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Excessive Consumption of Additives in Processed Foods

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ABSTRACT

Food additives are substances that are added to processed foods during the manufacturing process. They are used for several purposes (efficacy), such as improving the processing method and storage stability. If the added concentration is too high, these additives may have a negative effect (toxicity) on the person's health; therefore, care must be taken to not add them excessively. In recent years, overdoses and related additives that may cause the overdose have been reported. This paper outlines food additives and exemplifies those where overdose is a problem. Exemplified compounds are food additives licensed in, including some that are exclusive to Japan.

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INTRODUCTION

Food additives are substances added during the manufacturing of processed foods[1),2)]. They are sometimes used to improve the ease of processing, shelf life, appearance, and taste, and to increase nutrition. Food is processed either by cooking or served as is for eating, which we consume to gain nutrients[3)]. The amount of nutrients in many foods varies depending on the place of origin and the time of acquisition, and its quality deteriorates during storage. Therefore, additives may be required to maintain the value of foods as much as possible, while delivering to consumers. Quality deterioration results from a decrease in the number of nutrients and also includes a decrease in appetite or commercial value of food due to changes in color or taste.

Food additives have a positive effect (efficacy) on food but may also have negative effects (toxicity) on the human body when ingested. According to the Food Safety Commission of Japan, all chemicals have health risks[2)]. In some cases, the adverse effects of additives are acceptable, but in other cases, they are prominent and cannot be overlooked. Additives that have some beneficial effect may be added, but too much can cause lesions or can even be fatal. These food additives usually have a usage limit concentration, and the manufacturer must legally comply.

In this paper, an overview of the types of food additives is provided, along with a discussion on food additives that have recently required attention. We introduce cases where the usage standards have not been followed or are difficult to follow. These contents are food additives licensed in Japan and may include those not licensed in other countries.

History of food additives in Japan

Colorants have been used frequently in Japan since ancient times, but there was little awareness of their harmfulness. Due to the opening of the country after the Meiji Restoration (1868), many foods containing foreign pigments, whose toxicity was unknown at the time, were imported. For this reason, in 1876, the Tokyo Shogunate (the ‘old government’) banned the use of foreign-made colorants in foods, and regulations on food additives began in Japan[4].

Since then, there have been many cases of poisoning leading to comprehensive restrictions and regulations related to food additives. The Food Sanitation Law, enacted in 1947, defines food additives as substances that are added, mixed, infiltrated, or otherwise used in food during manufacture, processing, or storage. Only additives that have been confirmed to be safe at set

concentrations are specified and can be used (called a positive list system). In other words, the permitted additives do not exhibit extreme toxicity if their usage complies with usage limit concentration. If added excessively, intentionally, or unintentionally, the additives will result in toxicity. Regarding the concentration of food additives used, Japanese and foreign standards have not yet been unified. To solve this problem, foods imported into Japan must comply with the standards in Japan, and conversely, foods exported from Japan to other countries must comply with the importer's standards. Although unclear about the intention, additives that are restricted in Japan may be detected in imported foods. In Japan, food additives have a designated system; therefore, additives that are not designated are unlicensed.

Efficacy and toxicity of the additives

Food additives have several benefits and are thus, added to processed foods[2]. The classification of additives is listed in Table 1. The purpose of adding these substances are broadly aimed at (a) prolonging the life of food, (b) improving shape, (c) adding color and aroma, and (d) improving taste and texture. Additives need food manufacture and processing help (b). Improving the flavor and appearance of food help (b), (c), and (d), while, good food preservation and prevention of food poisoning help (a). Those that enhance the nutritional components of food do not fall under (a)–(d) but may be necessary to increase the value of food. Some argue that powdered milk used for childcare can cause serious health problems in babies unless it is fortified with various vitamins, calcium carbonate, copper sulfate, zinc sulfate, and other food additives[5]. Tofu and konjac do not coagulate without additives in the first place. So, many foods cannot be manufactured without additives[4].

However, there is also a side that disapproves of the use of food additives[3]. Table 2 lists typical examples of food additives that require attention. Some additives, mainly tar dyes, are distributed in Japan, although their use is restricted in other countries due to the risk of carcinogenicity, chromosomal abnormalities, and teratogenicity. For this reason, some consumers question their safety[3]. These toxicities are likely to develop when the concentration of toxins is close to a threshold concentration, or when it is added in large amounts for long-term storage. In any case, even nutrients can be toxic if taken in large amounts (such as sugar, which causes diabetes, and protein, which causes renal failure). Food additives should also be considered as constant risks of toxicity[2]. However, as with pharmaceutical products, their use should be decided based on the balance between their effects and risks. The value of food was higher when the additive was added, and if the toxicity due to the additive is extremely low, its use is selected. Consumers do

not always buy products that use additives (because they are rarely preferred and are unavoidably selected). Manufacturers or the national government need to take measures, such as educating about the effects of additives and preparing additive-free foods. There is no scientific evidence that additive-free foods contribute to better health than additive foods[5]. There is also an opinion that the zero-risk commercial method for daily necessities, such as additive-free products, spread misunderstandings and anxieties in consumers deferring the building of trust in processed products.

Examples of additives exceeding or likely exceeding the permissible concentration

A recent problem is that the intake of aluminum-containing food additives in children exceeds the standard[6]. It is presumed to be ingested from confectionary bread and substances (baking powder, a leavening agent containing aluminum, is often used in bread). Aluminum-containing additives have the potential to affect the reproductive system and neurodevelopment internationally. The Codex Alimentarius Commission, an international inter-governmental organization to protect health, and the EU have been reviewing the standards for additives, intending to reduce the intake concentration of aluminum compounds. In Japan, the Ministry of Health, Labor, and Welfare has previously attempted to approve the use of four types of food additives containing aluminum (acidic aluminum phosphate (leavening agent (similar to baking soda); used for confectionary bread, baked confectionery, steamed confectionery, *etc*.), sodium aluminosilicate (anti-caking agent), calcium aluminum silicate (anti-caking agent), and carmine (colorant)) as international general-purpose additives. For this purpose, the Food Safety Commission of Japan was requested to evaluate their safety and these additives were approved. Due to these problems, the Ministry of Health, Labor, and Welfare has reviewed the standards for using potassium aluminum sulfate and ammonium aluminum sulfate, which are used as baking powders for bread and confectionery, and requested industry officials to voluntarily reduce the amount. In response, in 2013, the Japan Baking Industry Association decided not to use aluminum food additives. Since there are many baked confectioneries and similar products, aluminum-containing food additives are still widely distributed, which poses a threat to human health.

Sodium nitrite is a food additive that is recognized as a color former. The nitrite part (called nitrite root) is a substance that can be reddish and by combining with myoglobin and hemoglobin in meat and fish[7] can make it look fresh. Since the permissible limit is based on the residual and not the used concentration, the manufacturer must consider its expiration date and decomposition

in production. Since the additive is usually added at a high concentration to extend the storage period, there is a risk of exceeding the allowable concentration. When this substance is added at a high concentration, it has an antibacterial effect, suppresses the growth of *Salmonella* and other bacteria, and contributes to the prevention of food poisoning. If the concentration is too high, it exhibits carcinogenicity by reacting with amines coexisting in foods. When a reducing agent, such as vitamin C, coexists with sodium nitrite, its decomposition is promoted, and it becomes difficult to maintain the required concentration. While it is highly monitored in human food few considerations have been made about its use in animal feeds. The determination of the permissible concentration of additives in pet food for dogs and cats is a slow process, and its value is high compared to that of humans[7].

Food dyes are classified as colorants, available in supermarkets, and can be added directly when cooking confectionery. Since the concentration is controlled by the cook, there is a concern that toxicity may develop due to excessive addition. If the dye is a tar dye, as listed in Table 2, there is a risk of dysgenesis and carcinogenesis.

CONCLUSION

In this paper, we described the various types of food additives and showed that they have advantages (efficacy) and disadvantages (toxicity). Food additives are added to obtain efficacy; if their toxicity is high, they are not added despite their advantages and are not permitted for use in foods. It was shown that even if the additive is permitted, the limit concentration may be exceeded, depending on the concentration of the additive and the amount produced during storage. In addition, consumers with an unbalanced diet are more likely to develop toxicity. This value was based on the average intake of Japanese people in the National Health and Nutrition Examination Survey. Although there is a computational grace in the number of additives used, toxicity can develop if one continues to eat extremely limited food. People may be biased towards the idea that food additives should not be used, but it is also true that they benefit from their additions, such as increased shelf life. Care must be taken to prevent additive overdose; however, the inevitable use of additives must be considered.

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Table 1 Types and effects of additives (possibility and explanation of toxicity)

Intended use	Additional explanation	Application example*	Example of compound	Those that are likely to develop toxicity due to the excessive addition
(A) Necessary items for food manufacturing and processing		Enzyme Filtration aid Oil eluent Defoamer Processing aids (acid, alkali)	Amylase Activated carbon Propylene glycol Silicone resin Brine water (alkaline salt aqueous solution)	△ It must be added for processing, but it may be removed after production.
(B) To improve the flavor and appearance of food	Improve the color of food Add a scent To improve the taste Improve texture	Colorant Color former Bleach Fragrance Sweetener Seasoning Emulsifier Thickening / stabilizing / gelling agent	Tar dye Sodium nitrite Sodium hypochlorite Vanilla essence Saccharin Sodium citrate Phosphate Pectin	○ There is an optimum concentration to achieve the purpose such as coloring, and it must be considered separately from toxicity.
(C) Improves food preservation and prevents food poisoning	It prevents food oxidation / spoilage and spoilage due to the propagation of microorganisms and enhances food preservation.	Preservative Antioxidant Sterilizer Fungicide	Nisin Ascorbic acid (Vitamin C) Hypochlorous acid Sodium benzoate	◎ There is a common reason with the above, and there is an aspect that high concentration is inevitable in order to exert a sustainable effect.
(D) Those that enhance the nutritional components of food	It is added for the purpose of supplementing and strengthening the nutrients originally contained in food and the nutrients necessary for humans.	Nutrition enhancer Vitamin Mineral Amino acid	 Ascorbic acid Calcium chloride Sodium aspartate	Some are △ Originally a nutritional component, the retention and addiction of fat-soluble substances are sustained.

*Classification by purpose of use.

The underlined text refers to the usage and category of the substance as per food packaging in Japan.

Based on references 1), 5) and 8-10).

Table 2 Examples of food additives that require caution

Name	Intended use	Example of use	Problem
Sodium nitrite	Color former	Processed meat products (Sausage, Ham), Cod roe	It reacts with amines in meat and fish and turns into a carcinogen.
Tar dye	Colorant	Candy, Japanese sweets, Ice cream, Jam	Infertility, dysgenesis, carcinogenic risk.
Saccharin	Sweetener	Gum, Soft drinks, Canned foods, Sauces	Risk of chromosomal abnormalities, carcinogenesis, motor paralysis, hemorrhagic nephritis.
Sodium benzoate	Preservative, Fungicide	Energy drinks, Carbonated drinks	Reacts with ascorbic acid to produce carcinogens.
Enzyme	Catalyst	Japanese sweets	Some enzymes generate hydrogen peroxide, which is a carcinogen.
Phosphate, Polymerized phosphate (Sodium phosphate, Sodium polyphosphate, Sodium metaphosphate)	Binder, Emulsifier, Texture improvement	Kneaded products, Processed meats, Raw confectionery	It has been reported that the induction of renal dysfunction and the incidence of renal calcific tendinitis increase.

Based on references 5) and 8).