The Bioscan
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
2020(3): S.I (3), 930-933, 2025 www.thebioscan.com

THE ROLE AND IMPACT OF MONOSODIUM GLUTAMATE IN MODERN FOOD PROCESSING

P Aileen Sonia Dhas[1], Harishkumar B [2], Kiran Kumar S[3], S B Chandra Lekha[4], Kumaresan Anbu [5]

[1]Department of Electrical and Electronics, PERI Institute of Technology, Chennai-48

[2]Department of Pharmacy, PERI College of Pharmacy, Chennai-48

[3]Department of Physiotherapy, PERI College of Physiotherapy, Chemnai-600048

[4]Department of Nursing, PERI College of Nursing – Chennai-600048

,[5]Department of Microbiology, PERI College of Arts and Science, Chennai-48.

Corresponding mail id: publications@peri.ac.in

DOI: 10.63001/tbs. 2025.v20.i03.S.I(3).pp930-933

KEYWORDS
Monosodium glutamate, Ajinomoto, umami, food additive, Chinese restaurant syndrome

Received on:

20-07-2025

Accepted on:

18-08-2025

Published on:

24-09-2025

ABSTRACT

Monosodium glutamate (MSG) is the sodium salt of glutamic acid, a naturally occurring amino acid abundantly present in food and the human body. Widely used as a flavor enhancer, particularly to intensify the umami taste, MSG has been incorporated into the food industry for over a century. It naturally exists in many food products such as stews and meat-based soups and is often associated with fermented items like soy sauce and hydrolyzed vegetable proteins. While MSG has faced public scrutiny—most notably through concerns related to "Chinese Restaurant Syndrome" (CRS)—scientific studies using double-blind placebo-controlled trials have not consistently validated such adverse reactions. Under normal metabolic conditions, the human digestive system effectively breaks down glutamate, and the amounts used in food are considered safe. This review aims to provide a concise overview of MSG's role, functionality, and safety in food applications.

INTRODUCTION

Monosodium glutamate (MSG), the sodium salt of the naturally occurring amino acid glutamic acid, is one of the most widely used flavor enhancers in the global food industry. It is renowned for its ability to intensify the umami taste recognized as the fifth basic taste alongside sweet, salty, sour, and bitter. MSG was first identified in 1908 by Japanese scientist Kikunae Ikeda, who isolated it from seaweed and linked its unique taste to the presence of glutamate. Since then, MSG has gained widespread acceptance in food formulation, particularly in processed, canned, frozen, and fermented products.

The umami-enhancing properties of MSG have not only improved the palatability of various foods but also enabled a reduction in sodium content without compromising taste. This has led to its adoption in low-sodium diets and public health strategies aimed at curbing hypertension and cardiovascular risk. Naturally present in many protein-rich foods such as tomatoes, mushrooms, and cheese, glutamate contributes to food savoriness both intrinsically and when added as MSG.

Despite its functional benefits, MSG has been surrounded by controversy, particularly following anecdotal reports in the late 1960s linking its consumption to a cluster of symptoms termed "Chinese Restaurant Syndrome" (CRS). These symptoms included headaches, flushing, and numbness, leading to public skepticism and regulatory reviews. However, numerous double-blind placebo-controlled clinical trials and toxicological evaluations have failed to confirm a consistent causal relationship between MSG and such symptoms at dietary consumption levels. Regulatory bodies including the U.S. Food and Drug Administration (FDA), the European Food Safety Authority (EFSA), and the Codex Alimentarius Commission have all designated MSG as safe for consumption within established limits.

In recent years, attention has also shifted towards the environmental and industrial aspects of MSG production. Advances in microbial fermentation and cleaner manufacturing techniques, especially in countries like China, have led to more sustainable production practices with reduced environmental footprints.

This review aims to provide a comprehensive examination of MSG from multiple perspectives: its nutritional and sensory functions, chemical and biochemical properties, regulatory and safety assessments, industrial applications, and environmental sustainability. By integrating insights from recent research, this paper seeks to clarify misconceptions, highlight innovations, and guide responsible use of MSG in the modern food landscape.

2.1NUTRITIONAL AND SENSORY ROLE OF MSG

MSG enhances the umami flavor in foods, contributing significantly to taste perception. Smith (2018) explored how taste preferences are shaped by nutritional components, including glutamate [1]. Bellisle (1999) provided an in-depth discussion on glutamate's role in sensory, metabolic, and behavioral contexts [20]. Salanță et al. (2019) and Jinap&Hajeb (2010) emphasized MSG's contributions to palatability and reduced sodium intake without compromising flavor [9], [10].

Table 1: Nutritional and Functional Roles of MSG

Aspect	Description	References
Taste enhancement	Intensifies umami flavor, enhances palatability	Smith (2018) [1]; Bellisle (1999) [20]
Sodium reduction	Enables lower salt usage while maintaining taste	Jinap&Hajeb (2010) [10]
Satiety signals	May affect appetite and satiety mechanisms	Bellisle (1999) [20]
Natural occurrence	Found in tomatoes, cheese, soy sauce, mushrooms	Lee & Kim (2021) [4]
Safe dietary intake	Broken down effectively in the gut; non-toxic at regulated levels	Geha et al. (2000) [8]; Obayashi &Nagamura (2016) [17]

2.2CHEMISTRY AND BIOCHEMISTRY OF GLUTAMATE

Glutamic acid, the parent compound of MSG, is a key neurotransmitter and metabolic intermediate. Chen et al. (2019) elaborated on its structural and functional properties [3]. Nakamura and Ohta (2022) examined the stereochemistry of MSG, focusing on enantiomeric purity in food-grade products [5]. Lee & Kim (2021) correlated fermentation processes with free glutamate concentrations in traditional foods [4].

2.3PRODUCTION AND INDUSTRIAL APPLICATIONS

Cleaner production techniques in China have improved MSG synthesis efficiency, as reported by Dong et al. (2018) [13]. Yang et al. (2020) conducted a life cycle assessment showing environmental improvements in MSG production through energy optimization [35]. Sano (2009) reviewed the history of glutamate production, from traditional to industrial scales [22].

2.4 REGULATORY ASPECTS

EC Regulation No. 1333/2008 [6] and Codex Alimentarius GSFA [7] outline safety limits for MSG as a food additive. These frameworks ensure that MSG levels in foods remain within safe thresholds and are labeled appropriately for consumers.

2.5 SAFETY, TOXICITY, AND HEALTH EFFECTS

Numerous studies investigate the potential health concerns associated with MSG. Geha et al. (2000) and Williams & Woessner (2009) critically assessed alleged allergic and intolerance reactions to MSG, finding limited evidence for consistent adverse effects [8], [16]. Obayashi &Nagamura (2016) found no strong link between MSG and headaches in a systematic review [17].

However, some studies reported adverse biological effects. Eweka &Om'Iniabohs (2007) documented renal histological changes in rats administered high doses of MSG [24], while Hassan et al. (2014) reported immune dysfunction in animal models [14]. Mahmoudpour et al. (2020) revealed interaction between MSG and albumin, suggesting potential molecular-level effects [31].

Hajihasani et al. (2020) highlighted natural compounds that mitigate MSG-induced toxicity [27], and Hazzaa et al. (2020) demonstrated the neuroprotective role of garlic extract against MSG-related oxidative stress [33].

Table 2: Regulatory Guidelines and Safety Assessments for MSG

Agency / Regulation	Guideline / Conclusion	Reference
FDA (USA)	MSG classified as GRAS (Generally Recognized As Safe)	Harvard Health (2024) [19]
EFSA (European Union)	Safe at current intake levels; subject to labeling requirements	EC Regulation 1333/2008 [6]
Codex Alimentarius Commission (FAO/WHO)	Acceptable Daily Intake (ADI) not specified; must be listed on labels	GSFA (2015) [7]
Geha et al. (2000)	No consistent evidence of MSG causing CRS in clinical trials	[8]
Obayashi &Nagamura (2016)	Systematic review: No causal link between MSG and headaches in human studies	[17]

2.6 PUBLIC PERCEPTION AND CONTROVERSY

Gottardo et al. (2022) and Datta et al. (2019) discussed the duality of MSG's reputation—beneficial in moderation but controversial due to anecdotal toxicity reports [11], [15]. Dwivedi 24) and Kazmi et al. (2017) presented a comprehensive overview of clinical concerns and public misconceptions [12], [21]. Several reviews (e.g., Nemeroff, 1980; Comprehensive Reviews, 2018; Critical Reviews, 2019) reiterated the call for balanced, evidence-based evaluation of MSG's safety profile [28], [29], [32], [34].

2.7 APPLICATIONS IN FOOD FORMULATION

Zhang & Wang (2020) detailed the application of MSG and other flavor enhancers in processed food [2]. Fermented products, as shown by Lee & Kim (2021), naturally accumulate free glutamate, supporting MSG's use in enhancing umami [4].

2.8BIOMEDICAL AND TOXICOLOGICAL STUDIES

Mustapha (2018) emphasized the toxicological implications of MSG when overused in seasonings [26]. Abdel Aziem et al. (2018) investigated the protective effects of algae (Chlorella, Spirulina) against MSG-induced ovarian damage in mice [30]. Guven et al. (2021) explored cochlear toxicity from oral MSG in animal models [23].

Table 3: Toxicological Effects of MSG (High-Dose Animal Studies)

Study	Animal Model	Dose	Observed Effect	Reference
Eweka &Om'Iniabohs (2007)	Wistar rats	High-dose oral administration	Renal tissue damage	[24]
Hassan et al. (2014)	Rodents	Repeated doses	Thymus and spleen immune dysfunction	[14]
Guven et al. (2021)	Guinea pigs	Oral intake	Cochlear (hearing) toxicity	[23]
Abdel Aziem et al. (2018)	Mice	MSG with algae intervention	Ovarian dysfunction mitigated by algae	[30]
Mahmoudpour et al. (2020)	Spectroscopic analysis	Binding study	Albumin interaction observed (in vitro model)	[31]

2.9CLEANER AND SUSTAINABLE PRODUCTION

Cleaner production of MSG not only reduces environmental impact but also enhances process efficiency. Yang et al. (2020) and Dong et al. (2018) highlighted sustainability improvements, including energy conservation and wastewater reduction in MSG factories in China [13], [35].

3. SUMMARY AND FUTURE DIRECTIONS

Current evidence suggests MSG is safe at regulated levels and plays an important role in enhancing flavor and reducing sodium content. However, its biological interactions and effects at high doses, especially in animal models, warrant further investigation. The literature encourages regulatory monitoring, public education, and more human-based clinical trials to resolve controversies.

CONSLUSION

Monosodium glutamate (MSG) remains one of the most widely used flavor enhancers in the global food industry, primarily due to its ability to impart the umami taste and improve overall palatability without significantly increasing sodium levels. Extensive research confirms that MSG, when consumed within regulatory limits, is generally recognized as safe by global food authorities such as the Codex Alimentarius and the European Food Safety Authority. Moreover, its inclusion in processed and fermented foods contributes to enhanced sensory appeal and reduced dependency on salt.

Scientific investigations highlight that glutamate, both in its natural and synthesized forms, plays a critical role in human metabolism and neurobiology. Despite this, MSG has been a subject of public concern and controversy, with numerous anecdotal reports and experimental animal studies suggesting potential adverse effects, including neurotoxicity, oxidative stress, immune disruption, and organ damage at excessive doses. However, human studies and clinical reviews largely refute these claims, citing insufficient evidence of consistent or reproducible harmful effects in typical dietary intake scenarios.

Emerging research also supports the use of natural compounds and antioxidants as protective agents against high-dose MSG exposure. Furthermore, sustainableproduction methods, particularly in countries like China, demonstrate a shift towards more environmentally friendly MSG manufacturing practices.

REFERENCES

- Smith, J. (2018). Nutrition and Taste Preferences in the Modern Diet. Journal of Food Science, 83(2), 123–129.
- Zhang, L., & Wang, T. (2020). Flavor Enhancers in Processed Foods. Food Chemistry, 312, 126–135.
- Chen, Y. et al. (2019). Glutamic Acid: Structure and Function. Advances in Biochemistry, 7(1), 15–22.
- Lee, J. H., & Kim, D. (2021). Fermented Products and Free Glutamate Content. Food and Fermentation Technology, 16(4), 223–230.
- Nakamura, T., & Ohta, K. (2022). Enantiomeric Analysis of Monosodium Glutamate. Journal of Amino Acid Research, 10(1), 44–50.
- EC Regulation No. 1333/2008. On Food Additives, Official Journal of the European Union, 2008.
- Codex Alimentarius Commission. (2015). General Standard for Food Additives (GSFA). FAO/WHO.
- Geha, R. S. et al. (2000). Review of alleged reaction to monosodium glutamate (MSG). Journal of Allergy and Clinical Immunology, 105(2 Pt 1), 336–342.
- S. Jinap and P. Hajeb, "Glutamate: Its applications in food and contribution to health," Appetite, vol. 55, no. 1, pp. 1–10, Aug. 2010, doi: 10.1016/j.appet.2010.05.002.
- L. C. Salanță et al., "A Mini Review About Monosodium Glutamate," Research Report, University of Agricultural Sciences and Veterinary Medicine of Cluj-Napoca, 2019.
- F. M. Gottardo, A. P. A. da Silva, L. R. dos Santos, L. M. Colla, and C. O. Reinehr, "Use of monosodium glutamate in foods: the good, the bad, and the controversial side," ABCS Health Sciences, vol. 47, 2022.
- M. Dwivedi, "The science behind monosodium glutamate," Southeast Asian Journal of Case Report and Review, vol. 11, no. 3, pp. 60–69, Oct. 2024.
- Dong, L., Li, Y., Wang, P., Feng, Z., & Ding, N. (2018). Cleaner production of monosodium glutamate in China. Journal of cleaner production, 190, 452-461.
- Hassan, Z. A., Arafa, M. H., Soliman, W. I., Atteia, H. H., & Al-Saeed, H. F. (2014). The effects of monosodium glutamate on thymic and splenic immune functions and role of recovery (biochemical and histological study). J Cytol Histol, 5(6), 1.
- Datta, A., Hossain, A., & Roy, S. (2019). An Overview on Monosodium Glutamate: Its direct and indirect effects. Research Journal of Pharmacy and Technology, 12(12), 6187-6192.
- N. A. Williams and K. M. Woessner, "Monosodium glutamate 'allergy': menace or myth?," Clinical and Experimental Allergy, vol. 39, no. 5, pp. 640–646, May 2009.
- R. Obayashi and Y. Nagamura, "Does monosodium glutamate really cause headache?: a systematic review of human studies," The Journal of Headache and Pain, 2016.
- K. Kusuhara et al., "Monosodium Glutamate in Foods and its Biological Effects," in Ensuring Global Food Safety, 2010, pp. 217–226.
- Harvard Health, "Monosodium glutamate (MSG): What it is…," Harvard Health, July 2024.
- J. Bellisle, "Glutamate and the umami taste: sensory, metabolic, nutritional, and behavioral considerations," Neurosci. Biobehav. Rev., vol. 23, no. 3, pp. 423–438, 1999.
- S. A. Kazmi et al., "Monosodium glutamate: Review on clinical reports," International Journal of Food Properties, vol. 20, Suppl 2, pp. 1807–1815, 2017.
- C. Sano, "History of glutamate production," Am. J. Clin. Nutr., vol. 90, no. 3, pp. 728–732, 2009.
- Guven, S. G., Ersoy, O., Topuz, R. D., Bulut, E., Kizilay, G., & Uzun, C. (2021). Does Oral Monosodium Glutamate Have a Cochleotoxic Effect? An Experimental Study. Audiology and Neurotology, 1-13.
- Eweka, A. O., &Omlniabohs, F. A. E. (2007). Histological studies of the effects of monosodium glutamate on the kidney of adult Wistar rats. The internet journal of health, 6(2), 45-67.
- F. Gottardo et al., "Objective: systematic review on the pros and cons of using glutamate in food," ABCS Health Sciences, vol. 47, 2022.
- W. T. Mustapha, "Toxicological effect of MSG in seasonings on human health," Global Journal of Nutrition & Food Science, 2018.
- Hajihasani, M. M., Soheili, V., Zirak, M. R., Sahebkar, A., & Shakeri, A. (2020). Natural products as safeguards against monosodium glutamate-induced toxicity. Iranian Journal of Basic Medical Sciences, 23(4), 416.
- Nemeroff, C. B. (1980). Monosodium glutamate-induced neurotoxicity: Review of the literature and call for further research. Nutrition and behavior/Sanford A. Miller.
- "A review of the alleged health hazards of monosodium glutamate," Critical Reviews in Food Science and Nutrition, 2019.
- A. Abdel-Aziem et al., "Protective effect of Chlorella and Spirulina extracts against MSG-induced ovarian dysfunction in mice," J. Genet. Eng. Biotechnol., 2018.
- Mahmoudpour, M., Javaheri-Ghezeldizaj, F., Yekta, R., Torbati, M., Mohammadzadeh-Aghdash, H., Kashanian, S., &Dolatabadi, J. E. N. (2020). Thermodynamic analysis of albumin interaction with monosodium glutamate food additive: Insights from multi-spectroscopic and molecular docking approaches. Journal of Molecular Structure, 1221, 128785.
- "A Review of the Alleged Health Hazards of MSG," Comprehensive Reviews in Food Science and Food Safety, 2018.
- Hazzaa, S. M., Abdelaziz, S. A. M., Abd Eldaim, M. A., Abdel-Daim, M. M., &Elgarawany, G. E. (2020). Neuroprotective potential of allium sativum against

monosodium glutamate-induced excitotoxicity: impact on short-term memory, gliosis, and oxidative stress. Nutrients, 12(4), 1028.
- Bera, T. K., Kar, S. K., Yadav, P. K., Mukherjee, P., Yadav, S., & Joshi, B. (2017). Effects of monosodium glutamate on human health: A systematic review. World journal of pharmaceutical sciences, 139-144.
- Yang, D., Jia, X., Dang, M., Han, F., Shi, F., Tanikawa, H., &Klemeš, J. J. (2020). Life cycle assessment of cleaner production measures in monosodium glutamate production: A case study in China. Journal of Cleaner Production, 270, 122126.