



Implementation of the HACCP Food Safety Management System in Ensuring the Quality of Taiyaki Products: A Field Study in the Japanese Food Industry

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Abstract

Bakery products with cream fillings, such as Mini Taiyaki, are highly susceptible to microbiological hazards, particularly at the post-heating stage, and therefore require stringent process controls to ensure product safety and quality. This study aims to analyze the implementation of the Hazard Analysis and Critical Control Point (HACCP) system along the Mini Taiyaki production line based on field data collected during an internship programme. The scope includes hazard analysis, identification of critical control points, determination of critical limits, monitoring and corrective action mechanisms, as well as the planning of microbiological verification and documentation. The study adopts a descriptive case study design focusing on a single production line, with data collected through structured observations across all process stages, review of standard operating procedures and production records, directed interviews with operators and quality assurance personnel, and the development of a microbiological verification plan covering finished products, cream fillings, the packaging environment, operators' hands, air, and process water. Hazard analysis was conducted using a probability–severity matrix to determine hazard significance, while the identification of critical control points employed a decision tree adapted to the characteristics of the process. The results indicate that the dominant hazards are biological in nature, with five main critical control points identified: baking, rapid cooling, metal detection, packaging hygiene, and finished product storage. The system design emphasizes microbial elimination, prevention of microbial growth, and avoidance of recontamination. Consistent implementation with disciplined monitoring, corrective actions, microbiological verification, and FSMS integration strengthens sustainable safety and quality assurance for Mini Taiyaki.

INTRODUCTION

The ready-to-eat food industry is facing increasing regulatory pressure and heightened consumer expectations regarding product safety and quality, particularly for cream-filled bakery products such as taiyaki. These products are classified as high risk due to the intrinsic characteristics of their ingredients, which are rich in moisture and nutrients, the use of eggs and milk in the filling, and the presence of post-heating stages that create opportunities for recontamination. In this context, the Hazard Analysis and Critical Control Point (HACCP) system has been recognized as the most systematic approach for identifying, evaluating, and controlling hazards throughout the food processing chain (Uzoigwe & Kongolo, 2024). However, numerous studies emphasize that the effectiveness of HACCP is largely determined

by the accuracy of hazard analysis and the consistency of operational implementation, rather than by mere administrative compliance with system documentation (van Schothorst & Zwietering, 2015; Iversen et al., 2018; Soon et al., 2019).

With the development of Food Safety Management Systems (FSMS), HACCP has increasingly been positioned as the core of an integrated system that aligns with management standards, verification practices, and continuous improvement mechanisms to ensure batch-to-batch consistency and system resilience under changing production conditions (Djekic et al., 2022; Taylor et al., 2022; Djekic et al., 2023). Cross-sectoral evidence indicates that food safety control for high-risk products relies on two main pillars: the effectiveness of the heating process as the lethality step and the implementation of rapid cooling and cold storage to prevent the growth of pathogenic microorganisms (Yi, W., Li, & Luo, 2016; de Oliveira et al., 2017; Yi, L., et al., 2018; Al-Mutairi et al., 2019). In the bakery sector, post-oven control has expanded to include environmental hygiene, physical hazard detection, and packaging-area control (Borda et al., 2020).

Although the HACCP framework has been widely studied, empirical research that closely examines actual practices on cream-filled bakery production lines, particularly in developing countries and among micro-, small-, and medium-sized enterprises (MSMEs), remains relatively limited. In Indonesia, challenges in HACCP implementation include inconsistent documentation, variability in hygiene discipline, limitations in cold-chain infrastructure, and weak environmental monitoring (Lesmana et al., 2019; Jayadipraja & Tobigo, 2022; Malik & Anggraini, 2024). Previous studies have shown that consistency in temperature monitoring, batch traceability, and supplier qualification plays a significant role in reducing process deviations (Saputro et al., 2023; Ningrum, 2023). Nevertheless, direct links between these challenges and the performance of specific Critical Control Points (CCPs) in cream-filled bakery products are still rarely reported.

The integration of HACCP with quality management systems, halal assurance, food safety culture, and digitalization is increasingly recognized as a key determinant of FSMS sustainability. The implementation of ISO 22000 and ISO 9001 in synergy with HACCP has been reported to reduce process variability and enhance audit readiness through internal audits, equipment calibration, and the documented application of Corrective and Preventive Actions (CAPA) (Budiyono, 2022; Harini et al., 2022; Djekic et al., 2022). In Indonesia, the alignment of halal systems with food safety requirements necessitates consistent control of raw materials, equipment cleanliness, and the prevention of cross-contamination (Putri et al., 2022; Wahyuni, 2024). At the same time, digitalization through temperature sensors, data loggers, and digital CAPA systems offers opportunities to improve traceability and responsiveness to deviations, although it requires more precise validation of parameters and acceptance criteria (Soon et al., 2023; Taylor et al., 2022).

Based on these gaps, this study presents an empirical case study grounded in field data from a mini taiyaki production line to analyze the operational implementation of HACCP. The study focuses on baking as the primary lethality step, rapid cooling and cold storage as measures to prevent microbial growth, metal detection as a physical hazard control, and packaging hygiene as a barrier against recontamination. The objectives of this study are to analyze the implementation of HACCP in terms of hazard analysis, CCP determination and critical limits, monitoring, corrective actions, and microbiological verification; evaluate the

alignment of on-site practices with FSMS requirements and cross-sector best practices, including the integration of halal aspects and digitalization; and formulate measurable and sustainable improvement recommendations to strengthen food safety and product quality assurance. This research offers both theoretical and practical benefits. Theoretically, it enriches the limited literature on HACCP implementation for high-risk cream-filled bakery products in developing-country MSME contexts. Practically, it provides actionable insights for food producers, regulators, and the studied company, including structured monitoring, corrective actions, microbiological verification, halal integration, and digitalization, ultimately improving product safety, consumer trust, and market competitiveness.

RESEARCH METHODS

This research adopted a descriptive case study approach using the Hazard Analysis and Critical Control Point (HACCP) framework applied to a Mini Taiyaki production line in the Japanese food industry. The research design aimed to document the production process, from raw material receipt to product storage, and to evaluate control points affecting product safety and quality. Data were collected through structured observations, interviews with operators and Quality Assurance (QA) personnel, and document review such as Standard Operating Procedures (SOPs), Sanitation Standard Operating Procedures/Good Manufacturing Practices (SSOPs/GMPs), and Critical Control Point (CCP) records. The study was conducted between August and September.

Instruments used included thermocouple probes, infrared thermometers, data loggers, metal detectors, and microbiological swab kits. Data analysis was conducted in stages, beginning with validation of the process flow diagram, followed by hazard analysis using a semi-quantitative risk matrix, identification of CCPs using a HACCP decision tree, and evaluation of critical limits. Deviations were analyzed using the 5-Why method and the Ishikawa diagram (fishbone diagram), while the effectiveness of control measures was assessed through microbiological verification and environmental monitoring. The validity of the findings was strengthened through triangulation of sources and methods.

RESULTS AND DISCUSSION

Product Description: Mini Taiyaki

The product examined in this study is Mini Taiyaki, a type of fish-shaped Japanese cake filled with custard cream. This product was selected because it falls within the category of ready-to-eat foods that are susceptible to microbiological and physical contamination if not processed in accordance with hygienic procedures.



Figure 1. Mini Taiyaki

Source: Primary field documentation during production line observation, August–September 2025

Mini Taiyaki is a bakery product shaped like a small fish and filled with custard cream. It is produced using primary raw materials in the form of a J-929 flour mix (ミックス粉), which includes wheat flour, rice starch, sugar, and other ingredients, as well as TJ-Kusta-US custard cream (TJ-カスタ-US), which consists of water, sugar, rapeseed oil, skimmed milk powder, vanilla syrup, and other additives. Supporting ingredients include water, eggs, and sunflower oil. Mini Taiyaki measures approximately 8 cm in length and weighs about 28 grams per piece, with approximately 2.5 servings per container. The sensory characteristics of this product include a golden-brown colour, a soft texture, a distinctive sweet custard aroma, and a balanced sweet and savoury flavour. Although popular in the Japanese market, the presence of moist ingredients such as eggs and milk makes this product vulnerable to microbial growth if it is not managed in accordance with proper food safety principles, such as those applied within the HACCP system.

Table 1. Nutritional Content of Mini Taiyaki

Nutritional Component	Per Serving (84 g / 3 pcs)	% RI*	Per Container (approximately 2.5 servings)	% RI*
Energy	250 kcal	–	670 kcal	–
Total Fat	9 g	12%	24 g	31%
Saturated Fat	3,5 g	18%	9 g	45%
Trans Fat	0 g	0%	0 g	0%
Cholesterol	20 mg	7%	50 mg	17%
Sodium	240 mg	10%	640 mg	28%
Total Carbohydrate	39 g	14%	103 g	37%
Dietary Fiber	<1 g	3%	2 g	7%
Total Sugars	12 g	–	33 g	–
Added Sugars	10 g	20%	27 g	54%

Protein	4 g	10%	10 g	–
Vitamin D	0 mcg	0%	0 mcg	0%
Calcium	70 mg	6%	180 mg	15%
Iron	0,3 mg	2%	0,9 mg	6%
Potassium	100 mg	2%	260 mg	6%

*Note: % RI = Reference Intake based on a daily energy requirement of 2,000 kcal.

Source: Product specification sheet and packaging label data collected during internship, 2025

The nutritional profile of Mini Taiyaki indicates that this product is a relatively high source of energy, primarily derived from carbohydrates and fats. The levels of saturated fat and added sugars are considerable; therefore, while the product offers an appealing taste, excessive consumption should be moderated to maintain consumer health. This nutritional information is also essential in the implementation of HACCP, as product composition influences the potential for microbial growth and shelf life.

Hazard Identification

Hazard identification is conducted to determine potential food safety risks at each stage of the Mini Taiyaki production process. This hazard analysis covers three types of hazards physical, chemical, and biological which may arise from raw materials, the production environment, or processing practices that do not comply with established procedures. The assessment is carried out using three parameters: Likelihood (LH), referring to the probability of occurrence; Severity (SV), referring to the level of impact; and Significance (SF), referring to the significance of the hazard to food safety.

Table 2. Hazard Identification in the Mini Taiyaki Production Process

Process Stage	Hazard Type	Hazard Description	Cause	LH	SV	SF
Receipt of batter raw materials	Physical	Foreign materials (sack packaging fragments, small metal pieces)	Contamination from raw material packaging	L	M	NS
	Chemical	Pesticide residues in flour	Raw materials not subjected to residue testing	L	H	NS
	Biological	Pathogenic microorganisms	Raw materials contaminated prior to receipt	L	H	NS
Receipt of custard topping	Physical	Plastic fragments from packaging	Packaging opened not in accordance with SOP	L	M	NS
	Chemical	Excessive food additives	Topping supplier does not meet specifications	L	H	NS
	Biological	Pathogenic microbial contamination	Storage prior to use at inappropriate temperature	L	H	NS
Ingredient	Physical	Oil can fragment	Careless opening of	L	M	NS

if procedures are not properly implemented, for example due to insufficient baking temperatures or inadequate cooling. Therefore, HACCP implementation should prioritize temperature control, equipment sanitation, and hygiene procedures to ensure product safety and quality.

Determination of Critical Control Points (CCPs) and Establishment of Critical Limits for Each CCP

Based on the hazard identification conducted in the production of Mini Taiyaki, several stages within the production process present significant hazards, particularly of a microbiological and physical nature. These stages are therefore designated as Critical Control Points (CCPs), representing key moments at which hazards can be prevented, eliminated, or reduced to acceptable levels. The critical limits for each CCP are established in accordance with bakery industry best practices, equipment specifications, and food safety requirements applicable to high-risk products.

Table 3. Determination of CCPs and Critical Limits in the Mini Taiyaki Production Process

CCP	Process	Controlled Hazard	Critical Limit
CCP1	Baking (Cooking)	Vegetative pathogens (Salmonella, E. coli, Listeria monocytogenes) in batter/filling	Core product temperature ≥ 74 °C (≥ 15 seconds) at the coldest point; mould surfaces verified to have reached validated operating temperatures.
CCP2	Cooling (Cooling/Blast Chilling)	Growth of Listeria monocytogenes and spoilage bacteria after heat treatment	Temperature reduction from 60 °C to 10 °C within ≤ 2 hours, and further to ≤ 5 °C within ≤ 4 hours; cooling room temperature maintained at 0–5 °C.
CCP3	Metal Detection	Physical metal contaminants from equipment/packaging	Verified minimum sensitivity: Fe 1.5 mm, Non-Fe 2.0 mm, SS 2.5 mm; any product triggering metal detection is rejected and removed from the line.
CCP4	Packaging & Area Hygiene	Post-process microbiological cross-contamination	Clean area conditions; operators wear complete PPE; exposed product time ≤ 30 minutes; room temperature ≤ 25 °C; food-contact surface swab results below internal microbiological limits.
CCP5	Finished Product Storage (Chilled Storage)	Microbial growth during storage	Storage temperature controlled at ≤ 5 °C; First-Expired-First-Out (FEFO) applied; shelf life does not exceed specifications.

Source: On-site process evaluation and review of production standards at the Japanese food industry facility, 2025

Baking serves as the primary lethality step to eliminate pathogens, while rapid cooling prevents microbial growth after heat treatment. Metal detection addresses physical hazards, and proper packaging together with chilled storage prevents cross-contamination and further microbial proliferation. Collectively, these CCPs form an integrated control chain that ensures product safety and quality are maintained through to distribution.

Monitoring and Corrective Actions

Monitoring is designed to ensure that each CCP/OPRP (Operational Prerequisite Programme) consistently remains within the established critical limits. The monitored parameters focus on process temperature, exposure time, area/equipment hygiene, and the detection of physical contaminants. Monitoring results are recorded per batch and verified by the Production Supervisor/QA. Corrective actions are implemented immediately in the event of deviation, including product hold, root cause investigation, process/equipment correction, and CAPA (Corrective and Preventive Action) documentation.

Table 4. Monitoring and Corrective Actions in the Mini Taiyaki Production Process

Process	Type (Parameter)	Standard (Critical Limit/Target)	Corrective Action
Receiving – Batter ingredients (flour, eggs, oil)	Liquid egg temperature; packaging integrity; supplier COA	Eggs $\leq 5^{\circ}\text{C}$; packaging intact (no leaks/dents); COA meets specifications	Reject lots without COA/damaged packaging; eggs $>5^{\circ}\text{C}$ → quarantine, evaluate transport time–temperature, issue NCR report, return to supplier or scrap per QA decision.
Receiving – Custard topping (chilled)	Product temperature; packaging cleanliness	Receiving temperature $\leq 7^{\circ}\text{C}$; packaging clean & intact	If temperature $>7^{\circ}\text{C}$ or packaging dirty/torn → quarantine, recheck core temperature, trace cold chain, return or scrap; sanitize receiving area.
Storage – Ingredient & topping chiller	Chiller temperature; load and arrangement	Ambient $0\text{--}5^{\circ}\text{C}$; no overloading; FEFO	If $>5^{\circ}\text{C}$ for >30 minutes → transfer to compliant chiller, inspect doors & sensors, service unit; materials exceeding time–temperature limits → QA evaluation, reduce shelf life or scrap.
Baking (CCP1)	Core product temperature at coldest point	$\geq 74^{\circ}\text{C}$ for ≥ 15 seconds	If not achieved → continue baking until compliant; segregate batch; calibrate measuring devices; record deviation and conduct QA safety assessment.
Cooling/Blast chilling (CCP2)	Time–temperature curve post-oven	$60\rightarrow 10^{\circ}\text{C} \leq 2$ hours and $\leq 5^{\circ}\text{C}$ within ≤ 4 hours; chiller $0\text{--}5^{\circ}\text{C}$	If targets not met → immediately reduce load, increase airflow, adjust set-point; batches exceeding limits → microbiological/safety evaluation, reduce shelf life or scrap per QA decision.
Metal detection (CCP3)	Detector sensitivity; functional tests	Minimum: Fe 1.5 mm, Non-Fe 2.0 mm, SS 2.5 mm; ferrous/non-ferrous/SS tests at start of shift & lot change	If test fails or detection occurs → stop line, reject detected product, trace source, re-screen 100% from last passed test; release only after successful verification.
Packaging & area hygiene (CCP4/OPRP)	Open product exposure time; room temperature & cleanliness; swab results	Exposure ≤ 30 minutes; room temperature $\leq 25^{\circ}\text{C}$; surface swabs below internal limits	If limits exceeded → stop packing, re-sanitize/change gloves & PPE, re-clean area, repeat swabs; exposed product beyond limits → rework (if feasible) or scrap based on QA assessment.
Finished product storage (CCP5)	Storage temperature; holding time	$\leq 5^{\circ}\text{C}$; shelf life per specification & FEFO	If $>5^{\circ}\text{C}$ for >2 hours → quarantine; trace time–temperature; reduce shelf life or scrap; repair chiller/stacking procedures; retrain operators.

Source: Internship-based observation of operational procedures, monitoring records, and corrective action documentation, 2025

The monitoring framework above addresses three principal risk pathways: (1) pathogen elimination through control of core temperature during baking, (2) prevention of regrowth via rapid cooling and stable cold storage, and (3) prevention of recontamination through packaging hygiene control and metal detection. The use of measurable parameters (core temperature, time–temperature curves, detector sensitivity, swab results, and exposure time) ensures that corrective decisions are data-driven rather than assumption-based. Functional test frequency, instrument calibration, and document verification form part of the assurance that the system operates consistently across batches and shifts.

Food Microbiological Verification

Microbiological verification is carried out to demonstrate that controls at Critical Control Points (CCPs) and Operational Prerequisite Programmes (OPRPs) are genuinely effective in safeguarding the safety of Mini Taiyaki. Testing covers finished products, high-risk ingredients (custard topping), the processing environment (surface swabs, operators’ hands, and packaging-room air), as well as process water. Test results are compared against internal company criteria tailored to the characteristics of ready-to-eat, cream-filled foods and prevailing industry practices.

Table 5. Food Microbiological Verification Plan – Matrix, Methods, Sampling, and Acceptance Criteria

Matrix / Sample Type	Test Parameter	Method (accredited laboratory, example)	Sampling Plan	Acceptance Criteria (internal)	Frequency
Finished product – Mini Taiyaki (chilled)	Total Plate Count (TPC)	ISO 4833-1	n=5, c=2, m=1×10 ⁴ , M=1×10 ⁵ CFU/g	≤m for the majority of units; no unit >M	Each batch
	E. coli	ISO 16649-2	n=5, c=0	Not detected in 1 g	Each batch (random)
	Coliforms	ISO 4832	n=5, c=2, m=<10, M=10 ² CFU/g	In accordance with m/M	Each batch (random)
	Coagulase-positive S. aureus	ISO 6888-1	n=5, c=2, m=10 ² , M=10 ³ CFU/g	In accordance with m/M	Weekly
	Salmonella spp.	ISO 6579-1	n=5, c=0	Not detected in 25 g	Monthly or upon CCP deviation
	Listeria monocytogenes	ISO 11290-1	n=5, c=0	Not detected in 25 g	Monthly or upon cooling/storage deviation
Custard topping (before use)	TPC; E. coli; S. aureus; Salmonella; Listeria; Yeast & mould	As per parameters above; ISO 21527 (Yeast & mould)	n=5, c as per parameter	TPC m=1×10 ⁴ , M=1×10 ⁵ CFU/g; Yeast & mould m=10 ² , M=10 ³ CFU/g; pathogens “not detected”	Each incoming lot

Food-contact surface swabs (packing table, topping funnel, moulds)	Total aerobes; Coliforms; <i>Listeria</i> spp. (screening)	ISO 18593 (swab) + relevant enumeration methods	100 cm ² per point, ≥5 points	Total aerobes <10 ² CFU/100 cm ² ; Coliforms <10 CFU/100 cm ² ; <i>Listeria</i> not detected	Weekly (high-risk areas: daily)
Operators' hands/gloves	Total aerobes; Coliforms/ <i>E. coli</i>	Hand swab (contact plate)	≥5 operators/shift	Total aerobes <10 ² CFU/hand; Coliforms/ <i>E. coli</i> not detected	Weekly and during refresher training
Packaging-room air	Total aerobes; Yeast & mould (15-minute settle plates)	Passive/active sedimentation	3 points/room	Total aerobes ≤10 CFU/plate; Yeast & mould ≤5 CFU/plate	Weekly
Process/cleaning water	HPC; Total coliforms; <i>E. coli</i>	Drinking-water laboratory standards	3 bottles/point	HPC <10 ² CFU/mL; Coliforms 0/100 mL; <i>E. coli</i> 0/100 mL	Monthly

Source: Developed from company internal verification protocols and laboratory sampling plans observed during the study period, 2025

Notes: n = number of units tested per lot; c = number of units permitted to exceed m but not M (three-class plan); m/M = acceptable/maximum microbiological limits; “Not detected” = below the method’s limit of detection.

This verification design assesses control effectiveness end-to-end: (i) finished-product testing confirms that baking lethality and rapid cooling effectively suppress microbial loads and eliminate key pathogens; (ii) testing of custard topping, a high-risk ingredient, prevents the introduction of contaminants prior to product contact; (iii) surface, hand, and air swabs validate packaging sanitation discipline to prevent recontamination; and (iv) process-water testing ensures that cleaning media are not a contamination source. With a conservative n–c–m–M design and risk-based frequencies, any out-of-specification finding immediately triggers CAPA actions: quarantine or conditional release, deep cleaning, temperature–time process adjustments, and operator retraining. Trend analysis across all matrices provides feedback to confirm that CCPs 1–5 remain consistently under control and that the Mini Taiyaki produced meets the defined food-safety standards.

The findings of this study indicate that the implementation of HACCP in Mini Taiyaki production clearly positions hazard analysis at the core of process control design. Our observation that biological hazards most frequently attain significant status at the pre-heating stage (batter preparation), post-heating stage (cooling), and post-processing stage (packaging/storage) is consistent with the scientific consensus that regards the quality of hazard analysis as a “frequently overlooked” yet most decisive step in determining HACCP effectiveness (van Schothorst & Zwietering, 2015). The literature further emphasises that HACCP performance is influenced by the accuracy of process flow mapping, validation of critical parameters, and strong integration with prerequisite programmes (GMP/SSOP) within

a mature Food Safety Management System (FSMS) (Iversen et al., 2018; Soon et al., 2019). Comparisons with implementation studies in Chinese food industries, bakeries, and fresh-produce sectors demonstrate that lethality-based CCPs (baking) and growth-prevention controls (cooling/chilled storage) represent common patterns in ready-to-eat cream-filled products (Zhang et al., 2020; Borda et al., 2020; Castro et al., 2021). In addition, recommendations to strengthen verification activities and to anticipate emerging hazards reinforce the importance of ongoing calibration, internal audits, and management review (Taylor et al., 2022; Djekic et al., 2023), including process-sustainability innovations (Borda et al., 2024).

A substantial body of literature supports the present findings that HACCP-based controls in cream-filled ready-to-eat foods are effective when they focus on lethality points, rapid cooling, and the prevention of recontamination. Studies in the bakery and ready-to-eat food sectors show that baking with validated core temperatures, combined with cooling that rapidly passes through the danger zone, is associated with reduced post-process pathogen risk (Borda et al., 2020; Castro et al., 2021; Zhang et al., 2020). Similar evidence from the dairy and food-service sectors highlights post-heating controls and hygienic packaging as key determinants in preventing *Listeria monocytogenes* contamination in high-moisture, high-protein products (Yi et al., 2018; Jayadipraja & Tobigo, 2022). Nevertheless, several studies report that the mere presence of CCPs and HACCP documentation does not necessarily correlate with improved food-safety performance when not supported by a strong food-safety culture, consistent environmental verification, and disciplined operations (Soon et al., 2019; Griffith et al., 2015). Evaluations in some micro, small, and medium-sized enterprises further indicate that HACCP tends to become largely administrative when monitoring is not underpinned by reliable time–temperature data and when post-heat processing areas remain exposed to the surrounding environment (Malik & Anggraini, 2024; Saputro et al., 2023). These contrasting findings reinforce the argument that HACCP effectiveness is contextual and highly dependent on implementation quality rather than formal compliance alone.

The present findings directly address the research objectives by demonstrating that field-based (internship) hazard analysis is capable of identifying dominant risk points and translating them into operational CCPs, critical limits, monitoring procedures, corrective actions, and microbiological verification. An evaluation of alignment between on-site practices, FSMS requirements, and cross-sector best practices shows that the Mini Taiyaki production line is broadly aligned in its core elements (lethality–cooling–chilled storage), while still requiring reinforcement in packaging hygiene, environmental monitoring, and supplier governance. These findings are consistent with cross-sector recommendations from the bakery, dairy, and food-service industries (Borda et al., 2020; Budiyo, 2022; Djekic et al., 2022). Furthermore, the integration of halal assurance and digitalisation proposed in this study is well justified, as the literature indicates that aligning ingredient control and equipment hygiene with HACCP enhances audit efficiency and control consistency, while digital time–temperature recording and CAPA systems accelerate responses to deviations (Putri et al., 2022; Wahyuni, 2024; Soon et al., 2023). Accordingly, the proposed improvement measures enclosing topping-filling areas, strengthening risk-based environmental verification, and adopting digital monitoring are not only theoretically sound but also measurable and sustainable, thereby reinforcing the safety and quality assurance of Mini Taiyaki in line with the study’s objectives

CONCLUSION

This study demonstrates that the implementation of HACCP in mini taiyaki production has effectively controlled major hazards, particularly biological hazards, through critical processes such as baking, rapid cooling, metal detection, hygienic packaging, and cold storage, all of which function successfully as Critical Control Points (CCPs) to prevent contamination and microbial growth. Monitoring activities, corrective actions, and microbiological verification further ensure that products remain safe and compliant with applicable standards. However, several areas still require improvement, including enclosing the topping-filling area, enforcing stricter control of product exposure time, maintaining cold-chain consistency, strengthening environmental monitoring for *Listeria*, automating time-temperature recording, improving supplier qualification procedures, ensuring regular equipment calibration, and providing refresher training for operators. In addition, integrating HACCP into a certified Food Safety Management System (FSMS) and reviewing product shelf life based on microbiological evidence would further improve product quality, safety, and market competitiveness. Future research is recommended to evaluate the long-term effectiveness of digital monitoring systems, assess consumer safety outcomes associated with extended shelf-life validation, and compare HACCP implementation practices across different bakery-scale operations and food industry sectors.

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