Received: 24 April, 2024 | Revised: 28 April 2024 | Accepted: 30 April 2024

MANUSCRIPT ID: CoAS_V1IS11_05

POPULAR ARTICLE

Chronicle of Aquatic Science

Opportunities for Artificial Intelligence to Enhance Food Safety

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Conflict of Interest

The authors assert that the manuscript was developed without any commercial or financial associations that could be interpreted as a potential conflict of interest.

Authors Contribution

All listed authors have contributed significantly, directly, and intellectually to the work and have endorsed it for publication.

Abstract

Artificial intelligence (AI) represents Advancements in technology within the food industry have significantly progressed over the last few decades, As the global population continues to expand, accompanying the rise in food needs persists. The complexity and versatility of today's food requires utilizing contemporary technology to uphold top-tier food quality, safeguarding consumers against illness. AI enables the effective use of information by using data to create indicators that identify problems before they arise. This review aims to highlight various implementations of artificial intelligence in food production and associated domains, with the objective of enhancing food safety control Ensuring that the primary expectation of consumers is that food production occurs under hygienic conditions.

KEYWORDS

Artificial Intelligence, Food Safety, Risk Prediction, Public Health and Future of AI

INTRODUCTION

Artificial intelligence (AI) is typically described as a field within computer science aimed at mimicking human cognition, learning capabilities, and expertise (Krittanawong *et al.,* 2017 & Hamet *et al.,* 2017). AI has a significant opportunity for developing leading indicators and predicting issues with food safety. AI is formally defined as a technology that makes it possible for machines to perform tasks that humans normally perform. Food consumption percentage is projected to rise from 59% to 98% by 2050, attributed to the expanding global population (Elferink M & Schierhorn, 2016). As a result, AI has been used in a variety of contexts to meet this need for food, including in the food industry, supply chain management, food sorting, production development, food enhancement, and the maintenance of industrial hygiene standards are all fundamental components (Garver, 2018 & Utermohlen, 2019). For many years, the food industry has increasingly embraced artificial intelligence (AI) for various applications such as quality assurance, ensuring food safety, sorting products, and predicting and classifying parameters. The integration of AI in the food industry has been progressively advancing over time, having started decades ago and offering numerous benefits (Rahman *et al.,* 2012). AI has powerful solutions to improve food yield, quality, by leveraging AI, we can enhance safety and traceability, minimize resource consumption, and mitigate food waste. AI enables us to predict, monitor, and address issues related to food safety effectively.

AI IN THE FOOD SAFETY CONTROL

It is stated that machine vision is an automated, non-invasive & economical method of ensuring the safety and quality of food. Traditionally, humans have been in charge of quality control for food and agricultural products. However, these manual controls are often labour- and time-intensive, was reported that there was no guarantee on the control's correctness. Conversely, it has been noted that computerized food product monitoring is reliable, affordable, and efficient (Sun, 2000, Patel *et al.,* 2012 & McAllister *et al.,* 2018).

The most popular method for ensuring food safety is HACCP. Only when basic hygienic conditions are under control by programs like prerequisites and good manufacturing procedures (GMP) can this technology be employed effectively (McMeekin *et al.,* 2006). The documentation of the HACCP system's requirements and its execution both benefit greatly from the application of artificial intelligence. The two most crucial ideas in the food sector for satisfying consumer expectations are food safety and food quality. The food sector most commonly uses HACCP for food safety and ISO 9001 for quality to achieve these standards. When these two systems are used in tandem, their synergy is increased and the organization's performance is positively impacted (Topoyan, 2003). The most frequent work mishaps in the food production field are said to involve Foot slipping or falling due to a slippery floor, tripping over untidy materials, and objects falling from above are common workplace hazards (Kurt, 2019 & Utlu and Yılmaz, 2019). AI is essential for maintaining food safety & quality control in the food business. AI can help us in,

a) **Food Contamination Detection:** AI technologies employ advanced data processing and pattern recognition abilities to detect and mitigate food contamination. Through the analysis of extensive data obtained from sensors, cameras, and historical records.
b) **Quality Control and Shelf-Life Prediction:** AI-driven algorithms rapidly detect contaminants, thereby minimizing the possibility of contaminated goods being delivered to consumers. Additionally, these algorithms predict the shelf life of products, contributing to the reduction of food waste and spoilage.
c) **Predictive Analytics for Quality Control:** AI-powered predictive analytics models facilitate proactive measures to uphold quality control across the food supply chain.

d) **Food Fraud Prevention:** AI algorithms detect inconsistencies and irregularities in data from ingredient origins, supplier records, and quality certifications, aiding in the prevention of food fraud. This improves customer confidence and transparency by ensuring the authenticity and traceability of food products.

FOOD SAFETY RISK PREDICTION

The use of AI tools offers a potent method for predicting the presence and timing of foodborne pathogens as well as the likelihood of food contamination by these pathogens. AI solutions have the potential to improve public health as well as make decision-making about water treatment and harvesting easier. Other facets of microbiological food safety risk prediction may be impacted by AI. For example, research into COVID-19 diagnosis utilizing quantitative polymerase chain reaction (qPCR) demonstrated that AI techniques can amalgamate PCR findings with data from disparate tests, like patient CT scans, to improve diagnostic precision (Mei *et al.,* 2020). Similar methods could be applied in the context of food safety to analyse Quantitative polymerase chain reaction (qPCR) amplification curves are utilized for pathogen detection purposes, in the finished product or during production.

Some key stages of the food safety workflow that enhanced by AI technologies, from data collection and integration to regulatory compliance and consumer engagement. Each stage leverages AI-driven analysis, prediction, monitoring, and management to guarantee the safety and excellence of food items across the entire supply chain, comprehensive monitoring and control measures must be implemented at every stage of production, distribution, and storage (Figure 1).

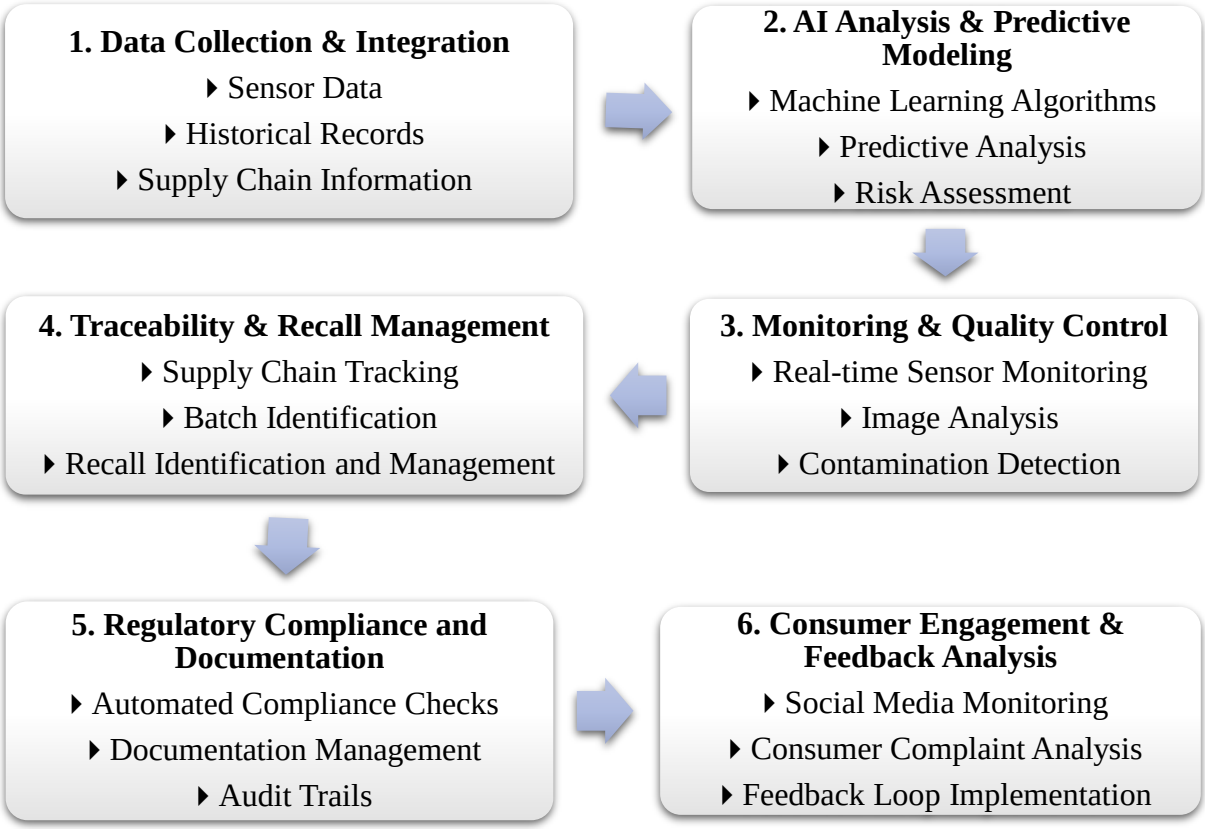

Figure 1. Food Safety Workflow That Enhanced by AI Technologies

LIMITS AND DRAWBACKS OF AI

All of these benefits notwithstanding, there are certain disadvantages to AI technology that pose difficulties. The foremost societal challenge we face is the potential rise in unemployment. Smart machines and robots can effectively substitute for a variety of repetitive tasks, leading to a decline in human participation in the labour market and posing a significant threat to employment standards. Additionally, machines are limited to performing tasks for which they are specifically designed or programmed; deviating from their intended functions often results in malfunctions or irrelevant outcomes. Furthermore, the significant costs linked with the creation and upkeep of intelligent machines and advanced computers can act as technological hurdles to the progress of AI. The high costs involved may also lead to increased prices of products. This issue encompasses several concerns, including extensive energy consumption, the challenge of managing e-waste, market consolidation, displacement of workers, and ethical considerations (Patelli and Mandrioli, 2020 & Gag, 2021).

CONCLUSION

AI technologies serve as potent solutions aimed at enhancing food yield, quality, and nutrition, as well as bolstering safety and traceability while concurrently reducing resource consumption and mitigating food waste. A comprehensive overview is offered on AI applications, its benefits, and constraints, alongside the incorporation of algorithms with diverse sensors such as E-nose and E-tongue in the food sector. In essence, AI holds promise to transform the food industry by elevating food safety and quality across the entire continuum, spanning from production to consumption.

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How to cite this article: Kariya PC and Kariya CJ. Opportunities for Artificial Intelligence to Enhance Food Safety. Chron Aquat Sci. 2024;1(11):32-36