

Can Synthetic Chemistry Create Sustainable Food Sources for a Growing Population?

Introduction

As the population of the Earth expands, the pressure on sustainable food sources is increasing in order to support the growing demands on food. In 2024, the United Nations stated that the population of humans on Earth is expected to increase by around 2 billion, from 8 billion to 10 billion by 2050. This raises concerns of how higher amounts of food will need to be produced with our limited number of natural resources and supplied to people around the world (Smith 2023). Many developing countries around the world such as Sudan, Haiti and Nigeria are facing famine because of their booming populations and it is only expected to worsen (World Food Programme 2025).

Another major challenge, that is undermining the sustainability of our food systems, is the increase in food wastages. Food waste refers to the edible food which is discarded by producers, retailers or consumers instead of being consumed. Around 2.5 billion tons of food is wasted every year which is about a third of the food that is produced (Safdie 2022). Developed countries play a huge role in food wastage problems as their high aesthetic standards of food and large portion size leads to the overproduction of food where most of it is discarded (Safdie 2022). If the food wastage problem continues to inflate, it can lead to the depletion of essential natural materials used to make food products which can result in food shortages.

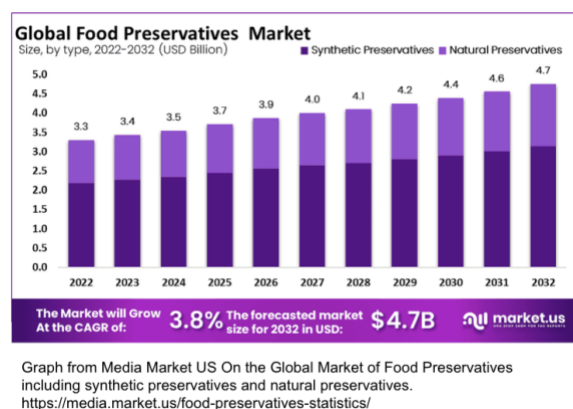
Thus, the solution to feeding a growing population is not by simply producing more food, but instead, is by saving, preserving or recycling the food that we already have. This report will focus on exploring how synthetic chemistry can be used to create sustainable food sources for the rapidly growing population by using chemical food additives and fertilizers, pesticides and herbicides.

The Use of Synthetic Chemistry in Developing Sustainable Food Sources for the Growing Population

Synthetic chemistry is a branch of chemistry which is involved in creating new chemicals or processes to synthesize the existing ones (Manahan 2020). At present, many of the food products we consume contain chemicals. They are referred to as artificial food as they have been manufactured using chemical processes or through biotechnology instead of directly being derived from natural plants or animal resources. Hence with global food security becoming an increasingly urgent issue, synthetic foods are emerging as a potential solution to bridge the gap between the limited supply and excess demand of food. (Grow 2024)

The Use of Chemical Preservatives in Creating Sustainable Food Sources by lengthening the Shelf life of Food Products

One of the ways that synthetic chemistry is incorporated in producing sustainable food is through synthetic food preservation. Synthetic food preservatives are chemicals that are added to a variety of foods products in order to lengthen their shelf life, prevent food spoilage and reduce microbial growth of yeast, bacteria or molds which can degrade the nutritional value of it (Prasad 2023). As shown in the graph, the global food preservatives market generated approximately USD 3.4 billion in 2023 and from 2022-2032, synthetic preservatives accounted for the majority of the revenue as it significantly increased from USD 2.18 billion in 2022 to USD 3.1 billion in 2023. The use of synthetic preservatives is predicted to increase in the next decade due to the increase in demand for food. (Yardi 2024)



Synthetic food preservatives can be classified into two main categories: antioxidants or antimicrobial agents. Antioxidants prevent the oxidation of lipids that usually occurs when they react with the oxygen in the air which alters their chemical composition and leads to a deterioration of the quality of food. On the other hand, antimicrobial agents destroy pathogenic microorganisms like bacteria and fungi by inhibiting their growth and preventing molds from growing on the bacteria which can cause various human diseases such as botulism. These include nitrates and nitrites.

Chemical food additives are a crucial element to reducing food waste as some chemicals such as benzoates and sulphites consist of properties which extend the shelf life of food items and prevent them from spoiling rapidly. This is a key characteristic of chemical food preservatives because it

can help to feed a growing population. Many of the food items derived from natural sources can easily become stale, oxidized, rotted and may even grow molds during the distribution stage when the temperatures and conditions vary, which makes distributing the fresh and healthy food items around the world a very challenging task. Hence by using synthetic food preservatives, the quality of the product will be preserved despite the unstable conditions which will enable the products to maintain their original forms for longer periods of time with no drop off in safety, health or taste. This can support sustainability in the supply chain and in food production leading to food items being able to be distributed easily to areas around the world without them being wasted. (Spoon 2020)

A developing country that has benefited from chemical preservation techniques is Nigeria. Over 26 million people out of an estimated population of 229.5 million people faced acute hunger in the period June to August 2024 (Tanimonure 2025). Food producers in Nigeria are using chemicals such as ascorbic acid and BHA, to add nutritional value to food items as well as to prolong their shelf life in order to overcome the immense malnutrition and food wastage. For instance, Flour Mills in Nigeria produces instant noodles, called Golden Penny Noodles that contain antioxidants like BHT (Butylated hydroxytoluene). This chemical prevents fat rancidity, which would otherwise cause the noodles to become stale and develop an unpleasant taste overtime (Penny 2023). Many juices, powdered beverages, canned fruits and vegetables contain citric acid which can enhance flavor of foods and beverages and increase their shelf life. Likewise, BHA is commonly used in meat to prevent its deterioration when it reacts with oxygen in the air which keeps its nutritional value and freshness (Van De Walle, 2023).

As Nigeria is a developing country, it does not heavily rely on synthetic food preservation techniques as it lacks access to those chemicals and instead, they depend on natural preservation techniques such as storing in cool places, shielding from direct sunlight, and sprinkling with lime water. Despite that, these natural preservatives can not solve the mass starvation problem in the country as they take a longer to grow which can decrease the rate of food which is produced. However, chemical preservatives can overcome the malnutrition and mass starvation in Nigeria, as not only does it provide nutritional value to a range of food, but the chemicals can be synthesized faster and endlessly. (Tanimonure 2025)

However, the overconsumption of chemical preservatives has a strong correlation with increasing the risk of developing various diseases and cancers in the body. After interviewing a doctor in Pakistan, Dr Sophia Lakho, it was clear that these synthetic food preservatives may cost our health as she stated that, “Our digestive system, gut and body cannot tolerate these synthetic chemicals found in our food because they often have negative side effects that can disturb our bodies in a wide range of ways, for example by disrupting the endocrine system. Likewise, there is already significant evidence which proves the rise in cancer cases as a result of the regular consumption of synthetic chemicals.”

On January 15th 2025, the Food and Drug Authority (FDA) banned the use of the color additive Red Dye No.3 in foods and medicinal drugs. (Davis 2024) This ban will take effect in 2027 for foods and beverages and in 2028 for medicinal drugs as time is required for food and drug manufacturers who use this dye to switch to other alternatives. This color additive was commonly used in sweets and candies to create a bright, cherry red color to make it appealing to children, however recent studies have revealed that the consumption of Red Dye No.3 has a strong correlation in being one of the causes of ADHD in children. (Davis 2024) This is as a result of Red Dye No.3 depleting two essential chemicals, zinc and iron which are involved in the development of the brain. Zinc is required by the brain as it is involved in the release and regulation of neurotransmitters, which are the chemical messengers that allow electrical signals around your body. Similarly, Iron is also required by the brain as it forms a key component of hemoglobin which is involved in transporting oxygen to the brain in order to keep it functioning. Without these two essential chemicals, the brain will not be able to function properly as no oxygen would reach it and nor will any electrical impulses be sent around the body. This could lead to people, especially children getting diagnosed with ADHD which can lead to hypersensitivity like allergic reactions such as inflammation and hyperactivity symptoms like inability to concentrate, restlessness, excessive movement and talking. (Geng 2022).

Therefore, despite synthetic food preservatives creating sustainable food sources by overcoming food wastage problems in countries around the world by extending the shelf life of food products, they can also be harmful to human health and can increase the risk of developing diseases.

Using fertilizers and pesticides to create Sustainable Food Sources by increasing food security.

Another way of creating food sustainability using synthetic chemistry is by developing fertilizers, pesticides and herbicides to boost crop yield and protect food sources. Fertilizers provide essential nutrients such as nitrogen, phosphorus and potassium to crops enabling them to grow larger and healthier. For example, in the early 1900s, chemists invented the Haber Process which was a way to mass produce a nitrogen containing compound that would act as a fertilizer, ammonia which plants could easily absorb from the soil and use it to synthesize essential compounds like proteins and chlorophyll. This innovation changed farming methods doubling the people that one acre of land could feed which supported the rapidly increasing population and demand on food. (Manthiram 2021)

However, the Haber process required very high temperatures and pressures which came from burning fossil fuels like coal and methane gas. The combustion of fossil fuels also increased the levels of greenhouse gases released into the atmosphere and had an effect on global warming. Ammonia manufacturing contributes to around 2% of the worldwide carbon dioxide emissions. Thus even though ammonia fertilizers increase the yield and quality of crops, their manufacturing

has a significant role in harming the environment as it contributes to the release of many greenhouse gases, mainly carbon dioxide. (Boerner, 2019)

The use of pesticides in modern agriculture also plays a critical role in food production as their primary purpose is to eliminate harmful pests, diseases and weeds that can compete with crops for space, light and water which can deprive them of important components, resulting in significant crop losses and diminishing crop quality. This increases their crop yield and enables farmers to grow more food with the same amount of land, thereby meeting the growing demand for food. (Bio Ag 2024)

Despite this, the use of pesticides and herbicides is raising concerns on the effect they have on the environment as they can cause environmental contamination. An herbicide that is used worldwide, is the glyphosate herbicide, RoundUp and it has been detected to leak into groundwater, rivers and rainwater and this water contamination can disrupt aquatic ecosystems by harming marine life, reducing biodiversity (Cardenas 2020). The use of the herbicide boomed in the 1990s as farmers used to spray it on their corn and soy fields to eliminate weeds and boost production, but this led to glyphosate leaching into the surrounding environment. "In Quebec, for example, traces of the harmful glyphosate chemical have been found in the Montérégie River," says Andrew Gonzalez, a McGill biology professor. (Cardenas 2020). It also kills beneficial microorganisms that play a critical role in nutrient cycling and soil structure which can lead to the degradation of soil by solid erosion decreasing soil fertility.

I asked Dr Sophia Lakho whether it is more sustainable to invest synthetic chemistry for food production or to focus on improving the productivity of current agriculture practices, to which she replied, "I think it is not advisable to invest in synthetic food products, rather we should invest time and money in improving the fertility of the agricultural lands that already exists and to cultivate it which will help increase food productivity whilst also being sustainable." Hence, the use of fertilizers, herbicides and pesticides can increase the food production and keep up with the growing demand on food by reducing the number of harmful pests as well as increasing the quality and yield of the crop. However, the excessive use of these chemicals can contaminate rivers and soil which can affect ecosystems and reduce biodiversity, overall having a negative impact on the environment. Therefore, alternative ways food production should be explored that have a lower environmental impact.

Conclusion

Upon conclusion, one can say that it is evident that synthetic chemistry can play a pivotal role in creating sustainable food sources for our rapidly growing population. For instance, chemical preservatives extend the shelf life of food products which reduces food spoilages and wastages and herbicides and pesticides have significantly improved the yield of crops by protecting them from harmful weeds and pests that could harm them which could help form a sustainable way of distributing food to a growing population.

However, these chemical interventions can also influence human health as the excessive consumption of synthetic food preservatives can increase the development of various diseases like ADHD and diabetes. Likewise, it can also lead to environmental degradation which can cause water contamination and soil erosion, affecting a huge impact on ecosystems and reducing biodiversity.

Therefore, I believe that if the use of synthetic chemistry is controlled and monitored carefully, it is an effective way of producing a sustainable food supply to support our increasing population. However, it is also important to look at other safer and sustainable techniques of providing food to our increasing population such as cultivating the land that has already been used for growing crops and adding more nutritional value to it.

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