

Impact of food additives in ultra-processed food on human health

Xinyue Liang

Changsha WES Academy, Changsha, China

erinliang.cwa@wes-cwa.org

Abstract. With the development of food processing, public concern was aroused by safety issues regarding the application of artificial additives. Ultra-ultra-processed food is made through a process by adding additives such as antioxidants, preservatives, and coloring agents to modify the properties of the food product and cater to customer demands. This essay focuses on food chemistry to research how additives present in ultra-processed food affect health. Moreover, common food additives used in food processing and their potential threats will be discussed. The fact is that many cases have proved that sodium benzoate, vitamin C, vitamin E, Yellow No.5, and Yellow No.6 do have an impact on human health. Other types of additives such as those present in nature do not have a significant relationship with cancer molarity and health problems. There need further studies on the relationship between synthesized additives and carcinogenicity. The purpose of studying chemical additives is to understand the chemical properties behind food additives will inform people of the actual harmful ingredients in ultra-processed food and avoid large dose intake.

Keywords: food chemistry, processed food, food additives.

1. Introduction

1.1. Food additives

In 2020, a consumer survey by INIC showed American consumer habits, trends, and opinions on food safety. 77% of people try to avoid certain ingredients in food, mostly mentioned are sugar, salt, and artificial ingredients. 43% of the survey population said avoiding certain ingredients in food is for long-term health benefits from the health effect of those ingredients. This means there is nearly one in four consumers concerned about nutrient content while they are shopping [1]. Food additives are chemical or natural substances that are used in the application of processing food to improve or maintain the safety, appearance, texture, freshness, or taste of the food. Humans have been using additives for a long time, and modern food processing has added some new additives to food. FAO and WHO have together categorized food additives into three main types depending on their properties and function, which are flavoring agents, enzyme preparations, and other additives. Other additives have a wide range of uses, e.g., food preservation, coloring, etc. Since some of them are harmful to human health, there are strict restrictions on daily intake [2].

1.2. Ultra-processed food & NOVA system

Ultra-processed food is foods that have been processed to change their properties, e.g., add salt, add colors, etc. And NOVA categorized all foods into four categories: Group 1 is unprocessed or minimally ultra-processed foods, un ultra-processed foods are considered as all foods separate from nature, such as fruits, leaves, roots from plants, eggs, milk, fresh meat from animals. Minimally ultra-processed foods are processed by disposing of unwanted or inedible parts through roasting, grinding, drying, freezing, etc. to preserve foods for longer periods. Freeze steak and vacuum-packaging seafood are examples of Group 1 food; Group 2 is Processed culinary ingredients. Salt, oil, butter, and sugar that originate from Group 1 foods are considered processed culinary ingredients; Group 3 is processed food, these include foods from Groups one or two, such as cheese, fresh bread, and canned fish, as well as products made with additional salt, oil, sugar, or foods from those groups. These foods typically have two or three ingredients. They are palatable on their own but can also be added to other dishes. This group's food was processed to make it more stable while maintaining its quality; Group 4 is Ultra-processed foods, which describe when the nutrient content is mainly additives and components derived from food. Also, group 4 has intact with Group 1 and Group 2. Group 1 food such as salt, oil, sugar, and chemical additives such as artificial sweeteners, preservatives, and antioxidants are commonly found in ultra-processed foods such as fry foods, beverages, and pre-prepared frozen dishes [3].

1.3. Recent studies about diseases and food additives

According to a study in the UK, the average percentage of UPF consumption was 22.9% of the total diet as shown in Figure 1. They concluded that cancer risk increase has a direct proportion to the growth in UPF consumption. Especially increased mortality of ovarian cancer in women is associated with a higher UPF consumption (See Figure 1) [4]. Since UPFs contain the most additives, the consumer may unconsciously take a large dose of additives and raise the potential of diseases. Numerous news organizations have posted various articles on social media approximately the well-being impacts of ultra-processed nourishments to raise mindfulness around nourishment well-being. Among them, the hurt of nourishment-added substances has been said numerous times, such as the pulverization of human cells by cancer prevention agents, the impact of colors on children's advancement, and the affiliation between additives and cancer [5]. Hence, how nourishment added substances cause hurt to well-being and the control of the daily admissions of added substances are what shoppers have to pay consideration to. This article will summarize the hurt of nourishment-added substances to the human body from the viewpoint of atomic structure and chemical properties, as well as the affiliation of expanding cancer chance.

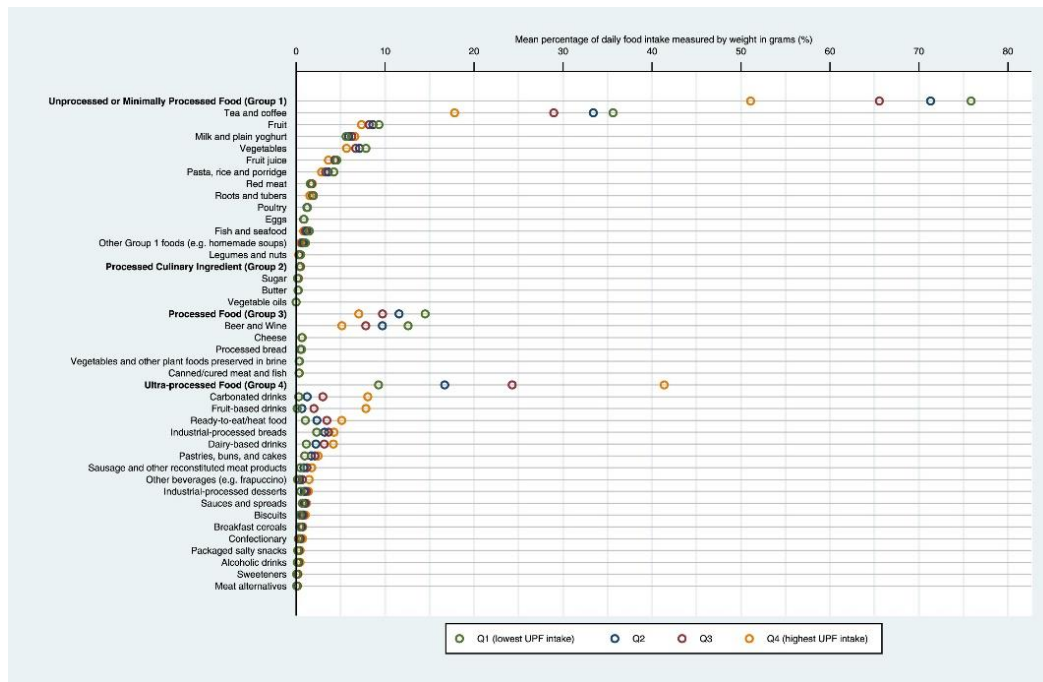


Figure 1. The total diet of ultra-processed food consumption [4].

2. Common food additives

To improve the taste and quality of food, food companies have adapted several chemicals into food. By using food additives, the texture, flavor, and properties of the food may cater to the customer's demands. Below are the three additives commonly used in food processing.

2.1. Antioxidants

Antioxidants are molecules that donate electrons to balance free radicals in the body to lower the damage to protein, and lipids. Vitamin C, Vitamin E, selenium, and carotenoids are examples of antioxidants preventing cancers. Free radicals are molecules that have unpaired electrons, which are highly reactive with other substances, mainly caused by radiation, chemicals, smoking, and excessive sugar intake. Those freely moving radicals may trigger "oxidative stress" and destroy cells in the human body. Antioxidants have been categorized into several types: Dietary Antioxidants, Endogenous Antioxidants, Exogenous Antioxidants, Synthetic Antioxidants, and Natural Antioxidants [6].

As the information mentioned in 2.1 Antioxidants, they are substances that give electrons to radicals. According to a recent research report, a higher antioxidants diet reduces the rate of mortality from CVDs and cancers [7]. This is due to the reduction in highly reactive radicals when antioxidants donate electrons and turns to lower active radicals which are harmless to the body. Therefore, antioxidants are widely considered essential nutrients in the diet. A common antioxidant in daily diet is vitamin C, which is also termed L-ascorbic acid, it was an important enzyme cofactor for several enzymatic reactions, e.g., post-translational hydroxylation of collagen, biosynthesis of carnitine, conversion of the neurotransmitter dopamine to norepinephrine, etc.

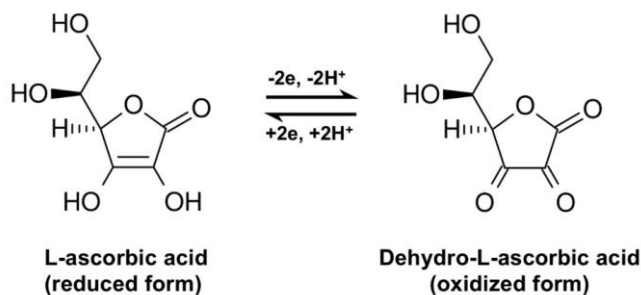


Figure 2. Reduced(left) and oxidized (right) forms of vitamin C by Stanislaw Gackowski [7].

When Vitamin C is dissolved in water, it is a key chain-breaking antioxidant. There have been proven that ascorbate can scavenge superoxide, hydrogen peroxide, hypochlorous acid, aqueous peroxy radicals, etc. During the antioxidant process of those free radicals, ascorbate goes through two reductions, initially forming semi-dehydroascorbic and subsequently forming dehydro-L-ascorbate as shown in Figure 2 [8]. Vitamin C reduces the free radicals in the human body while it has a low risk of causing damage. Many scientists speculate it would be possible to adapt antioxidants into cancer treatment. Though there still needs further clinical studies on using vitamin C to treat CVDs, antioxidants are a potential source to treat cancer [9].

2.2. Food preservatives

Food preservatives or antimicrobials are food additives that prevent food from natural spoilage caused by enzymological, microbiological, or chemical reactions for longer periods of storage. There are two main categories of food preservation: Natural preservatives and chemical preservatives. Class I Natural preservatives: salts, alcohol, vegetable oil, honey, sugar, etc. are examples of natural preservatives. Since they are naturally found in nature and less harmful to the body, there are fewer restrictions on their usage in food. Class II Chemical preservatives: they are classified as chemically synthesized preservatives that were artificially made in the laboratory. Such as benzoates, acetates, sulfur dioxide, nitrites, etc. They might affect the equilibrium within the human body. Therefore, organizations like FDA and the EU have strict regulatory measurement standards for preservatives. In addition, chemical preservatives are classified as antimicrobial, antioxidant, and anti-enzymes. Certain preservatives have specific regulations on their dosage [10].

Sodium benzoate as shown in Figure 3 is an odorless powder that is artificially made in the laboratory, formed by the neutralization of benzoic acid and sodium hydroxide [11]. Benzoic acid can be naturally found in many plants, such as berries, plums, prunes, and spices. In the food industry, benzoic acid is commercially made by toluene with oxygen with low-cost raw materials, but high production yield. This makes benzoic acid an effective food preservative in acidic foods, fruit juices, and carbonated or soda beverages. It could also be used in processing sauces and jams. Sodium benzoate inhibits the growth of potential microorganisms, mold, and other microbes in food in low pH conditions [12]. The antimicrobial activity of benzoate is related to pH and its complete molecule. The pKa of benzoate is 4.2 where bacterial growth could be well prohibited. In some cases, benzoate also acts as an effective prohibitor of mold and yeast [13].

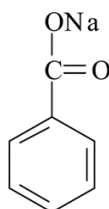


Figure 3. Sodium benzoate [11].

2.3. Coloring agents

Any dye, pigment, or other chemicals that can give food color is considered a color additive. Coloring agents are accessible within the following forms: Granular, Powder, Lake Colors, FD & C Colors, and D & C Colors [14]. They have a wide range of applications in our daily life, e.g., bakery, beverage, confectionery, cosmetics, dairy, meat & savories, pharmaceutical, seafood, and pet food. They are seen as essential ingredients in ultra-processed food because colorings increase the attractiveness of the food by making it appealing and tempting. There are more purposes for using color agents, e.g., intensifying the original color, preventing nutrient loss or damage by exposure to light, making food unique in appearance, improving taste, and masking food variations in color. Some examples of food colorings that both EFSA and the FDA approve are Yellow No.5 (Tartrazine), Yellow No.6 (Sunset Yellow) shown in Figure 4, Red No.3 (Erythrosine), Red No.40 (Allura Red) shown in Figure 5, Blue No.1 (Brilliant Blue), and Blue No.2 (Indigo Carmine) shown in Figure 6 [12].

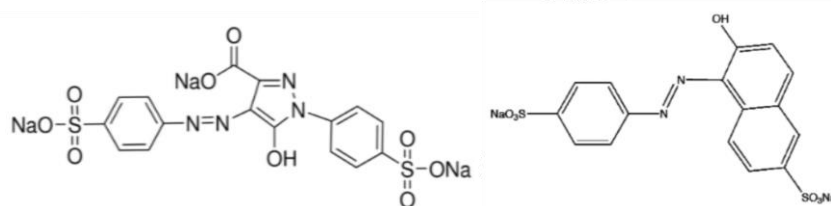


Figure 4. Tartrazine (left), Sunset Yellow (right) [12].

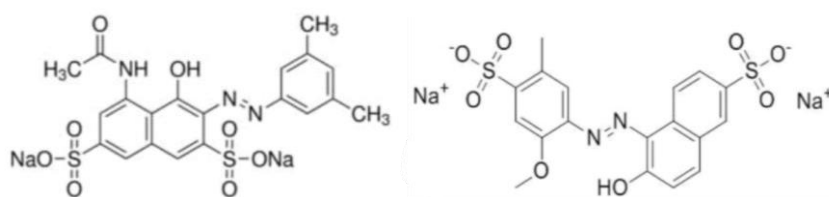


Figure 5. Erythrosine (left), Allura Red (right) [12].

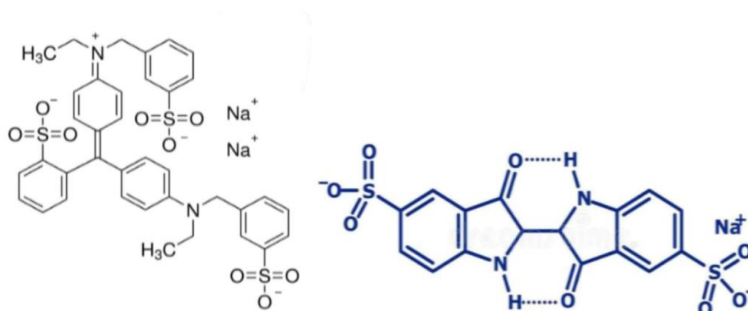


Figure 6. Brilliant Blue (left), Indigo Carmine (right) [12].

3. Threats and disease

3.1. Antioxidants' mechanism of the reaction and impact on health

As mentioned in section 2.1, oxidative stress is associated with nonequilibrium free radicals and antioxidant defense in the system. Tissues harmed by injury, contamination, warm harm, hyperoxia, poisons, or over-the-top work out may experience the short-term oxidative stretch. These harmed tissues deliver expanded radical-generating chemicals, phagocyte actuation, free press, copper particles, or a disturbance of the electron transport chains of oxidative phosphorylation, driving over-the-top ROS. The lopsidedness between ROS and the antioxidant defense framework has been connected to the start, advancement, and movement of cancer, as well as the side impacts of radiation

and chemotherapy. ROS has been related to the onset and movement of diabetes, age-related eye malady, and neurodegenerative infections for case Parkinson's malady. For cancer prevention agents, there have been two primary recommended modes of activity. The primary may be a chain-breaking component in which the system's free radicals, such as lipid radicals, are given electrons by the major antioxidants. Antioxidants that break chains work by removing free radicals and giving hydrogen atoms. By quenching the chain initiator catalyst, the second method involves the elimination of ROS and RNS initiator. Antioxidants that act as preventatives are typically reductants and metal chelators that can protect other antioxidants in vivo. These reactive species are capable of rupturing homeostasis and damaging essential biological molecules like deoxyribonucleic acid (DNA), proteins, carbohydrates, and lipids [15].

Therefore, antioxidants are used for cancer prevention and treatment. However, some studies have shown that they may increase or aggravate the tumor. A 2020 analysis showed that high beta-carotene or vitamin E diet has a higher risk of getting lung cancer. Still, there are only a few studies supporting the opinion and no direct results prove the relationship between beta-carotene intake and lung cancer. Whether tall dosages of vitamin A, vitamin C, vitamin D, vitamin E, calcium, selenium, and a combination of cancer prevention agents all have small to no contrast in lung cancer rate. Take vitamin E as an illustration. There are as it were slight contrasts that appeared. Vitamin E does have side impacts but no noteworthy effect on the mortality of lung cancer or the potential of lung cancer [16].

3.2. Preservatives and threat to health

Based on a diagram, in spite of the fact that sodium benzoate is respected as a safe substance, short-term exposure can cause eye, skin, and respiratory tract disturbance, while too delayed or rehased contact can exasperate skin sensitization. Tall sums cause histamine and prostaglandin discharge, ulcers, and changes in gastrointestinal bodily fluid generation. Concurring to 2007 consider, sodium benzoate hoisted blood weight, eventually breaking the vessels within the blood cells of rats [17]. A few inconvenient results of sodium benzoate utilization include devastation to the hepatocyte cell film and crista setbacks in mitochondria, association to the furthest shell of vacuole mitochondria within the cytoplasm, and liver and kidney abnormality [18]. Within the absence of metal catalysts, the investigation assist illustrated the forming of benzene within the response between benzoic corrosive and ascorbic corrosive in natural products and soft drinks [13]. Another research in 2015 studied the carcinogenicity of intake processed meat. 15 other cancer genre results were also readily accessible. Throughout the prospective study and demographically case analysis, there was an association relation between red meat consumption and pancreas and prostate cancer and between manufactured meat consumption and stomach cancer. Nearly all of the investigations concluded that it is satisfactory proof in people of the cancer hazard of mechanically delivered meat admissions based upon broad data and the persistent affiliations of colorectal cancer with expanding prepared meat over considers in various groups. Still, there's no exactitude for the information on ruddy meat utilization, since no clear affiliation was seen in a few examinations, and proceeding from other eating propensities and dangers is troublesome to dispense with. In conclusion, further research is required to prove the utilization of prepared meat increments the chance of cancer [19].

3.3. Food colorings and impact on health

According to Harvard Health Publishing, artificial food colors increase the risk of children's attention deficit hyperactivity disorder and ADHD [20]. Synthesis colorings were highly used in food manufacturing to make the products more attractive. Kraft Macaroni & Cheese used Yellow No.5 and Yellow No.6 to make the macaroni more appealing and attractive. The company stopped using artificial colors and instead of using natural colors just because the customer refuse to purchase food that contain artificial ingredients [21]. Later research into artificial colors showed that children who have taken more food colorings showed higher hyperactivity scores. But according to the latest studies, some children have shown more hyperactivated and some children have no effect. And the ratio is half

to half [22]. There is no sufficient research to support that food coloring is directly causing children's hyperactivity. Indeed, it is unhealthy and it is necessary to control the intake of food dyes in the diet.

4. Conclusion

Consequently, researchers and the public concur that ultra-processed nourishment is undesirable. In any case, they are destructive to our bodies not by having chemical added substances but the actual happening fixings such as sugar and carbohydrates. Most of the time, the fixing substance on the nourishment bundle, sugar, fats, and starch are the three fundamental sorts, when individuals eat sugar, they will get a sense of joy since sugar makes the brain create affront which influences our positive feelings, subsequently advancing individuals proceeding eating them. As a result, the tall sugar level within the circulatory system leads to tall blood weight causing cardiac illnesses, such as cardiovascular blockage and stroke. And high-fat slim down leads to being overweight additionally may damage heart tissues. Hence, ultra-ultra-processed nourishment is the most cause of heart malady.

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