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Research Note

Tetracycline residues in organic and commercial eggs in public markets of Davao City, Philippines

Mikhail Judd G. Espino[1†], Jallyssiah Civ M. Panes[1†], Maria Gwyneth A. Daclan[1†], Eldee Shane B. Mirafuentes[1], Sat Krizzler M. Ordinario[1], Nicole Amberly T. Roco[1], Quinee Gwen E. Yap[1], Nelyn Mae T. Cadotdot[1], April Joy Parilla-Sarabila[1,2], Nikka Mae R. Elipio[1], Alfredo A. Hinay Jr[1,2]*

[1]*College of Medical and Biological Sciences, University of the Immaculate Conception, Davao City 8000, Philippines*
[2]*Graduate School Department, University of the Immaculate Conception, Davao City 8000, Philippines*

Abstract Antibiotic residues in food products are a growing public health concern because they contribute to antimicrobial resistance. This study aimed to determine the levels and health risks of tetracycline residues in organic and commercial chicken eggs collected from wet markets in Davao City, Philippines. An Enzyme-linked immunosorbent assay (ELISA) was used to analyze 228 eggs (114 organic and 114 commercial), with sampling conducted in three rounds over one month to capture potential temporal fluctuations. Organic eggs had a mean tetracycline concentration of 18.16±82.5 ng/g, significantly higher than the 1.10±37.2 ng/g observed in commercial eggs ($p=0.004$). However, nearly all detected residues were below The Bureau of Product Standards maximum residue limit (MRL) of 400 ng/g, with only 1.75% of the organic samples exceeding this threshold. Health risk assessment based on estimated daily intake and hazard quotient showed that all values were well below the acceptable daily intake of tetracyclines and far below 1, indicating no appreciable risk of adverse health effects from dietary exposure to tetracycline residues through egg consumption at current intake levels. However, the higher mean residue levels in organic eggs highlight the need for continuous surveillance and stricter regulation of antibiotic use in poultry production to safeguard food safety and help mitigate the development of antimicrobial resistance.

Keywords poultry eggs, tetracycline residues, food safety, health risks

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†These authors contributed equally to this study.

***Corresponding author**
Alfredo A. Hinay Jr
Tel: +63-082-221-8181 (ext. 118)
E-mail: ahinay@uic.edu.ph

1. Introduction

Antibiotic residues in food pose a hidden, yet serious threat to consumer safety, undermining efforts to ensure the integrity of the food supply chain. The World Health Organization (WHO) has identified antimicrobial resistance (AMR) as one of the greatest public health and developmental challenges driven in part by the inappropriate use of antibiotics in food production systems (Morel et al., 2016). More than half of global antibiotic production is consumed by non-human sectors, with approximately 70% used in agriculture (ASOA, 2022; World Health Organization, 2024). The misuse of these drugs for growth promotion, prophylaxis, or disease control in animals contributes to residue accumulation in animal products and environmental contamination via excreta and wastewater (Manyi-Loh et al., 2018; Polianciuc et al., 2020). Persistent exposure to subtherapeutic antibiotics fosters resistant bacterial populations that can transfer resistance genes to human pathogens, posing a direct threat to food safety and public health (Ma et al., 2021; Pokharel et al., 2020).

Tetracycline is among the most widely used antibiotics in poultry farming in the Philippines. Barroga et al. (2020) reported that 12% of commercial poultry farms and 39% of backyard poultry farms used tetracycline or its derivatives. In contrast, Palisoc et al. (2019) found that eggs had the highest concentrations of tetracycline residues among poultry products, with both organic and non-organic samples exceeding the maximum residue limits. Eggs, a common and affordable protein source, represent a potential route for human exposure to these residues.

Despite growing concern about antibiotic contamination in food, studies on the occurrence of antibiotics residue in eggs remain limited in the Philippines, particularly in Davao City. In our previous study, we detected tetracycline residues in meat products sold at local public markets, underscoring the need for broader monitoring of antibiotic residues across various food commodities (Develos et al., 2024). Building on these findings, the present study aimed to determine tetracycline residue levels in organic and commercial eggs collected from poultry suppliers in selected wet markets and to assess their possible human health risk in Davao City, Philippines.

2. Materials and methods

2.1. Research location

The study was conducted in Davao City, the regional capital of the Davao Region (Region XI) in the southeastern part of Mindanao, Philippines. Covering approximately 2,443.61 square kilometers and home to 1.77 million people, the city serves as a major trading and food distribution hub in the region. The Davao Region contributed 5.43% of the country's total chicken egg production of 583,234 metric tons, with Davao City accounting for 68% of the region's output in 2019 (PSA, 2020). Given the high production and distribution volume, the use of antibiotics in poultry farming to prevent diseases, treat infections, and promote growth is inevitable. Such practices increase the potential for antibiotic residues, particularly tetracycline, to enter the local food supply chain, which is especially relevant in wet markets, where quality control may be limited.

2.2. Sampling procedure

A quantitative repeated cross-sectional design was used to determine tetracycline residue levels in organic and commercial chicken eggs sold in wet markets in Davao City. This design enabled the systematic detection of potential variations in residue concentrations across sampling intervals. Sampling was conducted in three rounds at one-week intervals within a single month to assess fluctuations in tetracycline levels and compliance with antibiotic withdrawal periods.

The egg samples were purchased from vendors across three representative public markets. Vendors were first interviewed to identify their suppliers and ensure the proper representation of local distribution. The sample size was calculated using OpenEpi (version 2.3.1) based on an assumed prevalence of 8% from the study by Yang et al. (2020) at the 95% confidence level. A total of 228 eggs were collected, comprising 114 commercial and 114 organic samples.

2.3. Sample preparation and assay

After collection, egg samples were stored at 4℃ and transported in ice boxes to the Clinical Laboratory of the University of the Immaculate Conception. The samples were kept away from light to preserve the stability of residue. Egg yolks were separated and transferred individually into 50 mL centrifuge tubes for analysis following the protocols described in the Tetracycline ELISA Test Kit (A327256). For sample preparation, 1 g of homogenized egg was mixed with 3 mL of 2X sample dilution buffer, shaken for 20 min, and centrifuged at 4,000 rpm for 5 min. The resulting supernatant (100 μL) was used to test the enzyme activity. The reagents and wash buffers (1X and 2X dilutions) were prepared according to the manufacturer's instructions. The assay procedure involved pipetting 100 μL of standards and prepared samples (in duplicate) into the designated wells of a 96-well microplate, followed by antibody addition and incubation at room temperature. After washing, 100 μL of TMB substrate was added, incubated for 15 min, and then stopped with 100 μL of stop solution. The absorbance was measured immediately at 450 nm using a BIOBASE BK-EL10A microplate reader. Seven calibration standards, along with blank and spiked egg samples, served as controls. The assay had a dilution factor of 4 and a detection limit of 0.4 ng/g for egg samples. The final concentrations were compared with the established Maximum Residue Levels to determine the frequency of samples beyond the threshold limit.

2.4. Risk assessment

This study estimated consumers' dietary exposure to

tetracycline residues through egg consumption. The mean concentrations of tetracycline residues in eggs and average daily consumption based on 60 kg body weight for adults and 10 kg body weight for children were considered. ADI values of 0-30 ng/g/day for tetracycline residues, established by the Joint FAO/WHO Expert Committee on Food Additives (JECFA, 2002), were used to calculate the Hazard Quotient. Risk assessment was performed by calculating the Hazard Quotient (HQ) using the following formula:

$$HQ = \frac{\text{Estimated daily intake (EDI)}}{\text{Acceptable daily intake (ADI)}}$$

EDI was calculated using the formula given by Juan et al. (2010).

$$EDI = \frac{\text{Mean tetracycline concentration} \times \text{Daily intake of food}}{\text{Acceptable daily intake (ADI)}}$$

An estimation of egg availability and consumption of eggs in the Philippines was carried out based on the report of the Department of Agriculture, Government of the Philippines.

2.5. Statistical analysis

The collected data were analyzed using JASP 0.19.3.0. Descriptive statistics were calculated to summarize tetracycline residue concentrations in both organic and commercial eggs, and the Mann-Whitney U test was used to examine whether there was a significant difference between the residue levels found in organic and commercial eggs.

3. Results and discussion

3.1. Concentration of tetracycline residues in organic and commercial eggs

Table 1 summarizes the tetracycline residue concentrations detected in eggs sampled from the public markets in Davao City. Organic eggs had a mean tetracycline concentration of 18.16±82.5 ng/g, whereas commercial eggs had a much lower mean concentration of 1.10±37.2 ng/g. The relatively large standard deviations, particularly in organic eggs, indicate pronounced variability in residue levels among individual samples, suggesting that while most eggs contained low or undetectable residues, a small number had markedly higher concentrations, inflating the dispersion around the mean. These values are considerably below the maximum residue limit (MRL) of 400 ng/g set by BPS (2015), indicating safety for consumer intake. The observed concentrations were consistent with the trends reported in previous studies. For example, a study in Egypt found tetracycline residues ranging from 18.73 to 265.9 ng/g in eggs from markets and farms (Amir et al., 2023). In contrast, another study found average levels of 3.10 ng/g, with a range of 0.56-9.77 ng/g (Kamali et al., 2020). Thus, eggs from both commercial and organic sources generally comply with international safety standards, despite the notable variability between individual samples and production systems.

These findings imply that eggs circulating in the public markets of Davao City, whether organic or commercial, pose minimal and immediate risk of exposure to tetracycline residue. Regulatory controls and production standards are effective in maintaining residual concentrations at safe levels. Nonetheless, continuous monitoring remains necessary, especially given the higher mean of organic samples, to maintain food safety and consumer confidence.

3.2. Significant difference in tetracycline concentration between organic and commercial eggs

Organic eggs exhibited a mean tetracycline concentration of 18.16±82.5 ng/g, which was markedly higher than the mean value of 1.10±37.2 ng/g found in commercial eggs (p=0.004). These findings illustrate a substantial difference in

Table 1. Comparison of tetracycline residue levels in organic and commercial chicken eggs

Type of egg	n	MRL[1)] in ng/g	Mean±SD (ng/g)	p-value	Rank-biserial correlation	95% CI
Organic	114	400	18.16±82.5[2)]	0.004[3)]	-0.228	[-0.364, -0.081]
Commercial	114	400	1.10±37.2			

[1)]MRL, maximum residue limit.
[2)]Two samples (1.75%) were found to exceed the MRL.
[3)]Significant difference in total tetracycline resides between liver and meat at $p<0.05$.

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the residue levels between the two egg types. This had a small to moderate effect size (r_{pb}=-0.228), with Group 1 (commercial egg) tending to have lower values than Group 2 (organic egg). The narrow confidence interval suggests that this negative difference is reliable, and the true population effect is likely to fall between small (-0.081) and moderate (-0.364) negative associations. The overall trend follows previously reported data from both in local and international markets, tetracycline residues are frequently detectable in eggs, yet their levels are typically well below established safety thresholds, such as the maximum residue limit (MRL) of 400 ng/g set by BPS (2015).

Organic eggs exhibited significantly higher levels of tetracycline residues than commercial eggs, which may seem counterintuitive given the expectation that organic products should be "chemical-free." This discrepancy could arise from several factors, including environmental exposure and cross-contamination, in which organic farms might share water, feed, or equipment with conventional farms, leading to indirect exposure (Sarkar et al., 2023; Sharma et al., 2018). Additionally, some organic certification standards permit limited therapeutic use of antibiotics under strict veterinary oversight, and failure to fully observe withdrawal periods could result in residual presence. Variability in supply chain practices and the less stringent enforcement of organic certification can further contribute to unexpected residues in organic eggs. Moreover, differences in farm management and health protocols might inadvertently expose organic hens to antibiotics, particularly if disease control options are limited. The wide variation in individual residue levels, reflected in the large standard deviation, underscores the complexity of the antibiotic residue dynamics in organic production systems. These findings highlight the importance of continuous surveillance, robust regulatory enforcement, and greater transparency in organic poultry production to maintain consumer trust and ensure food safety.

3.3. Human health risk assessment

The health risks associated with dietary exposure to tetracycline residues from organic and commercial eggs in Davao City were evaluated by comparing the estimated daily intake (EDI) for adults and children with the acceptable daily intake (ADI) of 30 ng/kg/day (Table 2). All calculated EDIs (0.0002-0.0261 ng/kg/day) were several orders of magnitude lower than the ADI, yielding hazard quotients (HQs) between 7.5×10^{-6} and 1.2×10^{-4}, which are far below the threshold value of 1 and therefore indicate no appreciable risk of adverse health effects from dietary exposure to tetracycline residues through consumption of eggs at current intake levels. These findings imply that, under the existing production and marketing conditions in Davao City, the current use patterns of tetracyclines are unlikely to pose a significant health concern for adult and child consumers, while still highlights the need for routine surveillance and prudent antibiotic stewardship to prevent residues from exceeding maximum residue limits and to limit the emergence of antimicrobial resistance (Bishnoi et al., 2025).

4. Conclusions

This study provides baseline data on tetracycline residues and human health risks in organic and commercial eggs from public markets in Davao City. Nearly all samples contained residues below the national maximum residue limit of 400 ng/g, and the estimated daily intake and hazard quotients for adults and children were far below the acceptable daily intake and threshold of 1, indicating a negligible risk from current consumption levels. However, the higher mean residues in organic eggs highlight the need for continuous surveillance and stricter antibiotic stewardship in poultry production to ensure long-term food safety and support evidence-based policymaking.

Table 2. Risk assessment based on hazard quotient for tetracycline residues via egg consumption in different age groups in Davao City, Philippines

Type of egg	Age group	Body weight (kg)	EDI (ng/g/day)	Hazard quotient
Organic	Adults	60	0.0037	1.2×10^{-4}
	Children	10	0.0261	8.7×10^{-4}
Commercial	Adults	60	0.0002	7.5×10^{-6}
	Children	10	0.0015	5.3×10^{-5}

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Conflict of interests

The authors declare no potential conflicts of interest.

Author contributions

Conceptualization: Espino MJG, Panes JCM, Daclan MGA, Hinay AA Jr. Methodology: Mirafuentes ESB, Ordinario SKM, Roco NAT, Yap QGE. Formal analysis: Espino MJG, Panes JCM, Daclan MGA, Mirafuentes ESB, Ordinario SKM, Roco NAT, Yap, QGE. Validation: Espino MJG, Panes JCM, Daclan MGA, Cadotdot NMT, Parilla-Sarabia AJ, Elipio NMR. Writing - original draft: Espino MJG, Panes JCM, Daclan MGA, Mirafuentes ESB, Ordinario SKM, Roco NAT, Yap, QGE, Cadotdot NMT, Parilla-Sarabia AJ, Elipio NMR, Hinay AA Jr. Writing - review & editing: Espino MJG, Panes JCM, Daclan MGA, Hinay AA Jr.

Ethics approval

This research was approved by IRB of The University of The Immaculate Conception Protocol Code UG-EX-01-25-0145.

ORCID

Mikhail Judd G. Espino (First author)
https://orcid.org/0009-0000-7380-8949
Jallyssiah Civ M. Panes (First author)
https://orcid.org/0009-0002-4306-0006
Maria Gwyneth A. Daclan (First author)
https://orcid.org/0000-0001-5882-8845
Eldee Shane B. Mirafuentes
https://orcid.org/0009-0001-1290-6032
Sat Krizzler M. Ordinario
https://orcid.org/0009-0008-5770-9551
Nicole Amberly T. Roco
https://orcid.org/0009-0009-7110-2737
Quinee Gwen E. Yap
https://orcid.org/0009-0001-4704-1091
Nelyn Mae T. Cadotdot
https://orcid.org/0000-0002-1994-0962
April Joy Parilla-Sarabila
https://orcid.org/0000-0002-9776-5717
Nikka Mae R. Elipio
https://orcid.org/0009-0004-3116-3870
Alfredo A. Hinay Jr (Corresponding author)
https://orcid.org/0000-0003-4761-1514

References

Amir H, El-Sherbini M, Marouf H. Prevalence of antibiotic residues in table eggs in Damietta Governorate. Mansoura Vet Med J, 24, 80-88 (2023)

ASOA. Antibiotic overuse in livestock farming. Available from: https://www.saveourantibiotics.org/the-issue/antibiotic-overuse-in-livestock-farming/. Accessed Nov. 11, 2025

Barroga TRM, Morales RG, Benigno CC, Castro SJM, Caniban MM, Cabullo MFB, Agunos A, De Balogh K, Dorado-Garcia A. Antimicrobials used in backyard and commercial poultry and swine farms in the Philippines: A qualitative pilot study. Front Vet Sci, 7, 329 (2020)

Bishnoi K, Moudgil P, Soni D, Jadhav VJ. Occurrence and risk assessment of tetracycline residues in layer eggs in Haryana, India. J Food Prot, 88, 100449 (2025)

BPS. Philippine National Standard. The Bureau of Product Standards, Quezon City, Philippines (2015)

Develos KMS, Nerio KJO, Fuentes KDC, Lanaban AB, Mapundo KJB, Guillen CAKO, Dumagan HMB, Buelis GCL, Cadotdot NM, Insular NL, Northrup CMA, Rivera JM, Hinay AA Jr. Tetracycline residues in retailed pork meat and liver in public markets of Davao City, Philippines. Food Sci Preserv, 31, 1057-1062 (2024)

JECFA. WHO technical report series no. 925, sixty-second meeting of JECFA. Available from: https://www.who.int/publications/i/item/9241209259. Accessed Feb. 19, 2026

Juan C, Moltó JC, Mañes J, Font G. Determination of macrolide and lincosamide antibiotics by pressurised liquid extraction and liquid chromatography-tandem mass spectrometry in meat and milk. Food Control, 21, 1703-1709 (2010)

Kamali A, Mirlohi M, Etebari M, Sepahi S. Occurrence of tetracycline residue in table eggs and genotoxic effects of raw and heated contaminated egg yolks on hepatic cells. Iran J Public Health, 49, 1355-1363 (2020)

Manyi-Loh C, Mamphweli S, Meyer E, Okoh A. Antibiotic use in agriculture and its consequential resistance in environmental sources: Potential public health implications. Molecules, 23, 795 (2018)

Morel C, McClure L, Edwards S, Goodfellow V, Sandberg D, Thomas J, Mossialos E. Co-development of antibiotics

https://doi.org/10.11002/fsp.2026.33.1.176

and diagnostics for bacterial infection. In: Ensuring Innovation in Diagnostics for Bacterial Infection. World Health Organization, Geneva, Switzerland, 89-129 (2016)
Palisoc S, De Leon PG, Alzona A, Racines L, Natividad M. Highly sensitive determination of tetracycline in chicken meat and eggs using AuNP/MWCNT-modified glassy carbon electrodes. Heliyon, 5, e02147 (2019)
PSA. Livestock and poultry situation report. Available from: https://psa.gov.ph/livestock-poultry-iprs. Accessed Nov. 11, 2025
Pokharel S, Shrestha P, Adhikari B. Antimicrobial use in food animals and human health: time to implement 'One Health' approach. Antimicrob Resist Infect Control, 9, 181 (2020)
Polianciuc SI, Gurzau AE, Kiss B, Stefan MG, Loghin F. Antibiotics in the environment: causes and consequences. Med Pharm Rep, 93, 231-240 (2020)
Sarkar S, Souza MJ, Martin-Jimenez T, Abouelkhair MA, Kania SA, Okafor CC. Tetracycline, sulfonamide, and erythromycin residues in beef, eggs, and honey sold as 'antibiotic-free' products in East Tennessee (USA) farmers' markets. Vet Sci, 10, 243 (2023)
Sharma C, Rokana N, Chandra M, Singh BP, Gulhane RD, Gill JPS, Ray P, Puniya AK, Panwar H. Antimicrobial resistance: Its surveillance, impact, and alternative management strategies in dairy animals. Front Vet Sci, 4, 237 (2018)
WHO. WHO List of Medically Important Antimicrobials: A Risk Management Tool for Mitigating Antimicrobial Resistance Due to Non-Human Use. WHO, Geneva, Switzerland, p 6-26 (2024)
Yang Y, Qiu W, Liu L. Antibiotic residues in poultry food in Fujian province of China. Food Addit Contam Part B Surveill, 13, 177-184 (2020)