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Synthetic and Natural Food Additives: Toxicological Hazards and Health Benefits

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Abstract

Food additives may be natural or synthetic substances; it is added intentionally to food during its processing and packaging for multipurpose targets such as preservation, adding flavor or sweetening. Nowadays, the safety of food additives is considered a major challenge because of the numerous number of food additives in the worldwide market; it is approximately more than 2500 food additives. Furthermore, there is continuous excessive use of food additives by consumers besides its adulteration by the manufactures in the market. Therefore, the risk assessment of any food additive becomes a necessity before its approval to ensure its safety. This review is an attempt to focus on some common food additives in the market that have toxicological hazards such as artificial sweeteners and colors, monosodium glutamate, and some preservatives. Moreover, it focuses also on some natural food additives that have health benefits and may be used as substitutes for unhealthy food additives in the future.

Keywords: Food additives; Toxicological hazards; Health benefits

Abbreviations: FDA: Food and Drug Administration; FAO: Food and Agriculture Organization; WHO: World Health Organization; EFSA: European Food Safety Authority; ADI: Admissible Daily Intake

Introduction

Food additives are natural or synthetic substances that are added intentionally to food during its processing, packaging, and transition for multipurpose targets such as preservation, adding flavor or sweetening [1]. In the last years, the Food and Drug Administration (FDA) approved more than 2500 food additives in the United States. It classified food additives into preservatives such as antioxidants and antimicrobials, food colorants such as indigos and xanthenes, flavoring such as sweeteners "aspartame and saccharin", texturizing agents such as stabilizers and emulsifiers, and nutritional additives beside miscellaneous agents such as chelating and enzymes [2]. Furthermore, there is another classification for food additives based on origin and manufacture; it is classified into natural additives that obtain from animals or plants, synthetic additives (artificial), modified chemically from natural origin, and similar to natural additives that are produced synthetically imitating natural ones [3]. Regard to the common worldwide use of food additives; there are more than 2500 food additives in the market. Recently, many international organizations such as Food and Agriculture Organization (FAO), the World Health Organization (WHO), European Food Safety Authority (EFSA), and the Food and Drug Administration (FDA) started to re-evaluate the market of food additives to determine health benefits and toxicological hazards of every food additive and the acceptable daily intake levels for human [4].

Therefore, the risk assessment of any food additive should be a necessity to carry out before its approval to enter the market to ensure its safety. Thus, some procedures and investigations should be carried out to get approval for any food additive. At first, identification of the chemistry and specification of the food additive. The second procedure is evaluation and dietary exposure assessment and then toxicological analysis to determine the possibility of the food additive hazards in Vitro and Vivo during chronic and sub-chronic use to exclude carcinogenicity, immunotoxicity, genotoxicity, and developmental toxicity of this food additive [5]. Despite these regulations and procedures, detection of the health hazards of food additives still represents a challenge because of the continuous excessive use of a number of food additives by consumers besides the adulteration in the market of these additives by the manufactures. Moreover, there is a continuous debate about some banned food additives in some countries while it approved in others, so more efforts should do by researchers to solve this issue. In the last years, much toxicological

research was conducted on some commonly used food additives using the strict regulations to be helping hand in assessing the safety of these food additives and the extent of the possible health hazards on humans. In this context and for example, but not limited to, this review will select some commonly used food additives that have toxicological hazards besides some commonly used natural food additives that have health benefits to show the harmful effect of some and the healthy effect of the other based on the available literature.

A-Toxicological Hazards

The followings are a summary of a number of common food additives that have toxicological hazards according to the published studies in this field.

Monosodium glutamate

Most fast food and many foodstuffs contain monosodium glutamate, as a food additive enhancing flavor. It synthesized from the fermentation of carbohydrates with a nitrogen source using bacterial or yeast species [6]. It is not a nutrient, vitamin, or mineral and then it has not any health benefits. Glutamate constitutes 78% of monosodium glutamate that negatively affects the human body. Noteworthy, the natural glutamic acid in food is safe while the synthetic glutamic acid that formed during industrial processing is a toxin [7]. In addition, monosodium glutamate is considered an excitotoxin food additive. Therefore, it can destroy neurons partly via stimulating the generation of large numbers of free radicals in the brain, other tissues and organs such as liver, kidney, and red blood cells. However, excitotoxin effects on humans may be varied; some individuals are sensitive to it and develop cardiac irritability leading to sudden death while other cases need a long period to have harmful symptoms [8,9].

In the same context, some studies conducted on monosodium glutamate revealed its toxic effects on different organs and body systems. Osman et al., [10] showed that the chronic use of monosodium glutamate causes hepatotoxicity that manifests as biochemical, histopathological, and immunohistochemical changes while another study confirmed that the repeated use of monosodium glutamate lead also to renal histopathological, histochemical, and biochemical changes in a dose-dependent manner [11]. Moreover, monosodium glutamate has toxic effects on adipose tissue and reproductive organs, it causes a metabolic disturbance with an increase in insulin, fatty acids and triglycerides in the serum besides an increase in the several genes expression that implicates in adipocytes differentiation [12].

Finally, the use of monosodium glutamate as a safe flavor enhancer is still controversial. Although some healthy individuals had unhealthy symptoms when consuming three grams of monosodium glutamate in the absence of food, United States Food and Drug Administration (FDA) concluded that it is safe for human consumption at customary levels because these reports are considered anecdotal [13].

Artificial sweeteners: Artificial sweeteners are considered non-nutritive food additives that replace sucrose in food as a flavor enhancer associated with low calories production. However, its safety has been controversial until now. The most common use of artificial sweeteners are aspartame and saccharin which are used as sugar substitutes in soft drinks and a wide range of food products [14]. Many studies that were conducted on artificial sweeteners in the last years indicated that the repeated use of artificial sweeteners even at the permitted level of Food and Drug agency leads to alteration in the oxidant and antioxidant balance causing oxidative stress and potential toxicity [15,16]. Therefore, manifestations of artificial sweeteners' potential toxicity in the body may be varied; it may be hepatotoxicity, nephrotoxicity, cytotoxicity, immune disorders, genotoxicity, and cancers [17,18].

Artificial colors: According to a number of studies, the use of artificial colors as food additives lead to many problems especially in children such as behavioral problems and a significant reduction in IQ. Nowadays, the use of artificial colors in soda, fruit juices, and salad dressings is popular although some artificial food colors have linked to cancer in many animal studies. Some of the artificial colors are already banned in some countries such as Blue 1 and Blue 2 (E133) that cause chromosomal damage besides Red dye (E124), Yellow dye (E110), and Yellow Tartrazine (E102) that may lead to cancer in the thyroid, kidney, and adrenal gland [19]. Furthermore, cytogenetic evaluation of tartrazine in some studies showed extensive DNA binding, reduced mitotic index, and cytostatic potential. However, chronic toxicity, mutagenicity, and long-term carcinogenicity of tartrazine are not well established in many studies until now. On the other hand, other studies reported that tartrazine might affect mating index leading to a reduction in reproductive performance based on the dose. In addition, tartrazine may cause hyperactivity, anxiety, depression effects and anti-social behavior [20]. Noteworthy, there are no standardized regulations for the safety status of the most artificial colors in national, regional and worldwide agencies. Therefore, there is not uniformity for the list of approved artificial colors or its acceptability or acceptable Admissible Daily Intake (ADI) for the most coloring agents whatever in the USA or European countries or even in Asian and African countries [21].

Preservatives: Nowadays, preservatives become essential elements in processing and packaging in the food industry. However, it is still associated with health risks although the determination of the Acceptable Daily Intake (ADI) of these preservatives for consumers. The most common preservatives used are nitrite, nitrate, sulfite, benzoate, and sorbate [22]. In the last years, many studies conducted to assess the associated risk of preservatives intake as food additives. These studies showed several toxic effects that range from urticaria, angioedema, and aggravation of asthmatic symptoms for sulfite and benzoate intake to more severe anaphylactic reactions for nitrite intake based on the dose, concentration and duration of use. In addition, the use of some preservatives may lead to cytotoxicity, mutation,

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and chromosomal aberrations such as benzoates according to some cytogenetic studies [23]. In the same context, other studies proved that prolonged use of sorbate might lead to an oxidative degradation product that is mutagenic and may cause genotoxicity. Furthermore, nitrites represent also a terrible threat to consumer because it reacts with secondary amines to form nitrosamines that are considered carcinogenic agents. In addition, the excess intake of nitrite causes oxidation of oxyhemoglobin leading to methemoglobinemia that induces harmful effects on human health [24].

Health benefits

According to the above-mentioned data about the toxicological hazards of the most commonly used food additives, there is a necessity to ban these additives and provide alternatives. The following presentation will show that the best alternative solution is to shift using natural food additives that have many health benefits wherein it gives the same desirable flavor and coloring effect.

Curcumin: Curcumin is considered one of the natural coloring food additives, its safety is approved by the Food and Drug Administration (FDA) in the USA, the Joint FAO/ WHO Expert Committee on Food Additives of the Food and Agriculture Organization/World Health Organization, and the Natural Health Products Directorate of Canada [25]. It has the ability to scavenge the free radicals as antioxidant counteracting the oxidative stress that may cause by the artificial dietary color dye such as tartrazine. Furthermore, curcumin has a wide spectrum of health effects such as anti-inflammatory, anticancer, antimicrobial as well as chemoprotection and cytoprotecting. In addition, it has also the ability to extend the shelf life and impeding decay of the food as natural antioxidant [26].

Gum arabic: Gum Arabic is used as an emulsifier and flavor stabilizer in the food industries as a natural food additive. It is a mixture of polysaccharides, oligosaccharides, and glycoproteins wherein it is extracted from exudates of Acacia Senegal or Acacia seal trees in Sudan and many African countries [27]. Gum Arabic is approved as a food additive by the Joint FAO/WHO Expert Committee wherein it has also a wide spectrum of health benefits such as antioxidant, anti-inflammatory, and antimicrobial effects. In addition, the Joint FAO/WHO Expert Committee suggested an acceptable daily intake of Arabic gum for human [28].

Nigella sativa: *Nigella Sativa* and its oil are considered a flavor enhancer as well as a preservative agent in the food industries wherein it has the ability to preserve the food from the degradation during processing and storage. Moreover, *Nigella Sativa* diminishes the microbial growth and delays the oxidation of oxidizable lipids by the oxidizing agents' reduction and the cellular antioxidant molecules induction [29]. In addition, *Nigella sativa* and its oil have a broad range of health benefits wherein it is considered anti-hypertensive, anti-diabetic, anti-inflammatory, analgesic, anti-hypercholesterolemic, anti-tumor, immunomodulator, anthelmintic, and antioxidant. Worthwhile, the nutritional and healthy efficacy of *Nigella sativa* oil is attributed to bioactive phytochemicals such as thymoquinone and tocopherols wherein it is considered a high rich source for these compounds [30].

Noteworthy, the above-mentioned presentation is a brief review of the toxicological hazards of some common food additives as well as the health benefits of other food additives. Moreover, we should note that the mentioned food additives in this review were for example but not limited to because the food additives are classified into many categories such as colorants, sweeteners, preservatives, and emulsifiers. After that, then every category has related subtypes. Finally, this review concluded that it should create a paradigm shift in the use of food additives in the food industries all over the world wherein it should use natural food additives as a substitute to synthetic food additives because many studies confirmed its toxicity even with the use of the Acceptable Daily Intake (ADI) of these food additives.

Conclusion

Food additives may be natural or synthetic substances; it is classified into many types according to its used purposes such as preservatives, flavor enhancers or sweeteners. However, the safety of a large number of commonly used food additives is still controversial. Some of the food additives that are already in the market have toxicological hazards such as monosodium glutamate, artificial sweeteners and colors, and some preservatives while other natural food additives have health benefits. Therefore, natural food additives may be used as alternatives for many toxic synthetic food additives.

Recommendation

Further human studies should be carried out to re-evaluate the safety of the commonly used food additives. International and national agencies should prepare a uniformity approved list for the safe food additives with determination its Acceptable Daily Intake (ADI) based on available animal studies until prove otherwise. Furthermore, there is also a necessity for creating the uniformity strict regulations all over the worldwide countries especially the developing countries to control the food additives market. In addition, it should be recommended that the use of natural food additives that have a lot of health benefits as alternatives for many toxic synthetic food additives.

References

1. Abramsson Zetterberg L, Ilbäck NG (2013) The synthetic food colouring agent Allura Red AC (E129) is not genotoxic in a flow cytometry-based micronucleus assay in vivo. Food Chem Toxicol 59: 86-89.

2. Jain A, Mathur P (2015) Evaluating Hazards Pos ed by Additives in Food: A Review of Studies Adopting a Risk Assessment Approach. Curr Res Nutr Food Sci Jour 3(3): 243-255.

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3. Carocho M, Barreiro MF, Morales P, Ferreira ICFR (2014) Adding Molecules to Food, Pros and Cons: A Review on Synthetic and Natural Food Additives. Comprehensive Reviews in Food Science and Food Safety 13(1): 377-399.

4. FAO/WHO (1995) Application of risk analysis to food standard issues. Report of the Joint FAO/WHO Expert consultation, WHO/FNU/FOS/95.3. Geneva, Switzerland, p. 13-17.

5. Joint FAO/WHO Expert Committee on Food Additives (JECFA). Evaluation of certain food additives and contaminants. Sixtyninth Report of The Joint FAO/WHO Expert Committee on Food Additives (JECFA). WHO Technical Report Series 952. WHO, Geneva: (2009). Available from: http:// whqlibdoc.who. int/trs/WHO_TRS_952.pdf. Accessed 2015 March 3.

6. Sano C (2009) History of glutamate production. Am J Clin Nutri 90(3): 728-32.

7. Zanfirescu A, Ungurianu A, Tsatsakis AM, Nițulescu GM, Kouretas D, et al. (2019) A Review of the Alleged Health Hazards of Monosodium Glutamate. Comprehensive Reviews in Food Science and Food Safety 18(4): 1111-1134.

8. Freeman M (2006) Reconsidering the effects of monosodium glutamate: a literature review. J Am Acad Nurse Pract 18 (10): 482-486.

9. Singh P, Karun AM, Harjit KM, Kaur G (2003) Prolonged glutamate excitotoxicity effects on mitochondrial antioxidants and antioxidant enzymes. Mol Cell Biochem 243: 139-145.

10. Osman HEH, Elshama SS, El-Kenawy AE (2012) Study Role of Antioxidant (Vitamin C) on Modulation Toxicity of Chronic Use of Monosodium Glutamate in Liver of Albino Rats. Ain Shams Journal of Forensic Medicine and Clinical Toxicology 19: 75-87.

11. Osman HEH, Elshama SS, El-Kenawy AE (2012) Assessment of Nephrotoxicity of Repeated Use of Monosodium Glutamate in Adult Albino Rats. Ain Shams Journal of Forensic Medicine and Clinical Toxicology 19(2): 88-96.

12. Husarova V, Ostatnikova D (2013) Monosodium Glutamate Toxic Effects and Their Implications for Human Intake: A Review. JMED Research: 1-12.

13. Bera TK, Kar SK, Yadav PK, Mukherjee P, Yadav S (2017) Effects of monosodium glutamate on human health: A systematic review. World J Pharm Sci 5(5): 139-144.

14. Whitehouse CR, Boullata J, McCauley LA (2008) The potential toxicity of artificial sweeteners. Journal of the American Association of Occupational Health Nurses 56(6): 251-259.

15. Abhilash M, Paul MV, Varghese MV, Harikumaran RN (2011) Effect of long-term intake of aspartame on antioxidant defense status in liver. Food and Chemical Toxicology 49(6): 1203-1207.

16. El Haliem NGA, Mohamed DS (2011) The effect of aspartame on the histological structure of the liver and renal cortex of adult male albino rat and the possible protective effect of Pimpinella anisum oil. Egyptian Journal of Histology 34(4): 715-726.

17. Andrejić BM, Mijatović VM, Samojlik IN, Olga Horvat J, Jelena Ćalasan D, et al. (2013) The influence of chronic intake of saccharin on rat hepatic and pancreatic function and morphology: Gender differences. Bosnian Journal of Basic Medical Sciences 13(2): 94-99.

18. Gombos K, Varjas T, Orsós Z (2007) The effect of aspartame administration on oncogene and suppressor gene expressions. In Vivo 21(1): 89-92.

19. Mpountoukas P, Pantazaki A, Kostareli E, Christodoulou P, Kareli D, et al. (2010) Cytogenetic evaluation and DNA interaction studies of the food colorants amaranth, erythrosine and tartrazine. Food Chem Toxicol 48(10): 2934-2944.

20. Himri I, Bellahcen S, Souna F, Belmakki F, Aziz M, et al. (2011) A 90-day oral toxicity study of tartrazine, a synthetic food dye, in wistar rats. Int J Pharm Pharm Sci 3(3): 159-169.

21. Thomas OE, Adegoke OA (2015) Toxicity of food colours and additives: A review. Afr J Pharm Pharmacol 9 (36): 900-914.

22. Jain A, Mathur P (2015) Evaluating Hazards Posed by Additives in Food: A Review of Studies Adopting a Risk Assessment Approach. Curr Res Nutr Food Sci Jour 3(3): 243-255.

23. Onyemaobi OI, Williams GO, Adekoya KO (2012) Cytogenetic Effects of two food preservatives, sodium metabisulphite and sodium benzoate on the root tips of Allium cepa. Linn Ife J Sci 14(1): pp.155.

24. Sindelar JJ, Milkowski AL (2012) Human safety controversies surrounding nitrate and nitrite in the diet. Nitric Oxide 26(4): 259-266.

25. Elshama SS, El-Kenawy AE, Osman HEH (2016) Curcumin improves atorvastatin-induced myotoxicity in rats: Histopathological and biochemical evidence. Int J Immunopathol Pharmacol 29(4): 742-752.

26. Elshama SS, Abdalla ME, Mohamed AM (2018) Role of Natural Antioxidants in Treatment of Toxicity. J Toxicol Anal 1(1): 1-7.

27. Elshama SS, El-Kenawy AE, Osman HEH, Youseef HM (2014) Amelioration of indomethacin systemic toxicity by arabic gum administration in the adult albino rats. International Journal of Medicinal Plants and Alternative Medicine 2(3): 32-46.

28. Elshama SS (2018) The preventive role of Arabic gum in the treatment of Toxicity. Opn acc Tox & Res 1(1): 27-29.

29. Elshama SS, Shehab GMG, El-Kenawy AE (2013) Role of Nigella Sativa Seeds on Modulation Testicular Toxicity of Colchicine Repeated Use in Adult Albino Rats. Life Science Journal 10: 1629-1639.

30. Elshama SS (2018) The preventive and curative role of Nigella sativa in poisoning cases. J Clin Exp Tox 2(2): 18-24.

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