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CAS JAMAICA

FOOD SAFETY NEWSLETTER

IN THIS ISSUE

A letter from the editor

Seventeen (17) sustainable goals for development were adopted in 2015 by all United Nations Member States. The aim of these goals is to develop a blueprint by which we achieve peace and prosperity for people and planet Earth. The second goal speaks to no hunger. It is projected that there will be 10 billion people living on earth by 2050. How do we feed so many people? Sustainability in food production can be improved by reducing green gas emissions created by agricultural production and reducing the conversion of remaining forest to agricultural land. Sustainable agriculture practices include organic farming, crop rotation, mulching, integrated farming, integrated pest management, integrated crop management and integrated nutrient management. Through advancements made in molecular biology we are able to improve crop production. Animal based foods are energy intensive requiring more resources for production. We can limit meat consumption and include more plant-based foods in our diets. Reduction of food waste is also imperative.

In this issue we explore new and emerging technologies that can be utilized to improve sustainability. One such technology is cold plasma. Vertical farming allows for the use of less agricultural land space. Rain harvesting and the utilization of solar energy may also be integrated into current practices. Let's play our part in improving sustainability.

Did you know?

Hibiscus sabdariffa (sorrel)

Sorrel Infusion, enjoyed by Jamaicans at Christmas

The major anthocyanins in sorrel are delphinidin 3-O-sambubioside and cyanidin 3-O-sambubioside which contribute to its colour and antioxidant properties.

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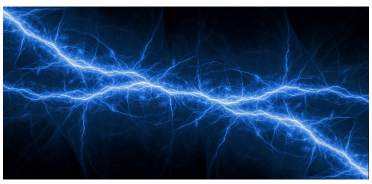
Cold Plasma Processing as an Emerging Non-thermal Food Processing Technique

By Jada Delahaye

The United Nations (UN) predicts that by 2050, the global population will exceed 9.7 billion, requiring an approximately seventy per cent (70%) increase in total food production to satisfy the anticipated demand (2017) [1]. Consequently, the effective management and sustainability of global food security is a persisting area of concern. Global food security encompasses the availability, accessibility, affordability and nutritional adequacy of food necessary to satisfy basic dietary needs [2]. Despite numerous advancements in technology, millions continue to experience food shortages [2, 3]. Over the years, there has been notable progress in advancing food processing technologies in response to food insecurity. Preservation techniques have evolved to extend food shelf life and ensure safety and accessibility. However, there has been less focus on maintaining the nutritional and sensory qualities of the food, along with environmental considerations.

Food preservation techniques have transitioned from traditional methods like drying to modern thermal and non-thermal technologies. For many years, the primary methods used in food preservation have been thermal processing techniques, such as pasteurisation, sterilisation, baking, frying, drying, and evaporation, as they are valued for their effectiveness, scalability, and reliability in safeguarding food safety and quality [4-6]. Nonetheless, these processes present some disadvantages. Although these methods can effectively extend the shelf life of food, they often result in nutritional degradation, undesirable changes in sensory attributes and the destruction of beneficial thermo-sensitive compounds in food [4,5].



Moreover, such techniques raise environmental concerns due to their high energy consumption, the generation of greenhouse gases and the potential production of harmful by-products [7]. The combined impact on food quality and the environment has geared research into greener, more sustainable food processing alternatives [8]. In this regard, non-thermal food processing technologies have attracted considerable attention due to their potential for sustainable food preservation practices. The concept of sustainable food preservation involves the employment of methods and technologies that not only effectively preserve food and its qualities but also reduce environmental footprint. This focus is increasingly relevant in an era where consumers increasingly prioritize health and seek more nutritional food options [3]. Examples of non-thermal processing include high-pressure processing (HPP), pulsed electric fields (PEF), ultraviolet (UV) treatment, irradiation, ultrasound, and ozone-based techniques [9]. Among these emerging technologies, cold plasma is a particularly noteworthy area of exploration [4,6,7,8,9,10].

Cold plasma, commonly referred to as the fourth state of matter, is an ionized gas containing reactive [6,9,10,11,12]. Initially designed for bonding and curing polymers, this technique has since found applications in various fields, including decontamination technology, surface treatment, sterilization of medical instruments, and food safety [4]. Moreover, cold plasma relies primarily on electrical energy, which can be sourced from renewable sources, making it a desirable option for achieving sustainability goals [6]. As such, cold plasma has the potential to develop safer, more sustainable, and minimally processed foods.

Concept of Cold Plasma Technology

The change of phase (or state) from solid to liquid and then to gas occurs when energy input increases [12]. Similarly, increasing the energy input beyond a certain threshold in the gaseous state causes the ionisation of molecules, yielding the plasma state [12]. Plasma is a distinct state of matter that describes a partially or completely ionised gas [11,13]. It consists of highly reactive species such as free radicals, molecules, atoms, electrons, and ions, which may exist in either the excited or ground states while maintaining an overall neutral charge [5]. The term "plasma" was first coined by Irving Langmuir in 1928 to describe this unique state of matter, characterised by its quasi-neutral nature – having balanced positive and negative charges.11 Among the various forms of plasma, it has received significant attention in food preservation due to its ability to inactivate microorganisms at low temperatures while preserving the quality of the food [4-13]. The unique properties of cold plasma provide interesting functionalities, making it promising for applications in sanitization, enhancing nutrition, improving sensory qualities, and eliminating pesticides and allergens from food products [6].

Plasma is generated by applying a substantial amount of energy to a gas. This energy can originate from various sources such as thermal, electric, or electromagnetic radiation [13]. When energy is introduced, electrons gain kinetic energy resulting in more frequent collisions among gas particles and the formation of the reactive species [12]. The specific properties of plasma depend on the composition of the gas used, the energy source, and the operating conditions which include pressure and temperature [12]. Plasma can be categorised into two types based on the energy input and operating conditions: thermal and non-thermal. Thermal plasmas are generated at high temperatures, often exceeding 20,000 K and are commonly utilised in applications such as welding, cutting and waste treatment [11]. In contrast, non-thermal plasma operates at near-ambient temperatures, typically ranging from 30°C to 60°C, making it suitable for heat-sensitive applications like food processing [5,8].

Cold plasma is a type of non-thermal plasma that is generated at low temperature and is generated when an electric current (as energy) is applied to a gas. Various electrical discharges can produce cold or non-thermal plasma, including corona discharge, glow discharge, radiofrequency (RF) discharge, pulsed corona discharge, dielectric barrier discharge (DBD), microwave discharge, and plasma jets [6,9,12]. Among the different plasma technologies, dielectric barrier discharge (DBD) plasma is most widely used in food applications because it can operate at atmospheric pressure, utilize air as a gas source, and facilitate continuous material processing [6].

Application in Food Processing

Cold plasma is an environmentally friendly technology that is biocompatible, chemical-free and cost-effective [11,13]. It effectively inactivates pathogens and other deleterious microorganisms. By reducing microbial load, cold plasma ultimately delays spoilage, maintains freshness and extends the shelf life of food products. Additionally, it can alter certain food properties, such as colour, texture, pH, and acidity [4,6]. Cold plasma is also involved in the treatment of packaging materials to enhance antimicrobial and barrier properties, providing improved protection against microbial contamination and an overall improved shelf life.13 This technology achieves its antimicrobial effects by exposing food products to reactive feed gas, either directly or indirectly.6 The antimicrobial action of cold plasma is driven by its reactive species, which target microorganisms through multiple mechanisms: inducing oxidative stress, disrupting cell membranes, damaging DNA, and denaturing proteins [6]. These reactive species inhibit microbial activity by promoting oxidation, compromising membrane integrity, inducing genetic mutations in DNA and ultimately disrupting the structure and function of essential enzymes [6].

Cold plasma is particularly effective for surface decontamination, showing effectiveness against critical pathogens such as *Escherichia coli*, *Salmonella*, and *Listeria monocytogenes* on food, packaging, and equipment [6]. Specific applications within the food processing sector include treating grains and legumes to reduce Aspergillus and Penicillium species, minimizing *E. coli* and *Salmonella* on meat surfaces, a non-thermal alternative to milk pasteurization, and enhancing the functionality of edible films as well as preserving the quality of minimally processed fruits and vegetables [4]. Overall, cold plasma provides non-thermal sterilization, preserving the sensory and nutritional qualities of food while ensuring microbial safety. However, its effectiveness is influenced by factors such as the plasma system used, operating conditions, the food matrix, and packaging [6].

Moreover, recent studies have examined the application of plasma as a pretreatment process. Evidence suggests that plasma treatments can substantially reduce the drying time of fruits.6 Research also demonstrates that plasma pretreatments may enhance the extraction of bioactive compounds. These findings further highlight the potential of plasma technology in improving the efficiency and sustainability of the food industry [6].

Limitations of Cold Plasma Technology

The reactive species that makeup plasma are capable of reacting with nearly all food constituents, potentially affecting the physicochemical and organoleptic attributes of food products.13 The effects of their interaction with the macro and micro-molecules of foods depend on the operating conditions and the processing time, as longer exposures will induce more significant changes in food.6 The nature of the change, whether it is deemed desirable or undesirable, relies on the type of food product. The resultant interactions may lead to flavour and aroma changes as a result of lipid oxidation, changes in bioavailability due to the oxidation of protein and changes to nutritional profile by the conversion of unsaturated fats to saturated fats [6,9]. These changes, while still under investigation, prove to cause fewer changes than thermal processes and can be leveraged for quality control and novel sensory experiences when carefully managed. Plasma technology operates on electrical energy, which can be sustainably sourced from renewable resources such as wind, solar, and hydroelectric power [6]. It is believed that plasma technology consumes less energy than traditional thermal processes; however, this assumption needs further examination [6]. A thorough comparison should evaluate the processing time and total energy consumption on a large scale, to provide a complete understanding of its efficiency.

Future Research

Despite significant advancements in cold plasma technology, several important research gaps remain. One key area of concern is the assessment of the long-term safety or associated risks with the potential production of toxic by-products [4,12,13]. Understanding these risks is crucial for the safe application of this technology. The complexity of plasma and its interactions makes it challenging to identify the specific mechanisms behind the activity of individual reactive species [9,13]. Much of the current understanding is based on assumptions rather than empirical evidence, which leads to uncertainties surrounding the technology's application [9].

A major challenge for the viability of cold plasma technology in food processing is achieving effective process control [9]. However, future research should explore the integration of cold plasma technology with other processing methods, which could enhance efficiency and reduce associated risks. Furthermore, regulatory approval is another factor that may influence the implementation of plasma technology [9]. Gaining consumer trust is equally important; consumers need assurance regarding the safety and efficacy of such technologies before they can be widely accepted [9]. Further research focused on broader, scaled-up applications of cold plasma technology will be essential in addressing these challenges or gaps in the literature and foster its practical use in food processing.

Conclusion

In summary, the challenges presented by a rapidly growing global population and the increasing demand for food makes the development of innovative solutions to enhance global food security a necessity. Given that traditional food preservation techniques often compromise nutritional quality and raise environmental concerns, there is an urgent need for sustainable alternatives. Non-thermal food processing technologies, particularly cold plasma, present an alternative for achieving both food safety and quality without some of the drawbacks associated with thermal methods. By exploring the unique properties of cold plasma, it is possible to extend shelf life, maintain nutritional integrity and minimize the environmental footprint of food production. As research continues to progress in this field, the implementation of such technologies could significantly contribute to a more sustainable food system, meeting consumer demands for healthier choices while simultaneously reducing environmental fallout.

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References

1. United Nations. World Population Prospects 2017 Revision Highlights; United Nations: New York, 2017.
2. FAO (Food and Agriculture Organization). Food Security and Agricultural Development; FAO: Rome, 2006.
3. United Nations, Department of Economic and Social Affairs. Policy Brief No. 102: Building a Resilient Global Economy and Food Security Systems in Times of Crisis; United Nations: New York, 2022. https://www.un.org/development/desa/dpad/wp-content/uploads/sites/45/publication/PB_102.pdf (accessed Nov 12, 2024).
4. Chaitradeepa, G. M.; Hanumantharaju, K. N.; Soumya; Chennappa, G.; Lokesh, A. C. Cold plasma technology and its applications in food industry. Biochem. Cell. Arch. 2023, 23, 0000–0000. https://doi.org/10.51470/bca.2023.23.S1.000
5. Chacha, J. S.; Zhang, L.; Ofoedu, C. E.; Suleiman, R. A.; Dotto, J. M.; Roobab, U.; Agunbiade, A. O.; Duguma, H. T.; Mkojera, B. T.; Hossaini, S. M.; Rasaq, W. A.; Shorstkii, I.; Okpala, C. O. R.; Korzeniowska, M.; Guiné, R. P. F.. Revisiting Non-thermal Food Processing and Preservation Methods—action Mechanisms, Pros and Cons: A Technological Update (2016–2021). Foods 2021, 10 (6), 1430. https://doi.org/10.3390/foods10061430.
6. Fernandes, F. A. N.; Rodrigues, S. Cold plasma technology for sustainable food production: meeting the United Nations sustainable development goals. Sustainable Food Technology 2024, 10.1039/D4FB00209A. DOI: 10.1039/D4FB00209A.
7. Lisboa, H. M.; Pasquali, M. B.; dos Anjos, A. I.; Sarinho, A. M.; de Melo, E. D.; Andrade, R.; Batista, L.; Lima, J.; Diniz, Y.; Barros, A. Innovative and Sustainable Food Preservation Techniques: Enhancing Food Quality, Safety, and Environmental Sustainability. Sustainability 2024, 16 (18), 8223.
8. Misra, N. N.; Pankaj, S. K.; Frias, J. M.; et al. Cold Plasma in Food and Agriculture: Fundamentals and Applications. Food Res. Int. 2014, 58, 26–36.
9. Farooq, S.; Dar, A. H.; Dash, K. K.; Srivastava, S.; Pandey, V. K.; Ayoub, W. S.; Pandiselvam, R.; Manzoor, S.; Kaur, M. Cold Plasma Treatment Advancements in Food Processing and Impact on the Physiochemical Characteristics of Food Products. Food Science and Biotechnology 2023. https://doi.org/10.1007/s10068-023-01266-5.
10. Rajan, A.; Boopathy, B.; Radhakrishnan, M.; Rao, L.; Schlüter, O. K.; Tiwari, B. K.. Plasma Processing: A Sustainable Technology in Agri-food Processing. Sustainable Food Technology 2023, 1 (1), 9–49. https://doi.org/10.1039/d2fb00014h.
11. Sharath Kumar, N.; Dar, A. H.; Dash, K. K.; Kaur, B.; Pandey, V. K.; Singh, A.; Fayaz, U.; Shams, R.; Mukarram, S. A.; Kovács, B. Recent advances in cold plasma technology for modifications of proteins: A comprehensive review. Journal of Agriculture and Food Research 2024, 16, 101177. DOI: https://doi.org/10.1016/j.jafr.2024.101177.
12. Thirumdas, R.; Sarangapani, C.; Annapure, U. S. Cold Plasma: A Novel Non-Thermal Technology for Food Processing. Food Biophysics 2014, 10 (1), 1–11. https://doi.org/10.1007/s11483-014-9382-z.
13. Bahrami, R.; Zibaei, R.; Hashami, Z.; Hasanvand, S.; Garavand, F.; Rouhi, M.; Jafari, S. M.; Mohammadi, R. Modification and Improvement of Biodegradable Packaging Films by Cold Plasma; a Critical Review. Critical Reviews in Food Science and Nutrition 2020, 1–15. https://doi.org/10.1080/10408398.2020.1848790.

Understanding and mitigating the risks of antibiotic residues in dairy products

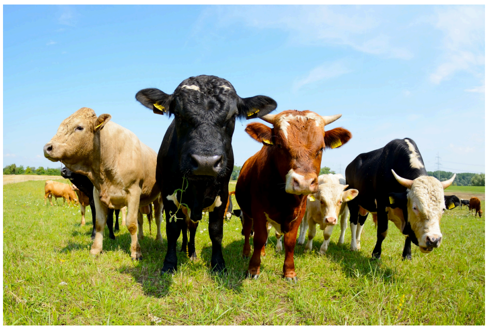
By Antonique Headman

Have you ever wondered what happens to the milk if a cow gets sick? It is very common for dairy cows to get ill, just as we normally do. Dairy cows undergo a similar treatment process when compared to humans. Dairy cows are treated with several medications, including antibiotics, when a potential risk to their health has been identified. Whenever cows are treated, especially with antibiotics, there is a high chance of residual effects. Antibiotic residues in dairy products present a significant concern for food safety, security, and public health. While antibiotics play a crucial role in treating and preventing diseases in dairy animals, their misuse or improper data collection, which involves the date of treatment, type of antibiotic used, and withdrawal periods, can result in residues persisting in milk and dairy products, posing risks to consumers. As dairy farmers or manufacturers of dairy products, it is very important to explore the sources of antibiotic residues in dairy products, look at the potential health implications, and develop and implement strategies to mitigate these potential risks.

Dairy farmers in Jamaica are known for providing the country with wholesome Grade A milk free from contaminants such as antibiotics. Dairy farming started back in late 1910 when a group of scientists crossbred different species of cows (Jersey, Sahiwal, and friesan) to create what we now know as the Jamaica Hope Cattle declared in 1952 [2]. An antibiotic is a chemical substance with antimicrobial properties used as a form of inhibitor to stop or prevent the growth of bacteria caused by infection with diseases [3]. These are molecules that remain after treatment is carried out on dairy cows. The most common disease that affects dairy cows is bovine mastitis.

Mastitis is an infection that is caused by the inflammation of the mammary gland as a result of trauma or an infection [4]. This disease results in a decrease in milk production and alters the quality of milk produced. To improve the animal's health and ensure consistent efficiency in production, antibiotics are administered. However, this practice is not without its complications, particularly concerning the residual effects of antibiotics in milk.

The primary source of antibiotic residues in dairy products originates from the treatment of dairy animals with antibiotics. Despite strict regulations governing the use of antibiotics in food-producing animals, instances of misuse or non-compliance can occur [1]. This involves farmers administering the antibiotics improperly by either using the wrong infusion preparation, failing to follow the manufacturer's instructions, which may result in exceeding recommended dosage levels, or even failing to observe appropriate withdrawal periods before milking [8]. Each antibiotic administered to animals has a withdrawal period, which is greatly affected by administration as well as the stage of lactation in dairy cows—early-mid-late lactating cows [3]. This can be done through intramammary infusions, intramuscular injections, or oral administration as either a form of medicine or a supplement [6].



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1.Education and Training: This will provide farmers and dairy workers with training on how to properly administer antibiotic dosage, how to determine or find information that states the withdrawal periods, and the importance of record-keeping to track medication usage.

2.Regular Testing and Monitoring: Conduct routine testing of milk samples for antibiotic residues at various stages of production, including on-farm bulk tanks, transport vehicles, and processing facilities [7]. Also, implement stringent quality control measures to detect and prevent contaminated milk from entering the food supply by involving preventative actions instead of corrective actions.

3. Enforcement of Regulations: Enforce strict adherence to regulatory guidelines governing the use of antibiotics in dairy farming. Implement penalties for non-compliance and conduct regular inspections to ensure compliance with withdrawal periods and other regulatory requirements [6].

4. Promotion of Alternatives: Encourage the adoption of alternative practices and products, such as probiotics, vaccines, and improved herd management techniques, to reduce the reliance on antibiotics for disease prevention in dairy animals.

Conclusion

In conclusion, antibiotic residues in dairy products pose significant risks to consumer health and food safety. By understanding the sources of antibiotic residues, recognizing the potential health implications, and implementing effective mitigation strategies, stakeholders can work together to ensure the production of safe and high-quality dairy products. Continued collaboration between regulators, dairy farmers, processors, and consumers is essential to safeguarding public health and maintaining the integrity of the dairy industry.

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References

1. Byrne, M. K.; Miellet, S.; McGlinn, A.; Fish, J.; Meedya, S.; Reynolds, N.; van Oijen, A. M. The Drivers of Antibiotic Use and Misuse: The Development and Investigation of a Theory Driven Community Measure. BMC Public Health 2019, 19 (1). https://doi.org/10.1186/s12889-019-7796-8.

2. Dairy Cattle Breeds/Types in Jamaica | Jamaica Dairy Development Board. www.jddb.gov.jm. https://www.jddb.gov.jm/page/dairy-cattle-breedstypes-jamaica#:~:text=The%20Jamaica%20Hope%20cattle%20is.

3. Albright, J. L.; Tuckey, S. L.; Woods, G. T. Antibiotics in Milk—a Review1. Journal of Dairy Science 1961, 44 (5), 779–807. https://doi.org/10.3168/jds.S0022-0302(61)89819-6.

4. Bovine Mastitis. Cornell University College of Veterinary Medicine. https://www.vet.cornell.edu/departments-centers-and-institutes/baker-institute/our-research/bovine-mastitis.

5. Yazdanpanah, H.; Mahraz Osouli; Rashidi, E.; Karimi, Z.; Alireza Yazdanpanah; Sama Maani; Jamshid Salamzadeh; Arash Mahboubi; Eslamizad, S. Validation of Simultaneous Biochip-Based Method for Screening of 3 Beta-Lactam Families Residues in Cow's Milk in Accordance with the European Union Decision 2002/657/EC and Its Application on Real Samples. PubMed 2021, 20 (4), 178–187. https://doi.org/10.22037/ijpr.2021.115441.15375.

6. Seymour, E. H.; Jones, G. M.; McGilliard, M. L. Persistence of Residues in Milk Following Antibiotic Treatment of Dairy Cattle. Journal of Dairy Science 1988, 71 (8), 2292–2296. https://doi.org/10.3168/jds.s0022-0302(88)79806-9.

7. Jones, G. M.; Seymour, E. H. Cowside Antibiotic Residue Testing. Journal of Dairy Science 1988, 71 (6), 1691–1699. https://doi.org/10.3168/jds.s0022-0302(88)79734-9.

8. Anika, T.; Noman, Z.; Ferdous, M.; Khan, S.; Mukta, M.; Islam, M.; Hossain, M.; Rafiq, K. Time Dependent Screening of Antibiotic Residues in Milk of Antibiotics Treated Cows. Journal of Advanced Veterinary and Animal Research 2019, 6 (4), 516. https://doi.org/10.5455/javar.2019.f376.

9. McEwen, S. A.; Black, W. D.; Meek, A. H. Antibiotic Residue Prevention Methods, Farm Management, and Occurrence of Antibiotic Residues in Milk. Journal of Dairy Science 1991, 74 (7), 2128–2137. https://doi.org/10.3168/jds.s0022-0302(91)78385-9.

Green, Active, and Intelligent Packaging and Storage Systems

By Rhay-Lee Waldron

Food packaging was a great innovation created to protect and preserve the integrity of foods that we consume daily. However, our dependence on plastic packaging in the food industry has led us to a global environmental challenge due to plastic not being biodegradable. As such, there is a significant demand for sustainable solutions within the food industry to address the environmental concerns while maintaining and enhancing food safety and quality [1]. This paper discusses sustainable food technologies, focusing on the ability of packaging technologies to reduce environmental impact while extending food shelf life and maintaining quality and integrity. Green packaging involves the use of biodegradable, recyclable and compostable materials that are an eco-friendly alternative to plastics [2]. These materials are designed to return to the environment without leaving behind harmful residues. Active packaging incorporates some type of functional component to better prolong the shelf life and integrity of the food whereas intelligent packaging monitors the food product and its environment providing information about its freshness and safety [3]. This paper also discusses the economic and technological challenges that are associated with implementing these systems in the food industry. While cost and consumer acceptance may pose some challenges, green, active, and intelligent packaging systems provides a step toward sustainability and efficiency in the industry. This paper concludes that with continued research and investment, these technologies hold potential for further revolutionizing the food packaging industry, contributing to sustainability and food security.

The global challenges that we are faced with has led almost all industries to strive to reduce waste and minimize environmental footprint. Within the food industry traditional and conventional packaging systems has contributed significantly to environmental pollution with the excessive use of non-biodegradable plastics that usually ends up in our landfills and oceans. On the other hand, food spoilage is another issue the food industry is faced with. These challenges led to great innovations in packaging technologies with the development of green, active and intelligent packaging systems which seem to offer solutions for enhancing sustainability and food preservation.

Biodegradable packaging refers to packaging materials that can be broken down and decomposed by natural biological processes. These materials are designed to return to the environment without leaving behind harmful residues. Intelligent, active, and smart packaging refer to packaging technologies that go beyond containing and protecting the product, they are advanced packaging systems that have multiple additional functionalities. Green packaging prioritizes the use of environmentally friendly materials from renewable and recyclable resources that reduces the ecological impact of packaging waste. Active packaging incorporates components that interact with food products or the environment inside to actively enhance preservation and improve and maintain food quality. In contrast, intelligent packaging integrates sensor technologies and indicators that provide real time information about the quality, safety and freshness of the food, allowing both consumers and producers to monitor the product's condition.

This paper explores the evolution of sustainable food technologies, focusing on the ability of packaging technologies to reduce environmental impact, extend food shelf life and maintain quality and integrity. Additionally, this paper discusses the economic and technological challenges that are associated with implementing these systems in the food industry. This paper also seeks to demonstrate how these innovative and creative packaging systems can contribute to a more sustainable and efficient food industry in the future.

The innovation and integration of sustainable food packaging systems such as green, active and intelligent packaging presents a solution to the growing environmental and food preservation challenges faced by the food industry. Green packaging certainly provides a way to sustainability by reducing the industry's reliance on plastics by encouraging the use of biodegradable, renewable, recyclable and environmentally friendly materials. For instance, polylactic acid (PLA) and polyhydroxyalkanoates (PHA) are biopolymers that degrade under natural conditions, minimizing long-term environmental harm.8 However, the cost of production of these materials are extremely expensive and hinders the successful integration of green packaging in the food community globally. Additionally, the use of these bioplastics also produces performance limitations.

These limitations are a result of bioplastics lacking the strength and some barrier properties when compared to that of the traditional plastics that are fossil fuel based. Though for future complete and successful adoption of green packaging one of the major mainstream packaging systems in the food industry, further research into material enhancement and also compatibility with most food products need to be done. As at the present moment, green packaging is a simple pathway toward sustainability within the industry.

In contrast, active packaging technologies offer significant benefits in extending the shelf life of food, maintaining food quality and integrity while also reducing waste. Oxygen scavengers, ethylene absorbers, and antimicrobial agents embedded in packaging materials which is important as these can effectively and efficiently preserve the food product by reducing the rate of the spoilage processes, making the food product maintain its safety and remain fresh for longer periods. For instance, incorporating silver nanoparticles or organic acids into the packaging matrix has been shown to inhibit microbial growth, particularly in perishable products like meat and dairy. However, consumer safety and regulatory compliance must be adhered to as the introduction of these active components may have undesirable effects on the food quality and also on the human health. This may not really be of much harm though as the world enters into the technological era, creating solutions with medicine where most of these effects may be identified and solved efficiently and effectively.

The technological advancements throughout the most recent decades have enabled the food industry to use a futuristic approach with intelligent packaging systems. Intelligent packaging integrates digital technologies and smart sensors into the food packaging systems. These advancements are now able to monitor the condition of the packaged product and provide information about its status, such as freshness or spoilage. This ability to track food quality over time can enable early detection of food spoilage hence reducing the risk of consumers contracting foodborne illnesses.

The application of intelligent packaging can facilitate improved logistics and inventory management, reducing food waste across the supply chain from production until consumption.

However, the cost of sensor integration remains a barrier to widespread adoption, especially in developing markets, as affordability is a key concern. Despite the many benefits the innovation of sustainable food packaging in the industry may have, many obstacles persist with its integration and adoption globally. These solutions are difficult to implement due to challenges such as economical feasibility, consumer acceptance and regulatory approval. Green packaging materials often come at a higher production and maintenance cost compared to conventional plastics that are produced from fossil fuels. Furthermore, the implementation of active and intelligent technologies requires significant investment in research, development, and manufacturing infrastructure for a more global and widespread adoption.

Additionally, the industry's regulatory bodies would have to establish and implement guideline to ensure that the active components and intelligent technologies used in the packaging of food products are safe and clear. These guidelines will also be used by consumers to guide and educate them about the safety and effectiveness of these packaging systems

The adoption and implementation of green, active and intelligent packaging systems provides the global food industry with a sustainable pathway forward to address some challenges faced. These innovative technologies provide solutions that would reduce the environmental impact, enhance food safety and extend the shelf life for packaged food products. With using biodegradable and recyclable materials in green packaging, there is potential for the industry to reduce the environmental damage caused by conventional plastic waste.

However, for green packaging to be implemented globally, further advancements in its strength and barrier properties along with cost reduction in production and maintenance need to be done.

Active packaging has advantages in preserving food freshness and safety of the food product for consumers. Additionally, intelligent packaging systems, with their ability to monitor food conditions is a great tool for consumers and manufacturers during the logistics process. These technologies not only improve logistics but can reduce spoilage and food waste all of which is essential for the food industry. Despite the many benefits the innovation of sustainable food packaging in the industry may have, many obstacles persist with its integration and adoption globally. The successful integration of these packaging systems globally will require overcoming economic factors and regulatory compliance which influences the consumers. However, these obstacles can be addressed through further research along with more technological advancements and innovations to ensure the safety of the food product for consumption.

In summary, green, active, and intelligent packaging systems offer a viable path toward a more sustainable and efficient food industry for the future. As research continues to address current limitations and challenges, these technologies play an increasingly important role in promoting sustainability, reducing food waste, and improving food safety for consumers worldwide.

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References

1. Select Equip. Why Do We Need Food Packaging: Is it Important? Select Equip, https://selectequip.com.au/news-insights/why-food-packaging-important/.
2. Franco, D.; Pateiro, M.; Cerqueira, M. A.; Gómez, B.; Lorenzo, J. M. Active and Intelligent Packaging for the Preservation of Meat Products. Curr. Opin. Food Sci. 2022, 46, 100877. https://doi.org/10.1016/j.cofs.2022.100877.
3. European Food Safety Authority (EFSA). Active and Intelligent Food Contact Materials. EFSA, https://www.efsa.europa.eu/en/topics/active-and-intelligent-materials.

Food Production Systems Requiring Less Energy and Water Consumption

By Josette Miller

The consumption of energy within the food industry has been a major consideration in food preparation. The food industry consumes a significant portion of the world's total energy consumption utilizing about 30%. The growing demand for food, coupled with increasing environmental challenges such as water scarcity and energy constraints, necessitates the development of more sustainable food production systems. Controlled Environment Agriculture (CEA) further enhances resource efficiency by optimizing growing conditions, reducing both water and energy inputs while increasing yields [2]. Precision agriculture leverages data and technology to fine-tune water and nutrient application, ensuring resources are used only where and when needed [3]. This paper explores innovative methods and technologies that reduce energy and water consumption in agricultural and food production processes. Key strategies include optimizing irrigation techniques, adopting renewable energy sources, and incorporating precision farming practices. Additionally, alternative food production methods, such as vertical farming and aquaponics, are examined for their potential to conserve resources while maintaining productivity. By highlighting these advancements, this paper aims to provide a comprehensive overview of approaches that could contribute to a more sustainable and resource-efficient global food system. The findings underscore the importance of integrating sustainable practices to address the environmental impacts of traditional food production while meeting the growing global demand for food.

A sustainable food system (SFS) must provide food security and nutrition while preserving the economic, social, and environmental foundations needed to sustain future generations. This highlights the importance of minimizing resource consumption while ensuring the profitability, social benefits and environmental enrichment of food production systems. The global food system faces significant challenges in balancing the increasing demand for food with the responsible use of scarce resources, particularly water and energy over a growing population. Agriculture utilizes a great amount of freshwater which contributes to major water withdrawals. Simultaneously, farming relies heavily on fossil fuel consumption contributing to environmental degradation and resource depletion. These issues are exacerbated by a rapidly growing population intensifying the pressure on these agricultural systems to produce more food using fewer systems. While traditional food production methods are effective in increasing output over the past century, it brings about substantial environmental costs including high energy consumption, water depletion and contributions to climate change. These issues are concerning for regions with water scarcity or low energy resources. There is an urgent need to develop more sustainable food production systems that significantly reduce water and energy usage while ensuring food security. Innovative approaches such as hydroponics, vertical farming, controlled environment agriculture (CEA), and more efficient food processing methods offer promising solutions to these challenges.

This discussion will explore these innovative agricultural practices and their potential to transform food production into a more sustainable, resource-efficient system. By examining how each of these strategies reduces water and energy consumption, we can gain insights into how the global food system can meet the growing demand for food without compromising the resources needed for future generations.

According to FAO, a sustainable food system (SFS) is a food system that delivers food security and nutrition for all in such a way that the economic, social and environmental bases to generate food security and nutrition for future generations are not compromised. It went on to further explain that this system is profitable throughout (economic sustainability), it has broad-based benefits for society (social sustainability); and it has a positive or neutral impact on the natural environment (environmental sustainability). The food production faces significant challenges as it struggles to balance the pressures of the demand of the rapidly growing population and the increasing usage of scarce resources such as water consumption and energy utilization. Water is an important resource with usage of 70% freshwater in the agricultural sector. To ensure sustainability and meet the demands of future generations, there is an urgent need for more efficient food production systems that significantly reduce water and energy consumption. This discussion will explore various innovative approaches to sustainable agriculture, including hydroponics, vertical farming, controlled environment agriculture and food processing.

Traditional farming involves planting on open spaces, traditional tools and natural resources such as rain and sunlight. It is the most popular form of agriculture practiced around the world as it applies knowledge and experience over generations. Common traditional farming practices include agroforestry, intercropping, crop rotation, cover cropping, traditional organic composting, integrated crop-animal farming, shifting cultivation, and slash-and-burn farming. There are many benefits to traditional farming, but these systems depend on heavily on water for practices such as irrigation which are inefficient and result in great water waste. These systems also depend on energy for processes such as tilling, planting, harvesting, and processing crops, along with the energy required for pumping water, applying fertilizers, and maintaining large-scale agricultural operations. Traditional farming consumes vast amounts of both water and fossil fuels, contributing to resource depletion and environmental degradation.

To address the challenges of reducing energy and water consumption in food production, several innovative and sustainable agricultural practices have been developed, each contributing unique benefits to overall resource efficiency. These practices aim to balance the growing global demand for food with the pressing need to minimize environmental impacts, particularly in regions facing water scarcity and energy limitations. Controlled environment agriculture is another way to reduce water and energy consumption. It is a technology-based method of growing plants and their products in controlled environments, such as greenhouses, vertical farms, and growth chambers. The purpose is to give farmers greater control over the plant's environment such as light, carbon dioxide, temperature, humidity, water, pH levels, and nutrients to grow healthy crops any time. With climate impacting the yield of crops, it can be a significant burden when food cannot meet the demands of the consumer year-round [8]. This can lead to an increase in import of food which can contribute to a loss of quality in food, and it relies greatly on energy consumption for transport such as fuel. Furthermore, stated in the article by Cornell University, the energy input for electricity in the Controlled Environment Agriculture (CEA) facilities are equal to energy used in traditional farming. With CEA technology, it benefits the society as it avoids land conversion and eradicate increase in land taxes and promote job creation [9].

Additionally, another sustainable way for less water and energy consumption are hydroponics and vertical farming, which allows crops to grow without soil using nutrient-rich water solutions and controlled environments, which significantly reduce water usage and eliminate the need for large tracts of land. Hydroponics utilizes up to 90% less water than traditional farming methods. There are many benefits to this practice such as it grows faster than outdoor plants, it produces a higher yield, and less space is used as they are grown closer and there aren't any issues with invading plant species that would take away from the nutrients required by the crop [6].

Vertical farming is farming on vertically stacked layers which increases the food production using the same land space or less. When paired with renewable energy sources such as solar power, also has the potential to dramatically lower energy consumption while producing food year-round. Because of this benefit, food production increases up to 240% compared to traditional farming utilizing up to 98% less water and 99% less land space [7]. These sustainable practices not only conserve water and energy but enhance food security by providing food year-round and producing high yield crops in smaller spaces. These systems create more efficient and resilient food systems that significantly reduce environmental impact.

Lastly, food processing is a critical stage in food production system that requires significant amounts of water and energy for cleaning, preserving, packaging, transporting food products to consumers. Alternative methods for water and energy conservation are important as it helps with the production time and can save money and reduce a food company's exposure to rising water costs and potential shortages. Conducting a water balance or audit to track the input and output of water used throughout a facility,and considering four main areas for minimizing water use: Process, Equipment, Facilities, and Personnel [10]. These methods include using water efficient cleaning techniques, optimizing equipment for less water usage, reusing water, implementing batch processing instead of continuous flow, utilizing energy-efficient machinery and adopting proper sanitation practices. The paper "Energy use in food processing for nutrition and development" by David Pimentel and Marcia Pimentel addresses the importance of food processing and preservation in human history and its impact on energy use.

Drying of foods is one energy consuming method that can use the sun for its drying properties but also because of advancement, methods utilizing hot air can rely heavily on fossil energy. Smoking uses great amount of wood which require a lot of energy input and can be disadvantageous to regions with wood shortages. Salting is a preservation method that can eradicate vast energy use and dehydrate food by osmotic processes and decrease microbial growth of food. Canning also uses significant amount of energy during the processing and packaging of food particularly steel and glass containers. Using methods like freezing can cut costs and energy use which will help the economy. Optimising equipment involves upgrading the machinery to improve efficiency by using automated systems to precisely dispense water where needed. Reusing water is another key strategy, where water from one stage of production—like rinsing—can be treated and recycled for non-potable uses, reducing overall consumption. Implementing batch processing instead of continuous flow allows processors to control water use in smaller, more efficient stages, minimizing waste and optimizing resource use. By combining these approaches, food processing facilities can not only conserve water and energy but also enhance productivity, reduce operating costs, and contribute to more sustainable and resilient food production systems.

As global populations continue to grow and the effects of climate change intensify, the need for more sustainable food production systems has become increasingly urgent. Traditional farming practices, though foundational, are no longer sufficient to meet the demand for food while conserving critical resources like water and energy. The innovative agricultural methods explored, such as hydroponics, vertical farming, and controlled environment agriculture (CEA), offer promising solutions to these challenges.

By drastically reducing water consumption, optimizing energy use, and enabling year-round production, these practices not only enhance food security but also protect the environment and ensure the sustainability of food systems for future generations. Furthermore, more efficient food processing techniques can significantly lower resource consumption and reduce the environmental footprint of food production.

Together, these approaches represent a necessary evolution in agriculture—one that balances productivity with resource conservation. To secure a sustainable future, it is essential that these technologies and practices are embraced and implemented on a larger scale, ensuring that the global food system remains resilient, efficient, and capable of feeding the world without depleting its essential natural resources.

References

1. Gerbens-Leenes, P. W.; van Lienden, A. R.; Hoekstra, A. Y.; van der Meer, T. H. "Biofuel Scenarios in a Water Perspective: The Global Blue and Green Water Footprint of Road Transport in 2030." Global Environmental Change2012, 22 (3), 764–775.
2. Gebbers, R.; Adamchuk, V. I. "Precision Agriculture and Food Security." Science 2010, 327 (5967), 828–831.
3. Food and Agriculture Organization of the United Nations. The State of Food and Agriculture 2020: Overcoming Water Challenges in Agriculture; FAO, 2020; https://openknowledge.fao.org/server/api/core/bitstreams/b620989c-407b-4caf-a152-f790f55fec71/content (accessed Oct 2, 2024).
4. Cornell University, College of Agriculture and Life Sciences. “About Controlled Environment Agriculture (CEA).” Cornell University, https://cea.cals.cornell.edu/about-cea/ (accessed Oct 2, 2024).
5. Gillespie, C. "Beginner's Guide to Hydroponics." *The Spruce*, https://www.thespruce.com/beginners-guide-to-hydroponics-1939215#:~:text=Plants%20often%20have%20a%20higher,to%20extend%20the%20growing%20season (accessed Oct 2, 2024).
6. Eden Green Technology. "What Is Vertical Farming?" *Eden Green*, https://www.edengreen.com/blog-collection/what-is-vertical-farming?format=amp (accessed Oct 2, 2024).

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Potential Chemical Hazards in Bottled Water

By Earle Stewart

The consuming public worldwide has been increasingly gravitating towards bottled water. The bottled water market saw a growth of 73 % from 2010 to 2020 and is expected to increase by 110 billion litres from 2021 to 2030. This increase can easily be seen in the Jamaican populace. Some believe marketing has played a significant role in this observed increase in consumption. Advertising has not only highlighted the role of water in "staying hydrated" but has also promoted it as a key in maintaining a healthy lifestyle. Competing companies have sought to distinguish their products through not only taste but appearance in packaging allowing bottled water to also result in being fashionable.

Most bottled water is sold with plastic as its primary packaging material. The plastic polymer most used to produce these containers is polyethylene terephthalate (PET). PET is a particularly suited polymer, because it has high transparency, reflectiveness, is easily processed and has a relatively low price. PET does not occur naturally and as such is synthesized industrially using the appropriate compounds under high temperature and pressure in the presence of a catalyst. This can result in the formation of a variety of by-products. No packaging material is fully inert and as a result there will always be interaction between the packaging and its contents. During this interaction chemical bi-products can transfer from the packaging to the food in a process known as migration. When chemicals migrate unto food products, they are consumed becoming a part of the human diet. Some of these compounds are considered hazardous and are believed to exhibit unknown toxicity. Studies have shown that some of these chemicals have undesirable properties such as being carcinogenic, mutagenic or reprotoxic, bio accumulative and endocrine disrupting.

Reprotoxic chemicals are substances which when inhaled, ingested or come in contact with skin may be harmful to reproduction and cause adverse non-hereditary effects on offspring. While PET is considered fairly inert more than negligible migration can occur. The phenomenon of the migration of chemicals has been heavily researched leading to development of legislation to regulate their concentration to acceptable levels. One such example is seen in European countries. The COMMISSION REGULATIONS (EU) No. 10/2011 of January 2011 (3) on Plastic Materials and Articles to Come in Contact with Food outlines what compounds are authorized for use in plastic formulation and that its constituents do not migrate to food in quantities that could pose a risk to human health. The Food and Drug Administration in its Code of Federal Regulations, Title 21, Chapter 1, Subchapter B, Part 170, Subpart B also outlines parameters for migrants including absence of carcinogenic or suspected carcinogenic migrants as well as minimum concentration exposure; below 0.5 parts per billion.

The regulatory agencies responsible for food safety (processed food), primarily focus on microbiological profile of bottled water to determine its safety; leaving potentially dangerous chemical hazards absent. Studies have shown that exposure to migrant chemicals below toxicologically established no-effect levels can still have adverse health effects.

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