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Assessment of microbial contamination in street-vended ready-to-eat food products

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Abstract
Street-vended Ready-to-Eat (RTE) foods supply affordable meals for millions of Thai consumers, yet their microbial safety receives limited systematic monitoring. This research assessed contamination levels across five RTE food categories som tam, sandwiches, rice dishes, fresh juices, and fried snacks sold in Bangkok and Chiang Mai. A total of 300 samples (60 per category) collected over October 2022 to March 2023 were analysed for total plate count, coliform count, *Staphylococcus aureus*, *Salmonella* spp., and Escherichia coli using ISO protocols. Som tam samples showed the highest mean TPC (5.8 $\log_{10}$ CFU/g), exceeding the Thai FDA limit of 5.0 $\log_{10}$ CFU/g. S. aureus was isolated from 43.7% of samples, and *Salmonella* from 8.3%. Only 38.7% of samples met Thai FDA limits. Vendor hygiene scores were the strongest predictor of microbial load ($r = -0.74$, $p<0.001$). Seasonal surveillance and vendor training are recommended to reduce public health risk.

Keywords: Microbial contamination, street food, ready-to-eat food, food safety, total plate count, *Staphylococcus aureus*, *Salmonella*, Thai FDA standards, vendor hygiene, public health

Introduction
The tradition of street-vended cooked food stretches back centuries in Southeast Asia. The FAO estimates 2.5 billion people worldwide consume street meals daily, with the sector supplying up to 40% of daily calories for urban consumers in developing nations [1, 2]. Yet these foods are prepared under conditions prone to microbial hazards open-air cooking, limited potable water, and absent refrigeration allow pathogens to multiply during extended holding [3]. Multiple outbreaks of *Salmonella* gastroenteritis and staphylococcal food poisoning in Thai cities have been linked to street-vended items [4]. Thai FDA published microbiological criteria for RTE foods in 2010, updated in 2021 [5], but enforcement at vendor level remains weak. This research generated baseline contamination data across five food types and two contrasting market settings.

Material and Methods
Material
Sampling was conducted in Bangkok, central Thailand (13.76°N, 100.50°E) and Chiang Mai, northern Thailand (18.79°N, 98.98°E) from October 2022 to March 2023. Ethical clearance was obtained from the Research Ethics Committee, Chiang Mai University (Ref. CMU/EC/2022-08, 12 September 2022). Five RTE categories were targeted: som tam, sandwiches, rice dishes, fresh juices, and fried snacks. In each city, 10 stalls per category were randomly selected from municipal registers, with three samples per stall at monthly intervals, totalling 300 samples. Samples were collected in sterile containers, transported in cold boxes (4 ± 2 °C), and processed within four hours.

Methods
Analysis followed ISO 4833-1:2013 for TPC, ISO 4832:2006 for coliforms, ISO 6888-1:2021 for S. aureus, and ISO 6579-1:2017 for *Salmonella* [6]. E. coli confirmation used EMB agar with IMViC testing. Vendor hygiene was scored using a 20-point checklist covering hand-washing, glove use, utensil cleanliness, water source, and waste disposal [7].

Pearson correlation and stepwise regression related hygiene scores to microbial counts. SPSS v26.0 was used at $p<0.05$.

Ethical considerations

Vendor identities were anonymised to prevent punitive action. Verbal consent was obtained before sampling. Where pathogen loads exceeded thresholds, results were communicated confidentially to municipal health offices.

Results

Contamination varied markedly across food types, with som tam showing the highest levels and juices the lowest.

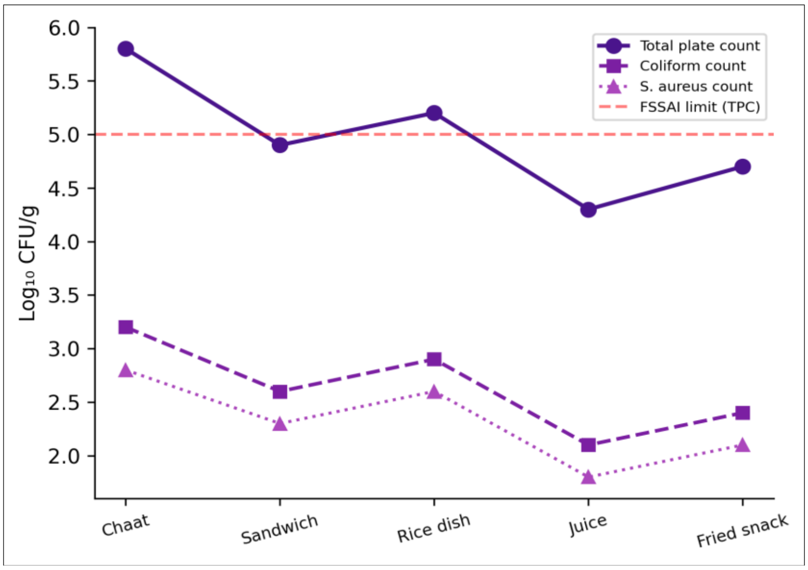

Figure 1: Mean microbial counts ($\log_{10}$ CFU/g) across five RTE food categories with Thai FDA threshold

Table 1: Summary of microbial contamination parameters (n=300)

Parameter	Mean ± SD	Range	Exceeding limit (%)
TPC ($\log_{10}$ CFU/g)	5.02 ± 0.73	3.1–6.9	61.3
Coliform ($\log_{10}$ CFU/g)	2.64 ± 0.58	1.2–4.1	47.0
S. aureus (+ve %)	43.7	—	43.7
Salmonella (+ve %)	8.3	—	8.3
E. coli (+ve %)	22.0	—	22.0

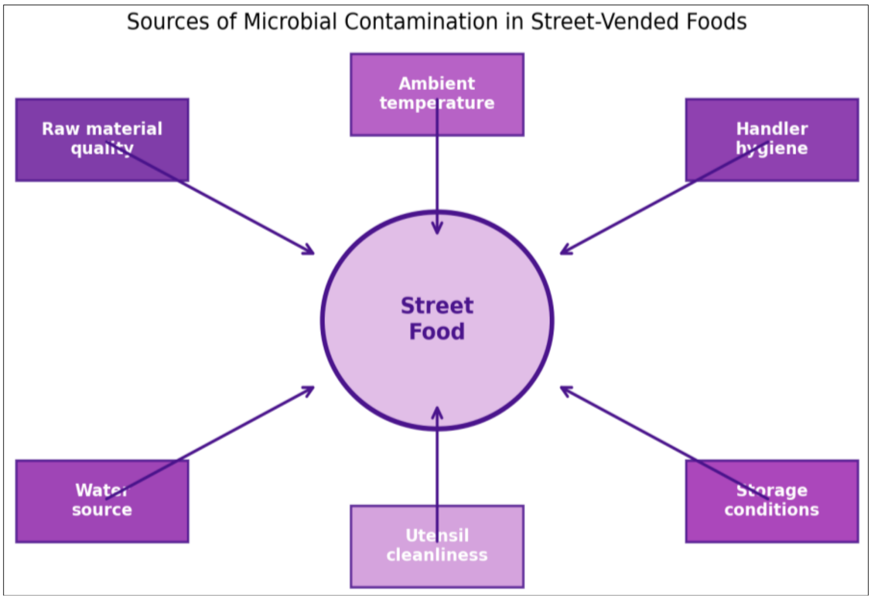

Fig 2: Sources of microbial contamination identified through vendor hygiene assessment

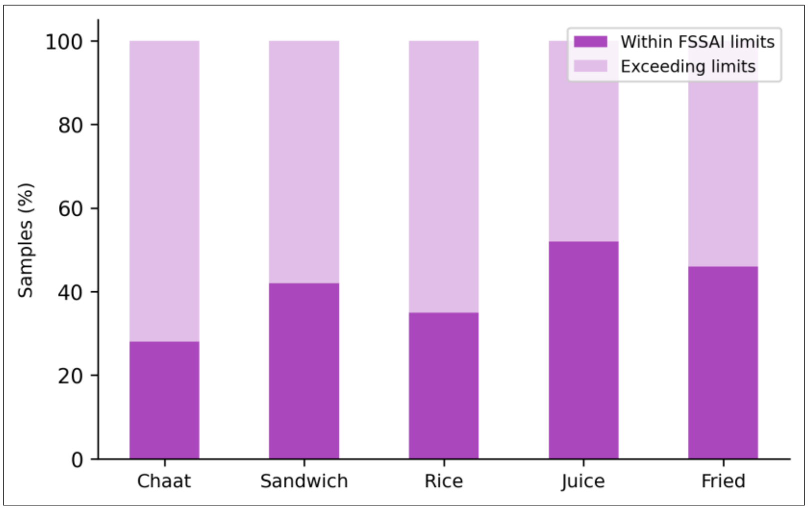

Fig 3: Thai FDA compliance rates by food category

Table 2: Seasonal variation in microbial counts and vendor hygiene scores

Month	Temp (°C)	TPC (log_{10})	Coliform (log_{10})	Hygiene (/20)
October	29.4	5.6	3.4	11.2
November	25.8	5.1	2.9	12.1
December	21.3	4.4	2.2	13.4
January	19.7	4.2	2.0	13.8
February	22.6	4.5	2.3	13.1
March	27.9	5.3	3.1	11.7

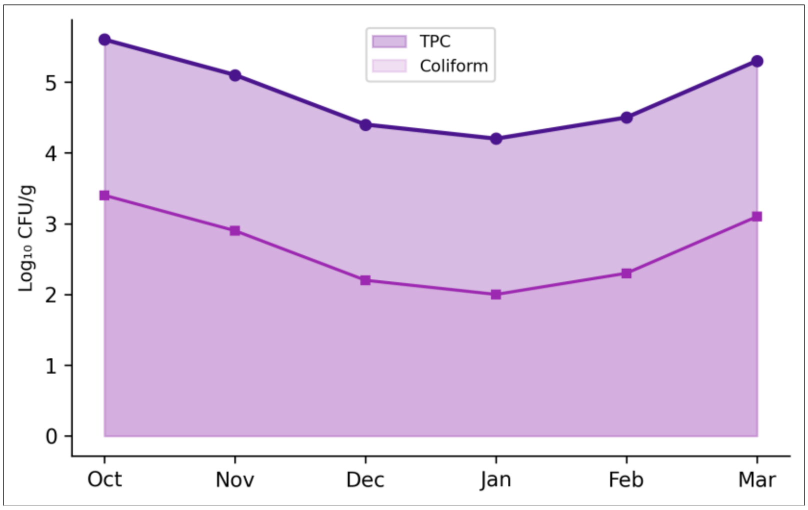

Fig 4: Seasonal trend in TPC and coliform count over the sampling period

Interpretation

Contamination tracked both food type and season. Vendor hygiene was the strongest modifiable predictor each one-point improvement on the 20-point scale corresponded to a 0.18 log_{10} reduction in TPC ($\beta = -0.18$, p<0.001).

Discussion

Over 61% of samples exceeded the Thai FDA TPC limit, consistent with non-compliance rates of 55–70% reported in Khon Kaen [8] and Phuket [9]. The 43.7% S. aureus prevalence mirrors the 47% found by Sharma *et al.* [10] in Bangkok som tam, reinforcing hand contact as the primary contamination route. The relatively low *Salmonella* rate (8.3%) compared with 15–20% in African street food surveys [11] likely reflects high-temperature cooking methods common to Thai snacks, though post-cooking handling eroded this initial safety margin. The strong seasonal pattern October TPC 33% higher than January aligns with mesophilic growth kinetics [12].

Limitations

The survey covered two cities over six months; extending through monsoon season would likely reveal higher loads. The hygiene checklist captures a snapshot and may miss daily variability. Future work should incorporate molecular typing for contamination pathway tracing.

Conclusion

This research quantified microbial contamination across five street-vended RTE food categories. Nearly two-thirds of samples failed Thai FDA standards, with som tam posing the greatest risk. Vendor hygiene was the strongest controllable factor. Structured training programmes coupled with seasonal surveillance offer the most practical path to reducing public health risk.

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