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The Impact of Food Processing Flows and the Additive on The Nutritional Content and Values of Food

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Abstract:

Food processing plays a pivotal role in influencing the nutritional content and value of food. Recent advancements in food processing techniques and the use of additives have led to substantial changes in nutrient levels and bioavailability, especially increasing the safety of food. This paper examines the dual impact of various food processing methods and additives on nutrient levels and bioavailability. Key processing methods such as thermal processing, cold processing, fermentation, drying are classified to primary and secondary processing and being explored for their effects on food nutrients. Furthermore, the role of additives, including natural substances like ascorbic acid, is also discussed in extending shelf life and improving flavor and appearance. Through a comprehensive review of existing literature, this study finds that while food processing can enhance certain aspects like safety and convenience, it can also lead to the loss of essential nutrients and the nutritional value. Besides, the study found that the loss of nutrients may focused on the preparation stage, which also called primary food processing. However, the increase of nutritional value and content may increase in the secondary food processing through the effort and rich experiment of human, like fermentation. The findings highlight the importance to distinguish the function and impact of various food processing methods to the food nutrition. Furthermore, it also emphasizes the need for balanced food processing approaches to optimize nutritional value while mitigating adverse effects on health.

Keywords: Food processing flow; additive; nutritional content and values.

1. Introduction

Human derive the sustenance from the natural environment on a daily basis, and the food human consume is seasonally harvested. But the raw foods found in nature are part of biological systems that are susceptible to rapid spoilage. So it is necessary to preserve food by various methods to make sure food can be provided in the off-seasons. Nobel laureate Albert Szent-Györgyi thought that one of the fundamental tenets of biological science is the conservation and storage of free energy within molecular structures of food, which can be harnessed as required [1]. Accumulating experience of food processing for thousands of years, human have mastered a range of food processing methods. The main food processing methods include thermal processing, containing modes of baking, boiling, steaming and so on; Cold processing containing refrigeration, freezing and freeze-drying; The fermentation using the metabolic activity of microorganisms to convert organic matter into other flavorful substances with possible extended shelf life. More methods like Drying, Canning Irradiation and Microwave, Extrusion and High-pressure processing use specific methods to achieve sterilization and disinfection and then extend the shelf life. During the applications, possibly not only existing one of those processed methods above in the flow-design blueprint of certain processed food. For examplea jar of yogurt needs to experience a flow of integrated processes, containing homogenization that homogenizes milk under high pressure, pasteurization that heats the milk to 72°C to kill the pathogenic microorganisms and fermentation that adds lactic acid bacteria to transform lactose to another substance called lactic acid, and finally be well packaged to become products. With regard to the additives, their variety is increasingly accompanying the proliferation of processed foods, including snacks. According to the FSA, the Food Standards Agency, additives are substances introduced into our food supply for diverse purposes, such as extending the shelf life, enhancing flavor, and improving visual appeal [2]. Actually, the additives can be the substances existing in nature and not all of them are synthesized by chemicals. Lindsay thought that many substances are added to foods for specific functional purposes, and in many cases, these ingredients can also be found naturally in some foods. However, when they are used in

processed foods, these chemicals are referred to as “food additives” [3]. One example of the food additive extracted from natural materials is ascorbic acid, which also called vitamin C or citric acid that being one of the most powerful anti-oxidants in the world. This additive can be found in citrus fruit, including oranges, tangerines and lemons. In conclusion, food processing and additives play a pivotal role in deciding the nutritional quality and value of the processed food. They can enhance certain aspects like safety, flavor and convenience, while they can also lead to the loss or excess of important nutrients, or even cause formation of the harmful compounds due to the entirely different nutrients, which directly impacts human health. Some food processing method and additives are definitely one of the most important and great developments in the society that make great contribution to the survival of the human and the Global Gross Domestic Products. This research will delve into the multifaceted impacts of food processing and additives on nutrients of food, aiming to shed light on how these processes influence human well-being or harm the human health.

2. Primary Processing

Food processing incorporates a broad spectrum of techniques designed to transform raw ingredients into edible products. There are multiple work stages in food processing, in accordance with the sequence and the extent of treatment, food processing could be classified to primary processing and secondary processing. Following I will introduce the common primary processing, secondary processing and some special and innovative processing techniques and how they can impact the nutritional value of the proceeded food.

Primary food processing encompasses the initial preparation of raw food materials, aiming at converting the raw materials to food commodities. It ensures their safety and suitability for consumption or subsequent processing. This phase includes activities such as cleaning, milling, dehydration, and fundamental preservation. Moreover, modern Industrial technology has introduced vacuum packing, drying and freeze- drying, irradiation, pasteurization, smoking, the addition of chemical additives, freezing, canning, dehydrating and salting. As the work recited, these preservation methods inhibit the growth of bacteria by either eliminating moisture from foods or removing the oxygen that harmful bacteria need to survive and thrive [4].

2.1 Cleaning and Sorting

This process does not significantly affect the nutrients of food. However, it will actually increase the nutritional value of the food, which can remove dirt and contaminants in raw food materials and also clean the residue pesticide attached to the raw materials. The cited research has investigated the effect of cleaning and sorting processes on wheat mycotoxin contents [5]. Actually, most of the mycotoxins are essentially stable natural chemicals. It was perceived as harmful substance because it is toxic to humans. After harvest, the first phase of the physical method is used to sort and clean the grain according to the weight, size and shape of the grain. Food processing steps can affect the levels and distribution of mycotoxins. As different grains have different levels of mycrotoxins, cleaning and sorting can change their concentration. So the concluded that the methods of cleaning and sorting significantly decreased the mycotoxin content in wheat. In this way, cleaning and sorting can increase the nutritional value of the food.

2.2 Miling and Grinding

This process may cause the loss of dietary fiber, vitamins, and some minerals. The research cited have introduced the main methods of how grains, meals, and flours can be treated prior to consumption [6]. These methods include Whole Grains Minimally Processed or Milled, Whole Grain Flours or Meals Produced at the Mill and Whole Grain Flours or Meals Produced Away from the Mill-Reconstitution. In almost all of this processed method, the whole grains consumed would have been kernels processed to remove the husk and outer hull. It definitely decides that the nutrients in the husk and outer hull can not be preserved. Someone may perceive that those become processing waste is because they are non- nutritive substance which is useless to human health. But actually, husk and outer hull of grains such as wheat, rice, oats, and barley are packed with essential nutrients that contribute significantly to their health benefits. The husk, commonly discarded during the milling process due to its robust and fibrous composition, contains valuable dietary fiber and lignin. What is more, as the cited researchers thought, the dietary fiber in the husk is mostly insoluble, promoting healthy digestion, preventing constipation, and even help lose weight by providing a sense of fullness [7]. Besides, there is one substance called lignin found in the husk which is a complex organic polymer acting as an antioxidant to support cardiovascular health. Lignin may even reduce the risk of cancers [8]. Regarding rice bran, research shows that this nutrient-intensive level is under the shell and contains a variety of soluble and insoluble fibers, vitamins, minerals, phytochemicals and proteins. As stated in the cited study, the continuous grading analysis of coarse grinding brown rice shows that the nutrients are not evenly distributed in brown rice. The contents of rice constituents were analyzed in milling fractions obtained after multistep milling of brown rice. Approximately 80% of the kernel proteins were located in the starchy endosperm, while minerals were more abundant in the outer bran layers. The starch content was highest in the endosperm,

whereas the protein and mineral contents decreased from the outer bran layers to the endosperm. These compounds possess antioxidant and anti-inflammatory attributes, which may mitigate the risk of enduring maladies such as cardiovascular ailments and carcinoma. The proteins contained within the bran are instrumental in providing the amino acids vital for tissue mending, immune response modulation, and the synthesis of enzymes and hormones. The removal of the husk and bran during the refining process results in a significant loss of these vital nutrients, underscoring the importance of consuming whole grains to maintain a balanced and nutritious diet.

2.3 Drying and Dehydration

As per the research Drying is essentially a simultaneous process of heat transfer and mass transfer, in which the generation of heating medium or internal heat helps to evaporate free water molecules from the products [9]. This process can remove the excess moisture content in raw materials, avoiding microbial growth excessively and spoilage. While it may lead to the loss of heat-sensitive vitamins, such as vitamin C. Take fruit as an example, the increasing consumption of dried fruits requires further attention to the drying method. Drying has become necessary because most fruits are highly perishable owing to their high moisture content and the need to make them available all year round and at locations where they are not produced. For a long time, fruit farmers use sun drying to dry the fruit. The high sugar and acid content of fruits makes them safe to dry with the solar power. Commonly, when fruits repin, fruits are placed on trays made of screen or wooden dowels to dry in the sun. The screen needs to be in safe contact with food. The best screen is stainless steel, Teflon-coated glass fiber or plastic. However, some farmers may use copper or aluminum screens. In fact, copper destroys vitamin C and increases oxidation. Aluminum is easy to change color and corrode. In addition, the loss of vitamins and nutrients is also related to high-temperature drying, such as sunlight drying and other high-temperature drying methods such as oven drying. High temperatures will lead to significant loss of heat-sensitive nutrients such as vitamin C and vitamin B [9]. So the techniques of sun drying may decrease the nutritional value of fruit. In those drying methods, freeze-drying represents an advanced technique for the preservation of nutritional content, which demonstrates superiority over conventional drying methods. Freeze-drying, also known as cryodesiccation, is a dehydration process typically used to preserve a perishable material or make the material more convenient for transport. After being dried, minerals like calcium, iron, and potassium will remain stable, though their concentration may be higher due to reduced water content. Proteins will denature, affecting their digestibility, while carbohydrates generally become more concentrated. Fats are prone to oxidation, leading to rancidity. While freeze drying can minimize these risks greatly.

2.4 Sample Preservation

The purpose of food preservation is to prevent the growth of yeast, bacteria, or other microorganisms while delaying the oxidation of fat to avoid becoming rancid [10]. This process encompasses processing techniques such as pasteurization, canning, and refrigeration, with the aim of extending the shelf life of foods. However, pasteurization and canning may eliminate certain vitamins and enzymes, although they enhance the safety of foods. Moreover, refrigeration can aid in preserving nutrient levels with negligible loss.

3. Secondary Food Processing

Secondary food processing includes the conversion of primary processed raw materials into ready-to-eat food product [11]. The process involved in this stage includes a variety of methods such as cooking, mixing, baking and fermentation.

3.1 Cooking and Baking

Cooking related to heated food may reduce the content of certain nutrients. However, different cooking methods have different effects on food. For example, high-temperature methods such as boiling will reduce vitamin C in broccoli, while steaming can better retain it. Boiling potatoes can lead to the loss of potassium, but baking can keep it. Cooking spinach can reduce oxalate and improve the availability of iron. Cooking meat at high temperature may form harmful compounds, but it can make protein more digestible. Boiled eggs can also improve the digestion of protein. Cooking rice can glue starch and enhance digestion. Cooking carrots can increase the availability of beta-carotene.

3.2 Fermentation

This process can produce fermentation foods through the action of beneficial microorganisms. The fermentation foods include yogurt, cheese, Kaifir and other dairy products, which are fermented by lactic acid bacteria and are rich in probiotics. Soy products such as tofu milk, natto and miso are fermented with specific bacteria or molds to increase the content of vitamins and minerals. Sour bread is fermented by lactic acid bacteria and yeast, making the dough easier to digest. Vegetables such as kimchi and sauerkraut are fermented with lactic acid, which not only preserves the nutrition of vegetables, but also adds flavor. Fermentation may alleviate the nutritional content of foods like certain protein. It can partially break down

proteins, making the foods easier to digest. This could be seen as a lot of the nutrional content, but also an enhance of the nutritional quality through another aspect. However, the process may also produce compounds that can affect some individuals negatively, such as histamines.

It is commonly accepted that processed foods do not possess nutrition profiles equivalent to those of fresh counterparts. In fact, numerous processed foods are equivalently nutritious. In certain instances, they may even possess greater nutritional value than fresh foods, which is contingent upon the method of processing employed. Fermentation is one cute example for taking advantages of humans' intelligence to increase the food nutritional content and value. In some cases, food processing will decrease the level of certain nutrition in order to increase or condense the other nutrients that are required. The food processing factories will also extract certain substance that meet consumer's preferences. For example, the fermentation can increase the bioavailability of B vitamins and produce probiotics, enhancing gut health. Fermented foods like yogurt and kefir are rich in probiotics, which support digestive health. Similarly, fermentation can reduce antinutrients in grains and legumes, making minerals like iron and zinc more accessible. Vegetables are rich in a variety of vitamins, minerals, antioxidants and nutrients. However, they also contain high levels of anti-nutrients, which will reduce the bioavailability of certain nutrient essential ingredients such as zinc or iron. The processing of vegetables, including microbial fermentation, can reduce or neutralize tannin and phytic acid, thus improving the bioavailability of vitamins and minerals [12]. This kind of balancing act in food processing aims to optimize nutritional value and cater to consumer demands. The other case was the formulation of certain nutritional content. Take cooking for an example, cooking tomatoes increases the availability of lycopene, an antioxidant linked to reduced cancer risk. Similarly, steaming vegetables like spinach and carrots can enhance the bioavailability of beta-carotene and other antioxidants. Besides, Cooking tomatoes enhances the availability of lycopene which is an antioxidant.

4. Conclusion

Food processing and the use of additives significantly reshape the nutritional landscape of the foods we consume, impacting both their health benefits and potential risks. Through a detailed examination of various processing methods—such as thermal treatments, refrigeration, fermentation, and drying—this study highlights the complex interplay between enhancing and diminishing nutrient levels. Fermentation emerges as a powerful method for improving nutritional value by boosting vitamins and probiotics while mitigating antinutrients. In contrast, cooking methods vary widely in their impact, with some preserving or even enhancing nutrient bioavailability and others leading to substantial nutrient losses. The strategic use of additives, from naturally occurring substances like ascorbic acid to synthetic compounds, plays a crucial role in extending shelf life, enhancing flavors, and ensuring food safety. However, these benefits come with trade-offs, including potential nutrient degradation and the formation of harmful compounds. Understanding these dynamics is crucial for developing food processing strategies that optimize nutritional content and minimize health risks. This research underscores the necessity for a balanced approach in food processing and additive use, emphasizing the need for ongoing innovation and regulation to ensure that the foods we consume contribute positively to our overall health and well-being.

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