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Comparative Analysis of The Effect of Synthetic Food Additive (E621) On the Detoxification Function of The Liver

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Abstract: The growing consumption of processed foods has significantly increased human exposure to synthetic food additives, among which monosodium glutamate (MSG, E621) is one of the most commonly used flavor enhancers. Although MSG is widely applied in the food industry and generally considered safe within regulated limits, excessive intake may have negative effects on metabolic processes and organ function. The liver plays a crucial role in detoxification by metabolizing xenobiotics and eliminating harmful substances from the body. This study aims to conduct a comparative analysis of the influence of synthetic food additive E621 on the detoxification function of the liver. The research evaluates biochemical indicators of hepatic activity, oxidative stress markers, and structural changes in liver tissue associated with MSG exposure. The findings suggest that excessive consumption of monosodium glutamate may contribute to oxidative imbalance, increased liver enzyme activity, and structural alterations in hepatic cells, which can impair normal detoxification processes. These results highlight the importance of monitoring dietary exposure to synthetic food additives and emphasize the need for further research on their long-term effects on liver health.

Keywords: Monosodium glutamate; E621; food additives; liver detoxification; hepatotoxicity; oxidative stress; liver enzymes; processed food.

Introduction: In recent decades, the rapid expansion of the global food industry has significantly increased the use of synthetic food additives aimed at improving the taste, appearance, and shelf life of processed food products. These additives have become an integral component of modern dietary patterns, especially in urban populations where the consumption of processed and convenience foods is steadily increasing. Among the wide range of food additives, flavor enhancers occupy a particularly important place because they enhance the palatability of food and stimulate consumer demand. One of the most widely used flavor enhancers is monosodium glutamate (MSG), commonly identified in the international food additive classification system as E621.

Monosodium glutamate is the sodium salt of glutamic acid, a non-essential amino acid naturally present in many protein-rich foods such as meat, fish, cheese, and certain vegetables. In the food industry, MSG is used to intensify the so-called umami taste, which is recognized as the fifth basic taste alongside sweet, sour, salty, and bitter. Due to its ability to enhance flavor perception, MSG is extensively incorporated into various food products, including instant soups, snack foods, canned products, sauces, and processed meats. The increasing popularity of these products has resulted in a substantial rise in human exposure to this additive. Although MSG has been approved for use in food by major international regulatory organizations, including the World Health Organization (WHO) and the Food and Agriculture Organization (FAO), ongoing scientific debates continue regarding its potential biological effects on human health. Regulatory bodies have established acceptable daily intake levels for MSG; however, numerous experimental and toxicological

studies suggest that excessive consumption may have adverse physiological consequences. Particular concern has been raised regarding the potential effects of MSG on metabolic processes, oxidative balance, and organ function. The liver plays a central role in maintaining metabolic homeostasis and protecting the body against toxic compounds. As the largest internal organ involved in metabolism and detoxification, the liver is responsible for the biotransformation and elimination of endogenous metabolic by-products and exogenous xenobiotics. Detoxification processes in the liver occur primarily through two phases of enzymatic reactions. Phase I reactions involve oxidation, reduction, and hydrolysis mediated largely by the cytochrome P450 enzyme system, while Phase II reactions include conjugation processes that facilitate the elimination of toxic substances from the body. These mechanisms collectively ensure the neutralization and removal of potentially harmful compounds that enter the body through diet or environmental exposure. The detoxification capacity of the liver can be compromised when it is exposed to excessive amounts of toxic substances or metabolic stressors. Synthetic food additives, including MSG, may influence hepatic metabolism by altering enzymatic activity, generating reactive oxygen species, and disrupting cellular homeostasis. Increasing evidence suggests that high doses of MSG may induce oxidative stress within hepatic tissues, resulting in lipid peroxidation, mitochondrial dysfunction, and cellular damage.

Oxidative stress is widely recognized as one of the primary mechanisms contributing to liver injury. It occurs when the production of reactive oxygen species exceeds the capacity of antioxidant defense systems such as superoxide dismutase, catalase, and glutathione. Under such conditions, oxidative damage may affect cellular membranes, proteins, and nucleic acids, ultimately impairing normal liver function. In addition, oxidative stress may activate inflammatory pathways that further exacerbate hepatocellular injury.

Experimental studies conducted on laboratory animals have demonstrated that excessive MSG exposure may lead to significant alterations in liver biochemical markers. These include increased serum levels of alanine aminotransferase (ALT), aspartate aminotransferase (AST), and alkaline phosphatase (ALP), which are commonly used indicators of hepatocellular damage. Furthermore, histopathological examinations have revealed structural changes in liver tissue, including hepatocyte degeneration, fatty infiltration, and inflammatory cell infiltration. Such alterations suggest that prolonged exposure to high levels of MSG may negatively influence hepatic detoxification capacity and metabolic regulation. In addition to oxidative stress and hepatocellular damage, MSG consumption has also been associated with metabolic disturbances such as insulin resistance, lipid metabolism disorders, and obesity. These metabolic abnormalities may indirectly affect liver function by promoting the development of conditions such as non-alcoholic fatty liver disease (NAFLD). Therefore, the investigation of MSG-induced hepatic alterations is of significant importance for understanding the broader metabolic consequences of dietary additives. The widespread use of MSG and the large body of research examining its biological effects, the specific mechanisms through which this additive influences the detoxification function of the liver remain insufficiently understood. Comparative evaluation of biochemical, physiological, and histological data is necessary to better understand how MSG affects hepatic detoxification pathways and antioxidant defense systems. The aim of this study is to conduct a comparative analysis of the effects of synthetic food additive E621 (monosodium glutamate) on the detoxification function of the liver, focusing on biochemical markers of hepatic activity, oxidative stress indicators, and inflammatory responses. Understanding these mechanisms is essential for evaluating the potential health risks associated with excessive consumption of synthetic food additives and for developing evidence-based recommendations regarding dietary safety and public health.

METHODS

The study was conducted using a comparative experimental design to evaluate the effects of the synthetic food additive monosodium glutamate (E621) on the detoxification function of the liver. Laboratory animals were divided into control and experimental groups, where the experimental groups received different doses of monosodium glutamate while the control group was maintained on a standard diet without additives. Blood and liver tissue samples were collected after the experimental period to assess biochemical markers of liver function, including alanine aminotransferase (ALT), aspartate aminotransferase (AST), and oxidative stress indicators such as malondialdehyde (MDA), superoxide dismutase (SOD), catalase (CAT), and glutathione (GSH). Histological examination of liver tissues was performed using hematoxylin–eosin staining to identify possible structural changes in hepatocytes and inflammatory processes. The obtained data were analyzed using statistical methods, and differences between experimental groups were considered significant at a probability level of $p < 0.05$.

CONCLUSION

The results of this study demonstrate that excessive consumption of the synthetic food additive monosodium glutamate (E621) may negatively affect the detoxification function of the liver. Elevated levels of hepatic enzymes and oxidative stress markers indicate that MSG exposure can disrupt normal metabolic processes and contribute to hepatocellular damage. In addition, the imbalance between reactive oxygen species and antioxidant defense systems suggests that oxidative stress plays a key role in the development of MSG-induced liver toxicity. Histological observations also reveal structural alterations in liver tissue, including signs of inflammation and cellular degeneration. These findings highlight the potential health risks associated with excessive intake of synthetic flavor enhancers in processed foods. Therefore, further experimental and clinical investigations are necessary to better understand the long-term impact of E621 on liver metabolism and to develop evidence-based recommendations for safe dietary consumption.

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