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Assessment of meat hygiene practices and microbial quality of chevon in wet markets of tier-II cities

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Abstract

The challenge of maintaining meat safety in open-air wet markets is magnified in tier-II cities where regulatory oversight and cold chain infrastructure lag behind metropolitan centres [1]. This research assessed meat hygiene practices and microbial contamination of chevon (goat meat) across 37 wet market stalls in four tier-II cities of Central Luzon, Philippines, between June and November 2023. Vendor hygiene practices were scored using a standardised 7-point checklist. A total of 148 chevon samples were analysed for total aerobic plate count (APC), coliforms, *Escherichia coli*, *Staphylococcus aureus*, and *Salmonella* spp. Mean APC was $6.12 \pm 0.87 \log_{10}$ CFU/g, with 68.2% of samples exceeding the Philippine National Standard limit of $6.0 \log_{10}$ CFU/g. *Salmonella* was detected in 26.4% of samples. Hygiene scores correlated inversely with APC ($r = -0.78$, $p < 0.001$). Roadside vendors had significantly higher contamination than municipal market stalls across all indicators ($p < 0.01$). These results identify critical control points for improving chevon safety in Philippine wet markets.

Keywords: Meat hygiene, chevon, goat meat, wet markets, microbial quality, food safety, *Salmonella*, *E. coli*, Philippines, tier-II cities

Introduction

Ensuring the microbial safety of fresh meat in tropical wet markets presents a persistent challenge: ambient temperatures of 28-34°C, open-air display without refrigeration, and high customer throughput create conditions that favour rapid bacterial multiplication [1, 2]. In the Philippines, wet markets remain the primary retail channel for fresh meat, accounting for an estimated 75-80% of meat sales outside metropolitan Manila [3]. Chevon (goat meat) has emerged as a rapidly growing segment of Philippine meat consumption, driven by cultural preferences in Central and Northern Luzon, yet it has received far less food safety scrutiny than pork, chicken, or beef [4].

Tier-II cities—defined as urban centres with populations of 100, 000-500, 000 outside metropolitan areas—face a particular vulnerability: meat consumption patterns mirror those of larger cities, but municipal meat inspection services, market infrastructure, and vendor training are significantly less developed [5]. The few existing Philippine studies on wet market meat safety have focused on pork and chicken in Metro Manila. No published data address chevon-specific contamination patterns in provincial markets. This research fills that gap by combining hygiene practice assessment with comprehensive microbiological profiling across four tier-II cities in Central Luzon.

Materials and Methods

Materials

Thirty-seven chevon-selling stalls (22 in municipal markets, 15 roadside vendors) were surveyed across four tier-II cities in Nueva Ecija and Tarlac provinces between June and November 2023. The Central Luzon State University Research Ethics Board approved the protocol (CLSU-REB-2023-054). From each stall, four samples (fresh cuts from different carcass regions) were collected at midday, yielding 148 samples. Samples were transported in sterile bags on ice to the laboratory within two hours.

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Methods

Vendor hygiene was scored on a 7-point scale covering: hand hygiene, use of clean utensils, display surface cleanliness, temperature control, separation of raw/cooked products, waste management, and protective clothing [6]. Microbiological analyses followed ISO 4833-1:2013 (APC), ISO 4832:2006 (coliforms), ISO 16649-2:2001 (*E. coli*), ISO 6888-1:2021 (*S.*

aureus), and ISO 6579-1:2017 (*Salmonella* spp.) [7]. Results were expressed as log₁₀ CFU/g or prevalence (%). Hygiene score-microbial count correlations used Pearson's *r*; market type comparisons used Mann-Whitney *U* (*p* < 0.05).

Results

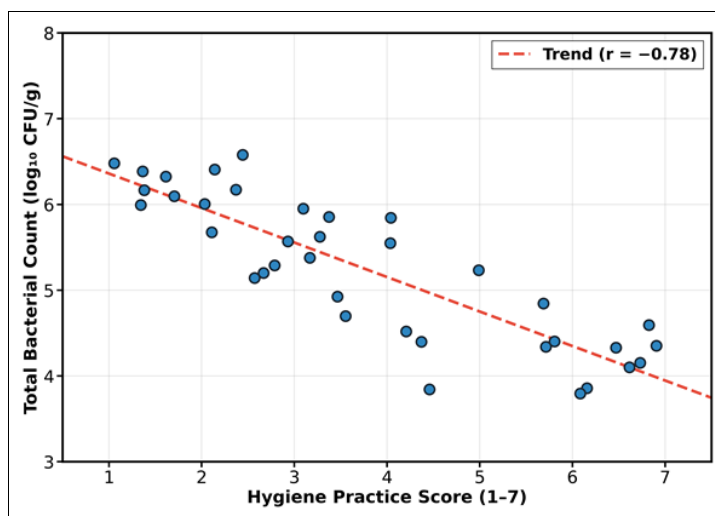


Fig 1: Relationship between vendor hygiene practice scores and total aerobic plate counts in chevon samples (n = 148)

Mean hygiene scores were significantly higher in municipal market stalls (4.8 ± 1.1) than roadside vendors (2.9 ± 0.8 , *p* < 0.001). *Salmonella* prevalence was nearly double in roadside samples (34.2%) compared to municipal market samples

(18.5%, *p* = 0.011). Among individual hygiene components, temperature control and surface cleanliness showed the strongest correlations with APC (*r* = -0.71 and *r* = -0.68, respectively).

Table 1: Microbial contamination of chevon samples by market type

Parameter	Municipal (n = 88)	Roadside (n = 60)	p-value
APC (log ₁₀ CFU/g)	5.42 ± 0.71	6.83 ± 0.64	<0.001
Coliforms (log ₁₀ CFU/g)	3.81 ± 0.62	4.94 ± 0.58	<0.001
<i>E. coli</i> (log ₁₀ CFU/g)	2.87 ± 0.54	3.72 ± 0.61	<0.001
<i>S. aureus</i> (log ₁₀ CFU/g)	3.24 ± 0.48	4.12 ± 0.57	<0.001
<i>Salmonella</i> (% positive)	18.5	34.2	0.011

Table 2: Compliance with Philippine National Standards for fresh meat by market type

Standard	Municipal (% pass)	Roadside (% pass)	Overall (% pass)
APC ≤ 6.0 log ₁₀ CFU/g	54.5	11.7	31.8
Coliforms ≤ 4.0 log ₁₀ CFU/g	68.2	26.7	48.6
<i>E. coli</i> ≤ 3.0 log ₁₀ CFU/g	61.4	30.0	47.3
<i>Salmonella</i> absent/25g	81.5	65.8	73.6

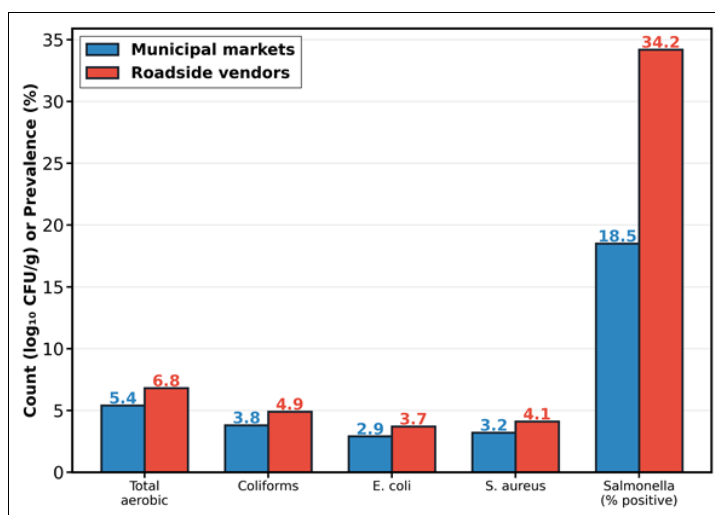


Fig 2: Microbial contamination levels by pathogen category in municipal market and roadside vendor chevon samples

Discussion

The finding that 68.2% of chevon samples exceeded the national APC limit underscores a systemic food safety failure in tier-II city wet markets. The strong inverse correlation between hygiene scores and microbial counts ($r = -0.78$) confirms that vendor practices—not inherent meat quality—are the primary determinant of retail contamination^[1, 8]. The two-fold *Salmonella* prevalence gap between roadside and municipal vendors is particularly concerning given that roadside operations typically lack running water, waste separation, and municipal inspection^[9].

Temperature control emerged as the single most impactful hygiene factor, consistent with the well-established relationship between ambient temperature exposure time and bacterial doubling rates in tropical climates^[10]. Simple interventions—insulated display cases, mandatory morning-only sales, and regular surface sanitisation—could meaningfully reduce contamination at minimal cost^[11].

Limitations

Sampling was limited to daytime midday collection, potentially missing peak contamination later in the day. Antimicrobial resistance profiling of isolates was not performed. Seasonal variation was partially captured (wet and dry seasons) but within a single year. Consumer handling post-purchase was not assessed.

Conclusion

Chevon sold in tier-II city wet markets of Central Luzon fails to meet Philippine National Standards at alarming rates, with roadside vendors showing the worst performance. Hygiene practice scores—particularly temperature control and surface cleanliness—are strongly predictive of microbial quality. Targeted vendor training, infrastructure upgrades for roadside operations, and enhanced municipal inspection frequency are recommended as priority interventions for improving chevon safety in provincial Philippine markets.

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Contributions Not Qualifying for Authorship

Municipal veterinary officers in the four surveyed cities facilitated market access and vendor coordination.

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