji Folorunsho AJAYI, (2024). Disruptive consequences of monosodium glutamate on male reproductive function: A review, *Current Research in Toxicology,* Volume 6,2024, 100148, ISSN 2666-027X, https://doi.org/10.1016/j.crtox.2024.100148.

Dixit, Shilpi & Rani, Puja & Anand, Akansha & Khatri, Kamlesh & Chauhan, Renu & Bharihoke, Veena. (2013). To study the effect of monosodium glutamate on histomorphometry of cortex of kidney in adult albino rats. *Renal failure,* 36(2): 266-270. 10.3109/ 0886022X. 2013.846865.

Dosuky M A., M.D.; Zaghlol D A,.,.Ouies S M., and Abdel-Naeim, H A (2018)..Effects of Monosodium Glutamate on the Liver of Male Adult Albino Rat and the Possible Protective Role of Vitamin C (Light and Electron Microscopic Study). *The Medical Journal of Cairo University;* 86: 3407-3418. doi: 10.21608/mjcu.2018.60313.

Egbuonu, AC., Obidoa, O., Ezeokonkwo, C.and Ejikeme,P (2008). Hepatotoxic effects of low dose oral administration of monosodium glutamate in male albino rats. *African Journal of Biotechnology;* 8 (13); 3031-3035.

Elmotasem, H., Farag, H. K., and Salama, A. A. (2018). In vitro and in vivo evaluation of an oral sustained release hepatoprotective caffeine loaded w/o Pickering emulsion formula–Containing wheat germ oil and stabilized by magnesium oxide nanoparticles. *International Journal of Pharmaceutics,* 547(1-2), 83-96.

El-Shafey RS, Baloza SH, Mohammed LA, Nasr HE, Soliman MM, Ghamry HI, Elgendy SA. (2022). The ameliorative impacts of wheat germ oil against ethanol-induced gastric ulcers: involvement of anti-inflammatory, antiapoptotic, and antioxidant activities. *Toxicology Research;*11(2): 325-338.

Eweka A, Igbigbi P, Ucheya R (2011). Histochemical studies of the effects of monosodium glutamate on the liver of adult wistar rats. *Annals of Medical and Health Sciences Research;1*(1):21-92.

Eweka, A and Adjene J.O, (2007). Histological studies of the effects of monosodium Glutamate on the medial geniculate body of adult Wister rat. *Electronic Journal of Biomedicine;* 2:9-13.

Farombi EO and Onyema OO (2006). Monosodium glutamate-induced oxidative damage and genotoxicity in the rat:modulatory role of vitamin C, vitamin E and quercetin. *Human & Experimental*

*Toxicology;*25(5):251-259. doi: 10.1191/0960327106ht621oa.

Field, R., Verghese, M., Walker, L., Panala, V., Shackelford, L. and Boateng, J., (2008). Feeding wheat germ meal and wheat germ oil reduced azoxymethane- induced aberrant crypt foci in fisher 344 male rats. *International Journal of Cancer Research*, 4. 127-136. 10.3923/ijcr.2008. 127.136.

Gumus, Z. P., Guler, E., Demir, B., Barlas, F. B., Yavuz, M., Colpankan, D., Senisik, A. M., Teksoz, S., Unak, P., Coskunol, H. and Timur, S. (2015). Herbal infusions of black seed and wheat germ oil: their chemical profiles, in vitro bio-investigations and effective formulations as phytonanoemulsions. *Colloids and Surfaces. B, Biointerfaces,* 133,73-80. http://dx.doi. org/10. 1016/j. colsurfb. 2015.05.044. PMid:26087391.

Imam, H. and Salam, N. (2019). Histological and Ultra structural Study of the Effect of Monosodium Glutamate on the Submandibular Salivary Gland of Adult Albino Rats. *Egyptian Dental Journal;* 65. 319-329. 10.21608/edj.2015.71419.

Karabacak, M., Kanbur M, Eraslan G and Soyer SZ (2011). The antioxidant effect of wheat germ oil on subchronic coumaphos exposure in mice. *Ecotoxicology and Environment Safety;* 74(7):2119-25. doi: 10. 1016/j.ecoenv.2011. 07.002. Epub 2011 Aug 17. PMID: 21851982.

Kayode, O., Bello, J., Oguntola, J., Kayode, A., and Olukoya, D. (2023). The interplay between monosodium glutamate (MSG) consumption and metabolic disorders. *Heliyon,* 9. e19675. 10.1016.

Khalaf, H., and Arafat, E. (2015). Effect of different doses of monosodium glutamate on the thyroid follicular cells of adult male albino rats: A histological study. *International Journal of Clinical and Experimental Pathology;* 8. 15498-15510.

Kumar, B Lokesh; Bharathwaj, V V; Rajmohan, M; Sindhu, R; Dhamodhar, Dinesh; et al. (2022): Effect of monosodium glutamate on salivary glands: A systematic review, *Journal of Advanced Medical and Dental Sciences Research; Amritsar;* 10: 72-77. DOI:10.21276/ jamdsr.

Kumbhare V, Gajbe U, Singh B.R, Reddy A.K, Shukla S (2015). Histological & histochemical changes in liver of adult rats treated with monosodium glutamate: a light microscopic study. *World Journal of Pharmacy and Pharmaceutical Sciences;* 4(04):898-911.

Liaqat, H., Kim, K., Park, S.y., Jung, S., Park, S., Lim, S.and Kim, Ji. (2021). Antioxidant Effect of Wheat Germ Extracts and Their Antilipidemic Effect in Palmitic Acid-Induced Steatosis in HepG2 and 3T3-L1 Cells. *Foods,* 10. 1061. 10.3390/foods 10051061.

Mahmoud, A., Soilman, H., Abd El-Hameed, A., and Salah, E. (2016). Wheat germ oil attenuates cyclophosphamide-induced testicular injury in rats. *World Journal of Pharmacy and Pharmaceutical Sciences;* 5(5); 40-52. 10.20959/wjpps20164-6604.

Matczuk J, Zalewska A, Łukaszuk B, Knaś M, Maciejczyk M, Garbowska M, Ziembicka DM, Waszkiel D, Chabowski A, Żendzian-Piotrowska M and Kurek K (2016). Insulin Resistance and Obesity Affect Lipid Profile in the Salivary

Glands. *Journal of Diabetes Reserch,* 8163472016; 2016: 8163474016/8163474. Epub 2016 Jul 13. PMID: 27471733; PMCID: PMC4951584.

Miranda RA, da Silva Franco CC, de Oliveira JC, Barella LF, Tófolo LP, Ribeiro TA, Pavanello A, da Conceição EP, Torrezan R, Armitage J, Lisboa PC, de Moura EG, de Freitas Mathias PC. and Vieira E (2017). Cross-fostering reduces obesity induced by early exposure to monosodium glutamate in male rats. *Endocrine ;*55(1):101-112. doi: 10.1007/s12020-016-0965-y. Epub 2016 Apr 26. PMID: 27116693.

Mohamed, M. and Ahmed, M. (2014). Apoptotic genes expression in γ-irradiated rats treated with wheat germ oil, zinc and /or bone marrow. *International Journal of Basic and Applied Sciences;* 3(4); 451-456. 10. 14419/ijbas. v3i4.3657.

Narayanan, S., Kumar,S, Raju, Paval, J., and Satheesha, B. (2010). Effect of ascorbic acid on monosodium glutamate- induced neurobehavioral changes in periadolescent rats. *Bratislavské lekárske listy* ;111(5):247-252. PMID: 20568412.

Oladipo, I., E.A., A. and Kuye, M. (2015). Effects of Monosodium Glutamate in Ovaries of Female Sprague-Dawley Rats. *International journal of Current Microbiology and Applied Science;* 4(5):737-745.

Onaolapo, O., Onaolapo, A., Mosaku, T., Onigbinde, O. and Abiodun, O. (2013). A Histological Study of the Hepatic and Renal Effects of Subchronic Low Dose Oral Monosodium Glutamate in Swiss Albino Mice. *British Journal of Medicine & Medical Research,* 3(2): 294-306.

Onyema, O., Farombi, O., Emerole, G., Ukoha, A. and Onyeze, G. (2006). Effect of vitamin E on monosodium glutamate induced hepatotoxicity and oxidative stress in rats. *Indian journal of biochemistry and biophysics,* 43. 20-24.

Ortiz GG, Bitzer-Quintero OK, Zárate CB, Rodríguez-Reynoso S, Larios-Arceo F, Velázquez-Brizuela IE, Pacheco-Moisés F, Rosales-Corral SA (2006). Monosodium glutamate-induced damage in liver and kidney: A morphological and biochemical approach. *Biomedicine and pharmacotherapy;* 60. 86-91. 10.1016/j.biopha.2005.07.012.

Pavlovic, V., Pavlovic, D., Kocic, G., Sokolovic, D., Jevtovic-Stoimenov, T., Cekic, S. and Velickovic, D. (2007). Effect of monosodium glutamate on oxidative stress and apoptosis in rat thymus. *Molecular and cellular biochemistry;*303. 161-166. 10.1007/s11010-007-9469-7.

Radi, A., Abdel Azeem, N., Mostafa, I., Helmy, N. and Ahmed, W. (2021). The Protective Role of Wheat Germ Oil Against Adverse Effect of Deltamethrin on Reproductive Aspects of Male Albino Rats. *Journal of Applied Veterinary Sciences;* 6. 70-75. 10.21608/javs.2021. 80220.1085.

Rani, P., Khatri, K. and Chauhan, R. (2013). Monosodium glutamate induced histomorphometric changes in thyroid gland of adult Wistar rat. *Journal of Medical and Applied Sciences;* 3. 67-71.

Shamel, M., Baz, S., Mahmoud, H., Taghyan, S., Bakr, M. and Al Ankily, M. (2024). Balancing Risks versus Benefits: Vitamin C Therapy versus Copper Oxide Nanoparticles Toxicity in Albino Rats' Submandibular Salivary Gland. *European*

Journal of Dentistry, 10.1055/s-0044-1786867.

Shi Z, Luscombe-Marsh ND, Wittert GA, et al. (2010). Monosodium glutamate is not associated with obesity or a greater prevalence of weight gain over 5 years: findings from the Jiangsu Nutrition Study of Chinese adults. *British Journal of Nutrition,* 2010;104(3):457-463. doi:10.1017/S0007114510000760.

Shredah, M and Nagy, D. (2017). Effect of monosodium glutamate on the sublingual salivary glands of rats (histological and histochemical study. *Egyptian Dental Journal;* 63. 3263-3270. 10.21608/edj.2017.76179.

Siraj, N. (2022). Wheat germ oil: a comprehensive review. *Food Science and Technology;*42. 10.1590/fst.113721.

Soliman, A. (2011). Extract of Coelatura aegyptiaca, a freshwater clam, ameliorates hepatic oxidative stress induced by monosodium glutamate in rats. *African Journal of Pharmacy and Pharmacology;* 5. 398-408. 10.5897/AJPP11.085.

Thomas S: Text Atlas of Histology W.B. Saundrs Company, Philadelphia. 1988.

Wyffels JT (2021). Principles and Techniques of Electron Microscopy: Biological Applications, Fourth Edition, by M. A. Hayat. Microscopy and Microanalysis ;7(1):66. PMID: 12597835.

Yang L, Gao Y, Gong J, Peng L, El-Seedi HR, et al. (2023). A multifaceted review of monosodium glutamate effects on human health and its natural remedies. *Food Materials Research; 3*:16 https://doi.org/10.48130/FMR-2023-0016.

Yaqub, H., Abdelbaky, N.,Attia, H. and Fadda, L. (2008). Hepatoprotective Effect of N-acetyl Cysteine and/or β-Carotene on Monosodium Glutamate-Induced Toxicity in Rats. *Research Journal of Medicine and Medical Sciences* ;3. 206-215.

ARABIC SUMMARY

تأثير زيت جنين القمح كعامل محسن مقابل أحادي الصوديوم جلوتامات على الغدة اللعابية تحت الفكية لدى الجرزان البيضاء البالغة

هاله محمد حسانين محمد و سالي سيد انور
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المقدمة : يعتبر أحادي الصوديوم جلوتامات احد اكثر معززات النكهة استخداما في جميع انحاء العالم.يظهر زيت جنين القمح نشاطا مضادا للاكسدة مع العديد من المركبات النشطة بيولوجيا.
تلعب الغدد اللعابية وظيفة حاسمة في الحفاظ على صحة الفم وحماية الأسنان من التسوس.
هدف العمل: تقييم الاستخدام المصاحب لزيت جنين القمح مع أحادى الصوديوم جلوتامات لتخفيف آثارها المدمرة على الغدد تحت الفكية.
المواد والطرق: تم تقسيم أربعين جرزا أبيضًا ذكرًا بشكل عشوائي إلى أربع مجموعات. المجموعة الأولى (مجموعة التحكم السلبية): تلقت الماء المقطر. المجموعة الثانية (مجموعة التحكم الإيجابية): تلقت زيت جنين القمح عن طريق الفم بجرعة 1.5 مل / كجم وزن الجسم مرة واحدة يوميًا لمدة ثمانية أسابيع. المجموعة الثالثة (المجموعة المعالجة باحادي الصوديوم جلوتامات): تلقت عن طريق الفم 15 مجم / كجم من أحادي الصوديوم جلوتامات مرة واحدة يوميًا لمدة 8 أسابيع. المجموعة الرابعة (المجموعة المعالجة باحادي الصوديوم جلوتامات وزيت جنين القمح): تلقت 15 مجم/كجم من أحادي الصوديوم جلوتامات مرة واحدة يوميًا لمدة 8 أسابيع بالتزامن مع إعطاء زيت جنين القمح بجرعة 1.5 مل/كجم وزن الجسم . تم التضحية بالفئران من جميع المجموعات وتم استخراج الغدتين اللعابيتين تحت الفكيه ومعالجتهما للدراسة المجهرية الضوئية والبنية التحتية.
النتائج: تسبب أحادي الصوديوم جلوتامات في حدوث تغييرات مدمرة في الغدة تحت الفكية ؛ واضطراب البنية، والفجوات في الخلايا الأسينية، والنوى الصغيرة والعميقة الصبغة. أظهرت القنوات بعض الفجوات والأوعية الدموية احتقانًا وتوسعًا وتسربًا. يؤدي إعطاء زيت جنين القمح بالتزامن مع أحادي الصوديوم جلوتامات إلى استعادة المظهر الطبيعي بصرف النظر عن بعض فجوات الخلايا الأسينية والأوعية الدموية المكتظة والمفرغة.
الاستنتاج: إن مادة احادي الصوديوم جلوتومات لها تأثير مدمر على بنية الغدة تحت الفكية والاستخدام المصاحب لزيت جنين القمح يمكن ان يخفف من هده التاثيرات.