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Utilizing the IFS Standard for the Implementation of Sustainable Development Practices in Juice Production

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Abstract: The aim of this study was to identify the most common threats and non-compliances occurring during the production of unpasteurized fruit juices in relation to the requirements of the IFS standard. Additionally, this study aimed to demonstrate how the IFS standard supports the introduction of sustainable practices in the production of fruit juices. The research material was data from internal audits conducted in three plants producing unpasteurized fruit juices and final product microbial assessment and swabs from the production environment taken from the three plants. These plants are located in western Poland. Based on the assessment carried out, it was found that most non-compliances were identified in the areas covered by prerequisite programs, but the final product and production environment met product and production safety requirements. It was also stated that the corrective actions proposed and approved by the auditors correct the existing non-compliance without the aspect of continuous improvement. The research and audits carried out as part of this work allowed us to conclude that international standards, such as the IFS, are an excellent tool for introducing the principles of a sustainable approach to production plants.

Keywords: IFS; sustainability; non-compliance; safety; juice

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1. Introduction

Sustainability in juice production focuses on minimizing environmental impacts while ensuring social and economic benefits. Key areas to consider for a sustainable juice production process include sourcing raw materials (local and organic farming, fair trade practices), energy efficiency, rational water management, waste management, supply chain transparency, and social responsibility [1]. In the era of accelerating globalization of the product market, constant increases in consumer demands, and the need to meet legal requirements, retail and wholesale traders have been obliged to take greater responsibility for ensuring food quality and safety [2,3]. Accordingly, members of the German Retail Federation, the French Retail Federation, the Italian retail trade union CONAD (Consorzio Nazionale Dettaglianti), COOP (Coop società cooperativa), and Federdistribuzione established the International Food Standard (IFS). This standard is intended for food producers and participants in the food chain. This implies unifying the assessment rules, the audit procedure, and the supplier qualification principle. It is intended to serve as a tool for periodic, independent work and objective assessment of food distributors. The standard contains requirements for the qualification process of suppliers, starting from defining the requirements imposed on them, to the principles of assessment and competencies of auditors, and ending with clear assessment criteria and confirmation of the implementation of the system with a granted certificate [4].

The IFS standard is based on a risk assessment approach, which provides users with certain flexibility to implement the requirements in their businesses based on specific risks associated with their products and processes. The IFS is internationally recognized by the Global Food Safety Initiative (GFSI) [5], which is based on general principles of food safety and quality management systems. However, the main focus is on instilling confidence in products and processes, i.e., safety, quality, legality, and compliance with specific customer requirements are ensured through on-site assessment, documentation review, and control [3]. Keeping records of tests carried out on semi- and final products allows for the collection of evidence that the production process is carried out in accordance with the adopted assumptions and procedures. This, in turn, is crucial for building the manufacturer's credibility and gaining consumer trust. Food quality standards are very much integrated with ESG (Environmental, Social, and Governance) principles in juice production. Using fruit from crops free from plant protection products for the production of juices, minimizing losses and production waste, and reducing chemical use in production, as well as transparency and support for the local community, are factors that guarantee high-quality products. This sustainable approach to production also guarantees production in accordance with the requirements of the IFS standard [1].

In recent years, the growing consumer interest in consuming 100% unpasteurized juices has led to a dynamic development of this product category. Directly pressed fruit and vegetable juices are termed NFC (Not From Concentrate) juices. NFC juices include the so-called "one-day-old" juices, the shelf life of which is declared by producers to range from 24 to 72 h, depending on the type of juice [6,7]. Consumption of NFC juices in Poland increased by almost 58%, while in Europe, the average increase was 12.5%. At the same time, a decline in the consumption of concentrated juices was observed throughout Europe [8]. Unpasteurized juices have gained popularity thanks to their fresh taste and aroma, as well as their high nutritional value. These juices contain health-promoting substances, such as polyphenols and antioxidants, along with an increased vitamin C content, which reduces the risk of lifestyle diseases [9]. Because of the lack of heat treatment, unpasteurized juices require refrigerated transport and storage. Any departure from these requirements may pose a potential threat to health, as these juices themselves may be a source of undesirable microflora [7].

Thanks to the low degree of processing, unpasteurized juices constitute a reservoir of natural microflora and may also be carriers of undesirable pathogenic microorganisms. Microbiological contamination occurs at the stage of raw material cultivation, where fruits are exposed to infection from the soil, water, and even air [8]. It has been proven that the source of pathogens in many cases is natural fertilizer, increasingly used for growing fruit on organic farms [10]. Despite the systems put in place to ensure food safety, cases of food poisoning caused by drinking juices are still reported around the world [11]. The introduction of the principles of sustainable fruit cultivation and sustainable production significantly reduces the number of quality incidents and non-conformities in the final product. High awareness of each participant in the chain "from farm to fork" significantly increases the safety of the produced juice and, at the same time, motivates both farmers and fruit processors to improve their work constantly. The introduction and regular auditing of procedures for compliance with the requirements of the IFS standard, on the one hand, guarantees a safe, high-quality product and reduces financial and material costs related to production errors (e.g., disposal of non-compliant products, repeated washing and disinfection of the lines, increased sampling of raw materials, semi-finished products, and finished products). This sustainable approach to production not only reduces losses but also significantly increases the awareness and responsibility of all participants in the juice production process to provide a good product while maintaining care for the environment and consumers.

Fruit juices are listed as one of the products with a high degree of non-compliance, including adulteration. In recent years, many actions have been taken to increase the safety of these products. The introduction of advanced and integrated systems ensuring product quality and safety, the development of analytical methods to detect potential non-compliances and adulterations, and increasing the frequency of sampling for analysis at every stage of production and distribution are the most effective activities. In an analysis of the last 30-year period, non-compliance reported only for fruit juices accounted for approximately 3.5% of the recorded incidents [12]. Each non-compliance detected in a plant is an incurred cost. Depending on the risk, if the potentially unsafe product is sent to the customer, the costs increase dramatically because the product must be recalled from the market. If, after detecting non-compliance, we control the non-compliant product, i.e., it is blocked at the plant, the costs are only economic. When it is necessary to recall a product from the market, image costs for the manufacturer are also incurred [13].

The aim of this study was to identify the most common threats and non-compliances occurring during the production of unpasteurized fruit juices in relation to the requirements of the IFS standard. The aim of this study was also to indicate how the IFS standard supports the introduction of sustainable practices in the production of fruit juices.

2. Materials and Methods

2.1. Assessment of Microbial Safety of Juices and Production Environment

2.1.1. Research Materials

The research material consisted of the following:

- Juice samples produced in three plants in western Poland.
- Samples from the surfaces of walls, floors, worktops, and equipment located in these plants and used directly for the production of fruit juices.

2.1.2. Research Methods

Microbiological Safety of Fruit Juice

The microbiological quality of the fruit juices was examined by inoculating plates with a sample (2.5 mL) on selective medium (Violet Red Bile Glucose Agar, suitable for microbiology, NutriSelect® Plus, MERCK Darmstadt, Germany, VRBG medium, nutrient agar P-0122 BTL, Warsaw, Poland) at 37 °C for 5 days. Three juice samples were randomly selected from production on three different production days for one month. Samples were taken from each of the analyzed production plants. The determination was performed in triplicate [14].

Microbiological Safety of the Production Environment

The microbiological cleanliness of the production environment was tested in accordance with ISO 18593:2018. Samples were examined using a surface-spread plate-count method. Three Petri dishes (triplicates) were used for each medium. The plates were incubated at 30–35 °C for 5 days for bacteria and at 20–25 °C for 7 days for fungi and molds. Samples were taken from each analyzed production plant on three non-consecutive production days [15].

2.2. Assessment of the Degree of Compliance with the IFS Standard Requirements

2.2.1. Research Materials

The research material consisted of data from internal audits conducted in three plants producing unpasteurized fruit juices. The plants where the audits were carried out employ 25 to 50 people. For production, the plants used raw materials mostly from local farmers. The IFS standard has been in place for at least 7 years. The audits carried out at the plant were not to initiate the introduction of the IFS standard. The audits were to maintain the certification obtained in previous years to meet the requirements of the IFS standard. The audits were performed once, and then the implementation of corrective action was checked.

2.2.2. Research Methods

The audits were conducted by qualified auditors with many years of experience in the food industry. The audits were conducted using checklists. The first step of each audit was initiating the procedure. The lead auditor indicated the dates of the audit, defined the scope and criteria to be covered by the audit, and arranged the audit date with the management responsible for a given organizational unit. A team of auditors was also appointed, which included the lead auditor and a junior quality specialist holding an internal auditor certificate. The audit team also has up-to-date knowledge of the IFS version 7 standard, as confirmed by respective certificates. The team then moved on to pre-audit activities, which included preparing the working documentation, along with a checklist, and planning the course of the audits. Seven days in advance, the lead auditor informed the managers of the audited enterprise about the date, scope, and criteria of the audit, which included the GMP/GHP Code, supervision of documents, supervision of records, production area, handling of complaints and non-conformities, corrections, corrective and preventive actions, and supervision allergens in the plant.

The audit activities began with an opening meeting attended by the team of auditors, managers of the audited organizational unit, the quality representative, and a representative of the Management Board.

After completing audit activities, the auditors prepared an audit report, which they submitted to the managers of the audited organizational unit. Managers assigned responsibilities to remove irregularities and proposed corrective actions.

3. Results and Discussion

Even though fruit juices are rich in vitamins and minerals, their consumption may carry the risk of microbial infection. The microflora of juices depends on the type of fruit, its origin, and the method of preservation or lack thereof. Most microorganisms detected on the surface of fruit come from the soil. Water and air can also be carriers that transfer microorganisms to the fruit surface [8].

The microbiological safety of juice is caused by both the microbiological purity of the raw material and the hygiene of production. The possibility of microbiological contamination is associated with the potential development of numerous groups of microorganisms also present in refrigerated storage conditions. The microflora that most often infects fruit includes the following:

- Bacteria resistant to environmental acidification, originating from soil or air;
- Lactobacilli;
- Acetic acid bacteria;
- Acid-tolerant fungi, including both molds and yeasts [10].

In the analyzed fruit juice production plants, great importance is attached to the selection of responsible and certified fruit suppliers. Each supplier is audited by the client (fruit juice production plant). Raw materials are assessed for microbiological and chemical purity. The chemical assessment takes into account both the potential presence of residues of plant protection products and other chemical substances that may potentially contaminate the raw material by migration from the soil. In the case of the analyzed production plants, inviting cooperation from local farmers also works very well, thanks to which the processed fruit exhibits an appropriate degree of ripeness and no damage resulting from extended transport. Additionally, this solution is part of a sustainable approach to running an organization belonging to the food chain [16]. Maintaining good relationships with suppliers, as well as having a high awareness of the care taken in each stage of production, washing, and disinfection, significantly determines the safety of the final product. The microbiological quality of the final product (Table 1) and the cleanliness of the production environment and equipment (Table 2) are the fundamental requirements of the IFS standard and a sustainable approach to food production.

Table 1. The microbial safety of fruit juice.

	Number of Bacteria (cfu/mL)
Enterobacteriaceae	ND
E. coli	ND
Salmonella spp.	ND

ND—not detected.

Table 2. The microbial safety of production surface.

Bacteria (cfu/mL)	Floor	Walls	Worktop	Equipment
Enterobacteriaceae	ND	ND	ND	ND
Total aerobic microbial count	<2	<2	<1	<1
Total yeast and mold count	<1	<1	ND	ND

ND—not detected.

Based on the microbiological tests of fruit juices and the production environment, it was found that in all assessed production plants, the attention to microbiological safety meets the IFS standard and legal requirements for this type of food product.

Despite the positive results of the product safety tests, the plants were audited for compliance with the remaining requirements of the IFS standard. Based on internal audits conducted in three companies producing unpasteurized fruit juices, the non-compliances listed in Table 3 were detected.

The proposed corrective actions (Table 4) are corrections in nature. The actions proposed by the Quality Representatives from the audited plants were approved by a certified IFS auditor. This suggests the need for greater verification of the knowledge and skills of auditors themselves by certification bodies. Corrective actions should, by definition, eliminate the potential risk of non-compliance occurring again. Corrections, however, only correct the existing non-compliance, without the aspect of preventing its occurrence in the future. The auditor's task is not only to indicate areas for improvement but also to identify a path for improvement in accordance with the assumptions of the selected quality standards. The justification for any quality assurance system is continuous improvement, which is possible thanks to regular audits conducted by both internal and external auditors.

In the food industry, ensuring high food quality is a multifaceted goal that involves various processes, regulations, and practices designed to maintain and improve the safety, nutritional value, and sensory attributes of food products. The future of food quality standards is likely to be shaped by several key trends and advancements in technology, sustainability, and consumer preferences [17,18].

Food safety is a critical aspect of the food industry, encompassing various measures and protocols designed to prevent foodborne illnesses and ensure that food is safe for consumption. Food safety concerns can be broadly categorized into biological and non-biological hazards [19].

A system of control for safety in factories producing preservative-free food products (not only juices) involves a comprehensive approach to ensure food safety and quality throughout the production process. Preservative-free products can be more susceptible to spoilage and contamination, so the safety control system must be especially robust. The safety and quality of high-risk products are guaranteed by the mandatory HACCP (Hazard Analysis and Critical Control Points) system, GMP (Good Manufacturing Practices), and GHP (Good Hygienic Practices) programs, traceability and recall systems, employee training and awareness, and continuous monitoring and auditing. This comprehensive safety system helps ensure that factories producing preservative-free food products can consistently deliver safe, high-quality products to consumers [13,19–22].

Prerequisite Programs (PRPs) are fundamental conditions and activities necessary to maintain a hygienic environment throughout the food chain. PRPs are essential for ensuring food safety and quality, and they address a wide range of challenges in the food industry. The resulting PRP assessment is based on the evaluation of establishment layout and workspace, utilities, waste disposal, equipment suitability, cleaning and maintenance, management of purchased materials and services, measures for prevention of contamination, cleaning, pest control, personnel hygiene and facilities, rework, withdrawal procedures, storage and transport, food packaging information and customer communication, food defense, and bioterrorism [23].

PRP assessment and verification activities showed that the weakest links requiring improvement are proper cleaning programs and frequent training on personnel hygiene and hand washing practices. Non-compliances found in the audited plants were also largely covered by the PRP [24]. However, a very positive aspect is the fact that the identified non-compliances did not have a direct impact on the safety of the product, which was confirmed by microbiological tests. This may indicate that employees' awareness of the impact of their work on product safety is very high despite the identified negligence, especially in documenting activities carried out during production.

Producers should focus on proper and effective management of the safety of produced food, not only quality. The introduction, maintenance, and ongoing verification of activities included in the PRP seem to be the path to success and the beginning of the introduction of integrated systems, guaranteeing product safety and quality [25]. Considering the requirements of the IFS standard from the perspective of sustainable development allows for its better understanding and more effective production management while taking care of socio-environmental factors.

Table 3. Non-compliance with IFS requirements identified during audits in companies producing fruit juices.

Requirement No.	Requirements According to the IFS Standard	Non-Compliance Detected
2.1.2.1.	Records and documented information must be legible and true. They are maintained in such a way as to prohibit subsequent revision or alteration. If records are documented electronically, a system should be put in place to ensure that only authorized personnel have access to create or amend these records (e.g., password protection).	Lack of the signature of the person performing weekly inspections of glass, hard plastics, and metal for one month.
2.2.3.5.	Records and documented information must be legible and true. They are maintained in such a way as to prohibit subsequent revision or alteration. If records are documented electronically, a system should be put in place to ensure that only authorized personnel have access to create or amend these records (e.g., password protection).	At the stage of rinsing glass bottles, the water stream pressure parameter, necessary to rinse bottles effectively before the filling stage, was not taken into account.
3.2.2.	Personal hygiene requirements must be implemented and followed by all relevant staff, contractors, and visitors	An employee in the production hall did not wear a protective apron when handling an open product, i.e., at the stage of pumping juice into plastic barrels (semi-finished product).
4.10.9.	Cleaning and disinfection chemicals must be clearly labeled, used, and stored appropriately to avoid contamination.	The warehouse for storing chemicals for the rest and refreshment room was not secured, i.e., locked.
4.12.6.	In areas where raw materials, semi-finished products, and finished products are processed, the use of glass and/or fragile materials should be excluded; however, where the presence of glass and/or fragile materials cannot be avoided, the risk must be controlled, and the glass and/or fragile materials must be clean and not pose a risk to product safety.	Broken plastic casing and sight glass on the pasteurizer. It was found that there were no measurable markings on the element in question that would clearly allow for the assessment of the crack during the weekly hard plastic inspection.
4.14.5.	All products must be clearly identified. Products are used in accordance with the First In/First Out and/or First Expired/First Out principles.	A container with 4.5 kg of dried, ground garlic was found in the additives warehouse. The label on the container in question had an illegible expiration date.
4.17.1.	Equipment should be appropriately designed and specified for its intended use. Before commissioning, please check whether the product requirements are met.	The machine inspection report (according to the schedule) lacked a signature/information about the person who performed the inspection.
4.18.6.	Labeling of batches of semi-finished or finished products takes place at the time of immediate packaging of the goods to ensure clear traceability of the goods. If goods are labeled at a later time, goods in temporary storage must bear a special batch label. The shelf life (e.g., expiration date) of marked goods is determined based on the original production batch.	There was an unlabeled semi-finished product in the production hall. Identification was possible based on production documentation and the batch number register.
5.7.1.	A quarantine (block/pause) procedure should be implemented that is justified by a risk assessment. The procedure ensures the processing and shipment of only raw materials, semi-finished and finished products, and packaging materials that comply with the product requirements.	The product release procedure for the finished product did not specify the person responsible for the product release.

Source: Our study based on the documentation of the tested facility.

Table 4. Corrections and corrective actions taken by the audited plants.

Deviation/Non-Compliance Detected	Corrections	Responsible Person	Corrective Action
Lack of the signature of the person performing weekly inspections of glass, hard plastics, and metal over one month.	Adding missing signatures.	Machine operator	Additional verification of documentation
In the hazard analysis at the stage of rinsing glass bottles, the water stream pressure parameter, necessary to ensure the effective rinsing of bottles before the filling stage, was not included.	Including the water jet pressure parameter in the hazard analysis.	Quality representative	Additional verification of documentation
An employee in the production hall did not wear a protective apron when handling the open product, i.e., at the stage of pumping juice into plastic barrels (semi-finished product).	Supplementing missing information regarding the language in which training was conducted.	Quality specialist	Detailed verification of documentation
The warehouse for storing chemicals for the rest and refreshment room was not secured, i.e., locked.	Securing the warehouse for storing chemicals with a key.	Quality representative	Checking security once a month during plant inspection
Broken plastic casing and sight glass on the pasteurizer. It was found that there were no measurable markings on the element in question that would clearly allow for the assessment of the crack during the weekly hard plastic inspection.	Replacing the sight glass housing. Measurable indication of a crack in the cap dispenser cover on production floor 1.	Production manager, quality specialist	Detailed verification of documentation
A container with 4.5 kg of dried, ground garlic was found in the additives warehouse. The label of the container in question contained an illegible expiration date but indicated the year 2022 or 2023.	Clear container labeling.	Quality specialist	Detailed review of raw material expiry dates once a month during plant inspection
The machine inspection report (according to the schedule) lacked a signature/information about the person who performed the inspection.	Adding missing signatures.	Production manager	Detailed verification of documentation
In the production hall, there was an undescribed semi-finished product, i.e., a plastic barrel. Identification was possible based on production documentation and the batch number register.	Labeling an unmarked barrel.	Quality specialist	Detailed review of the labeling of containers and barrels
The product release procedure for the finished product did not specify the person responsible for the product release.	Identification of the person responsible for releasing the finished product from the market	Quality representative	Detailed verification of documentation

Source: Our study based on the documentation of the tested facility.

4. Conclusions

Audits and microbiological tests carried out in the audited companies allowed us to conclude that the degree of compliance with the requirements is adequate for maintaining the IFS standard. However, the observed shortcoming is related to the proper and precise formulation of corrective and preventive actions. This is a task not only for quality representatives from the audited companies but also for certified auditors. The fundamental assumption of every system is continuous improvement, with an audit being the best tool to verify and stimulate the improvement process. However, it is crucial for the process to be carried out by highly specialized auditors who, based on their expert knowledge and experience, will ensure the improvement and development of systems implemented in an audited plant to guarantee the adequate quality of manufactured products. The research and audits carried out as part of this work allowed us to conclude that international standards guaranteeing food quality and safety, such as the IFS standard, are an excellent tool for introducing the principles of a sustainable approach to production plants. Interpreting the requirements of the IFS standard in a sustainable way allows us to achieve the following double benefit: responsible food production (corresponding to ESG elements) and certification of products with an international standard. This approach allows food producers to understand that sustainable production and international quality standards are not separate requirements that producers are expected to meet; they are complementary and supporting tools that guarantee economic, social, and environmental benefits.

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