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Next Generation Food Quality and Safety Assessment in Food Industry;
from the current single measurement to Data Science and Internet of Food
(things) approach

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Abstract

Ensuring food safety and quality is a major challenge in the agri-food industry, requiring innovative solutions for transparency, efficiency, and risk mitigation. **Agritrack** leverages **AI-driven Blockchain technology** to enhance traceability, quality control, and food integrity throughout the supply chain, focusing on perishable foods like fish, dairy, and meat. Using **IoT sensors, AI-powered analytics, and Process Analytical Technology (PAT)**, Agritrack automates data collection, detects contaminants, and optimizes food value chains in real-time. This modular platform strengthens consumer trust, reduces food losses, and provides cost-effective traceability for SMEs, revolutionizing food safety management from farm to fork.

1. Main text

Food management safety and/or quality system is probably the main challenges of the agri-food industry that is expected to be addressed in the current environment of tremendous technological progress, where consumers' lifestyles and preferences are in a constant state of flux.

Food chain transparency and trust are drivers for food integrity control and for improvements in efficiency and economic growth. Similarly, the circular economy has great potential to reduce wastage and improve the efficiency of operations in multi-stakeholder ecosystems.

Throughout the food chain cycle, all food commodities are exposed to multiple hazards, resulting in a high likelihood of contamination.

Such biological or chemical hazards may be naturally present at any stage of food production, whether accidentally introduced or fraudulently imposed, risking consumers' health and their faith in the food industry.

The current safety and quality controls in the food chain are lacking or inadequately applied and fail to prevent microbial and/or chemical contamination of food products, which leads to reduced confidence among consumers. On the other hand to meet market demands food business operators (producers, retailers, resellers) and regulators need to develop and apply structured

quality and safety assurance systems based on thorough risk analysis and prevention, through monitoring, recording and controlling of critical parameters covering the entire product's life cycle. However the production, supply, and processing sectors of the food chain are fragmented and this lack of cohesion results in a failure to adopt new and innovative technologies, products and processes. The potential of using information technologies, for example, data storage, communication, cloud, in tandem with data science, for example, data mining, pattern recognition, uncertainty modelling, artificial intelligence, etc., through the whole food chain including processing within the food industry, retailers and even consumers, will provide stakeholders with novel tools regarding the implementation of a more efficient food safety management system.

Nowadays, a massive amount of data is generated, not only from the next generation of food safety monitoring systems and along the entire food chain (primary production included) but also from the Internet of things, media, and other devices. These data should be used for the benefit of society, and the scientific field of data science should be a vital player in helping to make this possible.

These new approaches must meet market demands food business operators (producers, retailers, resellers) and regulators needs i.e., develop and apply structured quality and safety assurance systems based on thorough risk analysis and prevention, through monitoring, recording and controlling of critical parameters covering the entire product's life cycle. However the production, supply, and processing sectors of the food chain are fragmented and this lack of cohesion results in a failure to adopt new and innovative technologies, products and processes. The potential of using information technologies, for example, data storage, communication, cloud, in tandem with data science, for example, data mining, pattern recognition, uncertainty modelling, artificial intelligence, etc., through the whole food chain including processing within the food industry, retailers and even consumers, will provide stakeholders with novel tools regarding the implementation of a more efficient food safety management system.

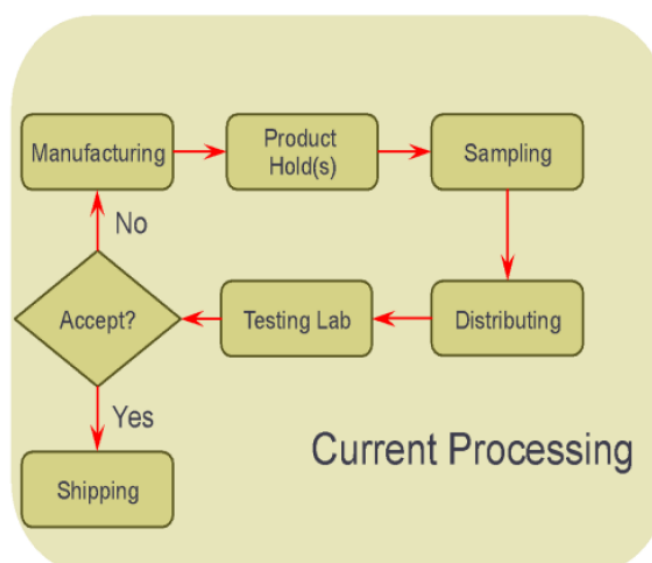


Fig. 1. Current testing and controlling of food safety implemented by the food industry.

2. Proposed Solution

The Agritrack Solution: There is currently no solution to deal with food fraud, food safety and food losses. Agritrack is a multi-actor and Artificial Intelligence driven secure digital Blockchain / ledger that collects and processes field value chain information through a combination of IoT sensors and mobile NIR sensors, which is a breakthrough to the market. We focus on perishable and high value foods, such as fish, dairy and meat, where time, quality and origin are key concerns for consumers, governments as well as companies producing food. Until nowadays, available traceability systems do not cover the whole spectrum of those aspects of the value chain simultaneously and are too expensive for most of the SMEs (and to some extent large organizations) involved in the food production value chain from farm to fork. Agritrack aims to disrupt this norm. The platform is composed of 4 modular and non-exclusive solution components each optimized to address a different segment of perishable food value chains

- (1) **Our Traceability and quality field automation solution** aims at providing the right information to stakeholders enabling them to reduce food losses via integration of IoT, Immutable Ledger and Artificial Intelligence (AI). The traceability automation module uses IoT sensors to allow field users to quickly capture and simplify their data collection process, while we secure transactions using an immutable ledger to have a verifiable record that will be accessible on the cloud platform.
- (2) **Our intelligent Food Value Chain (iFVC) Logic Engine** using AI, reports outlier events and suggest FVC improvements
- (3) **Our Production Quality Control (PQC)** is designed to leverage NIR IoT sensors, Fibre Optics and Machine Learning to provide a real time inline production quality control and incoming material classification automation. The implementation of Process Analytical technology (PAT) approach i.e., sensors that have been shown to be promising for the appraisal of different food protection issues and, as such, have been exploited. Specifically, applications related to the detection and quantitative assessment of microbial contaminants in foods and of chemical contaminants (e.g., mycotoxins) in raw materials will be presented. Given the critical role of information technology (IT) in data management and analysis, novel IT approaches exploited in the context of PAT in the food industry will also be presented and discussed.

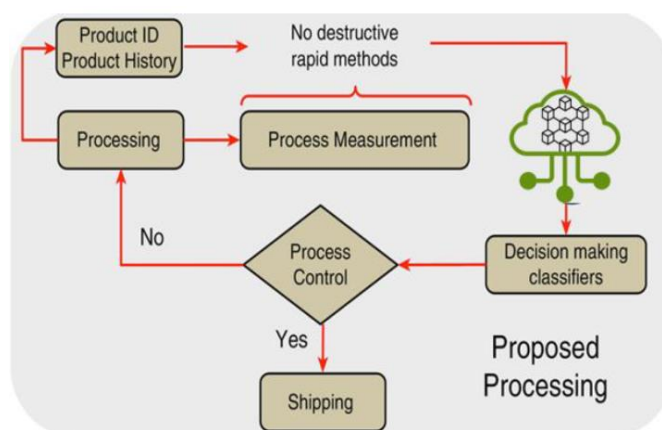


Fig. 2. process analytical technology (PAT) approach

The process analytical technology (PAT) approach (fig 2) in food processing constitutes a complete and integrated system which aims at end-product quality assurance in an efficient, detectable, and environmentally friendly manner via real-time on-line/in-line measurements of critical parameters. Such parameters can be physical, chemical and/or microbiological, and the measurements should be conducted after appropriate sampling and, ideally, using non-invasive analytical technologies. Analytical technologies that have been shown to be propitious in food processing are mainly spectroscopy methods, as well as hybrid technologies combining spectroscopy and image analysis such as multispectral imaging.

- (4) Our customer engagement module** is staged to provide a holistic view of the product's story to consumers, and soon to inspectors, through our QR-code certificate of origin and quality placed on product packaging.

Acknowledgements

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