E-ISSN: 1115 – 8492 P-ISSN: 3027 – 0693
MPRI-JNSAR
INTERNATIONAL JOURNAL OF NATURE AND SCIENCE ADVANCE RES.
VOL. 14 NO. 9 OCTOBER-2026

PRESUMPTIVE ANTIMICROBIAL ACTIVITY IN TABLE EGGS: A SCREENING STUDY

YARO, S. S.[1, 2]; DURU, S. C.[3]; MOHAMMED, A.[1, 2]; NUHU, S. H.[1, 2]; ABUBAKAR A.[2]; & GARBA H. M.[2]

[1]TETFund Centre of Excellence for Integrated Farming System, Federal Polytechnic Bauchi, Bauchi State, Nigeria. [2]Department of Animal Health and Production, Federal Polytechnic Bauchi, Bauchi State, Nigeria. [3]Department of Animal Production Technology, Federal College of Animal Health and Production Technology, Vom, Nigeria.
Corresponding Author: ysallausaidu@fptb.edu.ng
DOI: https://doi.org/10.70382/mejnsar.v14i9.0113

Abstract

Antimicrobial residues in foods of animal origin are a food-safety concern, particularly when veterinary medicines are used inappropriately or recommended withdrawal periods are not observed. This study investigated presumptive antimicrobial activity in the shell, albumen, and yolk of table eggs obtained from selected locations in Toro Local Government Area, Bauchi State, Nigeria. A laboratory-based screening study was conducted on 80 eggs collected from four locations: Mara, Wonu, Zalau, and Geji, with 20 eggs allocated to each location. The samples were examined using an agar-well diffusion assay with *Staphylococcus aureus* as the indicator organism. Frequencies and percentages were used to summarise screening positivity, and the association between sampling location and egg-level screening status was assessed using Pearson's chi-square test. Overall, 32 of the 80 eggs (40.0%) were classified as positive for presumptive antimicrobial activity. At the component level, positive results were recorded in 19 albumen samples (23.8%) and 13 yolk samples (16.3%), whereas no shell samples tested positive. Location-specific screening positivity was 35.0% in Mara and Wonu and 45.0% in Zalau and Geji. The comparison among sampling locations showed no statistically significant association between sampling location and egg-level screening status (χ^2 = 0.83, df = 3, p = .842). These findings indicate the occurrence of presumptive antimicrobial activity in a

Keywords:
antimicrobial screening, table eggs, egg components, agar-well diffusion, *Staphylococcus aureus*

EDITOR-IN-CHIEF
Prof. E. Mclenna [Australia]

proportion of the sampled table eggs. However, the screening method did not identify or quantify individual antimicrobial compounds. Confirmatory chemical analysis is therefore necessary to establish the identity and concentrations of any residues present and to assess compliance with applicable regulatory limits.

Introduction

Antimicrobial agents are widely used in poultry production for the treatment and, where appropriate, prevention of bacterial infections. Their use can contribute to flock health and productivity when guided by veterinary oversight and responsible administration. However, inappropriate dosing, unsupervised medication, and failure to observe recommended withdrawal periods may result in antimicrobial residues in foods of animal origin, including eggs (Donoghue, 2003; Kan & Petz, 2000). These residues may consist of the parent drug, its metabolites, or related compounds remaining in edible animal products following treatment. The Codex Alimentarius Commission recognises veterinary drug residues as a food-safety and regulatory concern and defines maximum residue limits (MRLs) for relevant substances in foods (Codex Alimentarius Commission, n.d.).

Table eggs are an important source of high-quality protein and essential nutrients and are consumed widely across different population groups. Ensuring their safety is therefore important for public health and food security. The presence and distribution of veterinary drug residues in eggs depend on several factors, including the antimicrobial compound administered, dosage, route and duration of administration, the time elapsed after treatment, and the physiological processes involved in egg formation. Because the yolk and albumen develop through different biological processes, some veterinary drugs may be distributed differently between these components. Kan and Petz (2000) examined the distribution of veterinary drug residues between egg yolk and white, demonstrating the importance of considering individual egg components when investigating residue occurrence. Donoghue (2003) likewise reviewed issues concerning antimicrobial residues in poultry tissues and eggs, including the relevance of drug disposition and appropriate monitoring.

The public-health relevance of antimicrobial use in food-producing animals also extends to antimicrobial resistance (AMR). The use and misuse of antimicrobials can create selective pressure that favours resistant microorganisms, potentially compromising the effectiveness of medicines used in human and veterinary medicine. This concern is particularly relevant where antimicrobial agents are administered without adequate professional guidance or where appropriate disease-prevention and medication-management practices are lacking. In a study of smallholder poultry production in Nigeria, Bamidele et al. (2022) documented antimicrobial use among poultry farmers and highlighted concerns about the use of medically important antibiotics and the potential implications for AMR. The World Health Organization (WHO, 2017) consequently recommended restricting routine use of medically important antimicrobials for growth promotion and disease prevention in healthy food-producing animals. These concerns support responsible antimicrobial

EDITOR-IN-CHIEF
Prof. E. Mclenna [Australia]

use, adherence to veterinary instructions and withdrawal periods, and appropriate surveillance of animal-derived foods.

Evidence from Nigeria indicates that antimicrobial residues in table eggs warrant continued investigation. Ezenduka et al. (2011) investigated antimicrobial residues in raw table eggs obtained from poultry farms and retail outlets in Enugu State, reporting screening-positive findings in samples from both production and retail settings. Mbodi et al. (2014) investigated chloramphenicol residues in commercial chicken eggs in the Federal Capital Territory, Nigeria, demonstrating the relevance of compound-specific residue analysis in the local context. Olatoye et al. (2019) also examined antimicrobial use in poultry production and gentamicin residues in commercial eggs from Oyo and Lagos States. Together, these studies show that antimicrobial residue investigations have been undertaken in different parts of Nigeria, while also illustrating the value of research that considers specific locations, sampling approaches, and analytical methods.

The reliability of residue surveillance depends partly on the analytical method used. Microbiological inhibition methods are commonly employed as screening approaches because they can indicate the presence of biologically active substances capable of inhibiting a susceptible test organism. Wu et al. (2021), for example, developed a microbiological inhibition-based method for screening antibiotic residues in milk, chicken eggs, and honey. Their study illustrates the potential application of microbiological approaches to animal-derived foods, although the performance and interpretive capabilities of a particular method depend on its design and validation. In a simpler inhibition assay, the appearance of a zone of inhibition indicates bacterial growth inhibition under the test conditions; it does not, by itself, establish the chemical identity or concentration of the substance responsible. Accordingly, results obtained using agar well diffusion should be described as screening-positive findings or evidence of presumptive antimicrobial activity unless supported by suitable confirmatory analysis. Where the objective is to identify and quantify particular veterinary drugs or assess compliance with an established MRL, appropriately validated, compound-specific analytical methods are required.

The distinction between egg-component results and overall egg-level positivity is also important when reporting findings. The shell, albumen, and yolk are different sample matrices, and results from each component can provide complementary information about the distribution of detectable antimicrobial activity. However, the number of positive components must not automatically be equated with the number of positive eggs, because more than one component may originate from the same egg. Overall egg-level positivity should therefore be calculated using the individual egg records, while component-level findings should be reported separately with clearly defined denominators. In addition, screening positivity should not be interpreted as proof that a specific antimicrobial drug is present, that its concentration exceeds an MRL, or that a regulatory violation has occurred. Such conclusions require evidence appropriate to the particular claim.

Therefore, this study aimed to investigate presumptive antimicrobial activity in the shell, albumen, and yolk of table eggs obtained from selected locations in Toro Local Government Area, Bauchi State, Nigeria. Specifically, the study screened samples from the three egg components using an

EDITOR-IN-CHIEF
Prof. E. Mclenna [Australia]

agar-well diffusion assay, determined the proportion of examined samples classified as screening-positive in each component, and described the distribution of screening-positive eggs across the four sampled locations.

Study Design and Study Area

A laboratory-based screening study was conducted to investigate presumptive antimicrobial activity in table eggs obtained from four locations in Toro Local Government Area, Bauchi State, Nigeria: Mara, Wonu, Zalau, and Geji. A total of 80 eggs were examined, with 20 eggs allocated to each location. The study investigated three egg components: shell, albumen, and yolk. An agar-well diffusion assay using *Staphylococcus aureus* as the indicator organism was employed to screen the samples for inhibitory activity.

Sample Collection and Preparation

The 80 table eggs were assigned unique identification codes to maintain traceability between individual eggs and their corresponding component samples. The albumen was separated from the yolk and collected in sterile containers, while the yolk was collected after opening its surrounding membrane with a sterile pipette. The albumen was gently homogenised before extraction, as described in the original project report.

Eggshell Preparation

The shells were carefully broken, washed thoroughly with sterile distilled water to remove residual internal contents, air-dried in a laminar flow hood, and ground into a fine powder using a sterile mortar and pestle. A suspension of this powder was made by dissolving in a fixed volume of normal saline.

Preparation of the Indicator Organism

Staphylococcus aureus was used as the indicator organism for the screening assay. According to the original project report, identification involved culture on mannitol salt agar, Gram staining, and biochemical tests, including catalase and coagulase tests. The organism was cultured in nutrient broth, and the bacterial suspension was prepared in sterile normal saline. Its turbidity was adjusted against a 0.5 McFarland standard, corresponding approximately to \(1.5 \times 10^8\) colony-forming units per millilitre under conventional conditions.

Agar-Well Diffusion Assay

The screening assay was performed using Mueller–Hinton agar seeded with the standardised *S. aureus* suspension. The prepared agar was sterilised, cooled, and poured into sterile Petri dishes. The bacterial suspension was spread over the agar surface to establish a uniform bacterial lawn. Wells measuring approximately 6–8 mm in diameter were made using a sterile cork borer, and the prepared egg-component extracts were introduced into separately labelled wells.

EDITOR-IN-CHIEF
Prof. E. Mclenna [Australia]

A standard antibiotic preparation and the extraction solvent were reportedly used as positive and negative controls, respectively. The plates were allowed to stand at room temperature for approximately one hour to facilitate diffusion and were subsequently incubated at 37°C for 24 hours. After incubation, the plates were examined for visible zones of inhibition, which were measured using a digital Vernier caliper, as reported in the project materials.

Data Analysis

The results were organised according to sampling location, egg identification code, and egg component. Frequencies and percentages were used to summarise the screening findings. Positivity percentages were calculated by dividing the number of positive samples by the total number examined and multiplying by 100.

Component-level results were reported separately for the shell, albumen, and yolk. Overall egg-level positivity was calculated using the number of distinct positive eggs among the 80 eggs examined. Each egg was counted only once in the overall total, even if more than one component from the same egg tested positive. Location-specific egg-level positivity was calculated using the number of distinct positive eggs at each location divided by the 20 eggs examined there, multiplied by 100. The findings were interpreted as presumptive antimicrobial activity rather than definitive identification or quantification of specific antimicrobial residues.

Screening Positivity by Egg Component

Of the 80 table eggs examined, 32 were classified as positive for presumptive antimicrobial activity, giving an overall egg-level screening positivity of 40.0%. At the component level, 19 eggs (23.8%) had positive albumen results, while 13 (16.3%) had positive yolk results. No shell samples (0.0%) were reported as positive (Table 1).

Table 1. Screening positivity for presumptive antimicrobial activity by egg component (n = 80)

Egg component	Number positive	Percentage (%)
Shell	0	0.0
Albumen	19	23.8
Yolk	13	16.3
Overall distinct positive eggs	32	40.0

Note. Percentages for individual components were calculated using 80 eggs as the denominator. The overall total represents 32 distinct positive eggs, not the sum of positive component observations.

The findings indicate that presumptive antimicrobial activity was detected in the internal egg components, whereas no positive results were reported for the shell samples. The difference in the observed component-level positivity percentages is descriptive; a statistically valid comparison requires analysis that accounts for the paired nature of the three components from each egg.

Screening Positivity by Sampling Location

EDITOR-IN-CHIEF
Prof. E. Mclenna [Australia]

The highest observed screening positivity was recorded in Zalau and Geji, where 9 of 20 eggs (45.0%) were positive at each location. Mara and Wonu each had 7 positive eggs out of 20 examined (35.0%). Overall, 32 of the 80 eggs examined across the four locations were classified as positive (40.0%) (Table 2).

The Pearson chi-square test showed no statistically significant association between sampling location and egg-level screening status ($\chi^2 = 0.83$, df = 3, p = .842). Although Zalau and Geji recorded numerically higher screening positivity than Mara and Wonu, the observed differences were not statistically significant at the 5% significance level.

Table 2. Egg-level screening positivity by sampling location

Sampling location	Eggs examined	Positive eggs	Positivity (%)
Geji	20	9	45.0
Mara	20	7	35.0
Wonu	20	7	35.0
Zalau	20	9	45.0
Total	80	32	40.0

Note. Positivity (%) was calculated as the number of positive eggs divided by the number of eggs examined at each location, multiplied by 100.

DISCUSSION

Overall Screening Positivity and Public Health Relevance

This study found presumptive antimicrobial activity in 32 of 80 table eggs (40.0%) obtained from four locations in Toro Local Government Area, Bauchi State, using an agar-well diffusion assay. The result indicates that the tested samples produced bacterial growth inhibition under the laboratory conditions employed. However, the assay did not identify the substances responsible for the observed inhibition or quantify specific antimicrobial compounds. Therefore, the findings should not be interpreted as confirmation of particular antibiotic residues, evidence that maximum residue limits were exceeded, or proof of a demonstrated health risk to consumers.

Microbiological inhibition methods are useful for preliminary screening because they detect biological activity capable of inhibiting the growth of a test organism. Nevertheless, their performance depends on the indicator organism, assay conditions, sample preparation, and sensitivity of the method to the substances present. Wu et al. (2021), for example, developed a microbiological inhibition-based method for screening and further characterising antibiotic residues in eggs and other animal-derived foods, using additional confirmatory procedures to improve compound classification. Their work illustrates the distinction between preliminary inhibition-based screening and confirmatory residue analysis.

The 40.0% screening positivity observed in the present study warrants further investigation, particularly because the samples were obtained from locations where eggs were available for consumption. However, the results alone do not establish the prevalence of confirmed antimicrobial residues across all eggs produced or marketed in Toro LGA. The sample comprised

EDITOR-IN-CHIEF
Prof. E. Mclenna [Australia]

80 eggs from four selected locations, and the extent to which these eggs represent the wider egg supply is uncertain.

Distribution of Screening Positivity Among Egg Components

The component-level findings showed that albumen had the highest observed screening positivity (19/80; 23.8%), followed by yolk (13/80; 16.3%), while no shell samples tested positive. This pattern suggests that presumptive antimicrobial activity was more frequently detected in the internal components than in the shell samples under the procedures used.

Differences in the distribution of veterinary drug residues between egg components may occur because substances differ in their physicochemical properties, including their solubility, ionisation, protein binding, and affinity for lipid-containing tissues. The processes through which albumen and yolk develop also differ, potentially influencing the distribution of substances between these components. However, the present study did not identify the compounds responsible for the observed inhibition; consequently, these mechanisms should be treated as possible explanations rather than demonstrated causes of the observed pattern.

The absence of positive shell results should likewise be interpreted cautiously. It means that no shell samples met the study's screening criterion under the assay conditions used; it does not demonstrate that the shells were free of all antimicrobial substances. Recovery may vary with the sample preparation method, and the shell procedure must be clearly specified to allow appropriate interpretation.

The observed difference between albumen and yolk positivity is descriptive. Since the three components originated from the same eggs, they constitute related observations rather than independent groups. A comparison of the proportions should therefore use an appropriate paired-data method, such as Cochran's Q test for three related binary outcomes, followed where justified by suitable paired comparisons.

Variation in Screening Positivity Across Sampling Locations

The highest observed screening positivity was recorded in Zalau and Geji (45.0% each), compared with 35.0% in Mara and Wonu. This represents an absolute difference of 10 percentage points between the highest and lowest observed location-specific percentages. However, the Pearson chi-square test did not show a statistically significant association between sampling location and egg-level screening status ($\chi^2 = 0.83$, $df = 3$, $p = .842$).

The absence of statistical significance does not establish that screening positivity was identical across the four locations. Rather, the analysis did not provide sufficient evidence of an association between sampling location and screening status at the 5% significance level. Because only 20 eggs were examined per location, the ability to detect smaller differences may have been limited. The observed variation should therefore be interpreted as descriptive and not as evidence that location influenced screening positivity.

EDITOR-IN-CHIEF
Prof. E. Mclenna [Australia]

Potential explanations for differences in screening positivity include variation in poultry management, veterinary drug use, adherence to recommended withdrawal periods, egg sourcing, and supply-chain practices. However, these factors were not directly assessed in the reported study. They should not be presented as established explanations for the differences between the four locations.

The findings support further investigation of egg production and distribution practices in Toro LGA. Larger studies incorporating information about egg sources, flock management, veterinary drug use, and sampling periods would help determine whether the observed numerical differences reflect consistent patterns.

Implications for Food Safety and Confirmatory Testing

The detection of presumptive antimicrobial activity in market-available eggs raises a food-safety question that merits further investigation. Veterinary antimicrobial residues in foods of animal origin are monitored because compliance with authorised use conditions and withdrawal periods is important for ensuring that residues remain within applicable regulatory limits. The World Organisation for Animal Health emphasises the importance of appropriate veterinary antimicrobial use and observance of withdrawal periods for food-producing animals (World Organisation for Animal Health, 2024).

However, the current findings do not demonstrate that consumers were exposed to unsafe concentrations of particular antibiotics. No individual antimicrobial compounds were identified, and no residue concentrations were quantified. Similarly, the study did not measure allergic reactions, toxicity, changes in intestinal microbiota, or antimicrobial resistance among consumers. Such effects should therefore not be claimed as outcomes of this investigation.

Confirmatory analysis using a validated method, such as high-performance liquid chromatography or liquid chromatography–tandem mass spectrometry, would help identify and quantify the compounds responsible for positive screening results. Wu et al. (2021) demonstrated the value of combining microbiological screening with chemical confirmation to improve the characterisation of antibiotic residues in animal-derived foods.

The findings consequently support further surveillance and confirmatory testing rather than an immediate conclusion that the sampled eggs violated residue regulations. They also highlight the importance of documenting veterinary drug use and observing recommended withdrawal periods in laying hens.

Conclusion

The study detected presumptive antimicrobial activity in 32 of 80 table eggs (40.0%) obtained from Mara, Wonu, Zalau, and Geji in Toro Local Government Area, Bauchi State, Nigeria. Screening positivity was highest in albumen (19/80; 23.8%), followed by yolk (13/80; 16.3%), while no shell samples tested positive. Zalau and Geji each recorded 45.0% screening positivity, compared with 35.0% in Mara and Wonu. However, the observed differences among locations were not statistically significant ($\chi^2 = 0.83$, df = 3, $p = .842$).

EDITOR-IN-CHIEF
Prof. E. Mclenna [Australia]

These findings demonstrate the occurrence of presumptive antimicrobial activity under the laboratory conditions employed. However, the screening assay did not establish whether the observed inhibition resulted from veterinary drug residues, naturally occurring antimicrobial constituents, or other inhibitory factors. Validated confirmatory analysis is therefore necessary to identify and quantify specific antimicrobial compounds and determine whether any detected residues comply with applicable maximum residue limits. The findings should be interpreted in the context of the study's sample size, selected sampling locations, and methodological limitations.

Conflict of Interest

The authors declare that they have no competing interests that could have influenced the conduct, analysis, or reporting of this study.

Acknowledgements

The authors gratefully acknowledge the support provided by the TETFund Centre of Excellence for Integrated Farming System, Federal Polytechnic Bauchi, Bauchi State, Nigeria, towards the successful conduct of this research.

References

Bamidele, O., Amole, T. A., Oyewale, O. A., Bamidele, O. O., Yakubu, A., Ogundu, U. E., Ajayi, F. O., & Hassan, W. A. (2022). Antimicrobial usage in smallholder poultry production in Nigeria. Veterinary Medicine International, 2022, Article 7746144. https://doi.org/10.1155/2022/7746144

Codex Alimentarius Commission. (n.d.). Glossary: Residues of veterinary drugs in foods. Food and Agriculture Organization of the United Nations and World Health Organization. https://www.fao.org/fao-who-codexalimentarius/codex-texts/dbs/vetdrugs/glossary/

Donoghue, D. J. (2003). Antibiotic residues in poultry tissues and eggs: Human health concerns? Poultry Science, 82(4), 618–621.

https://doi.org/10.1093/ps/82.4.618

Ezenduka, E. V., Oboegbulem, S. I., Nwanta, J. A., & Onunkwo, J. I. (2011). Prevalence of antimicrobial residues in raw table eggs from farms and retail outlets in Enugu State, Nigeria. Tropical Animal Health and Production, 43(3), 557–559. https://doi.org/10.1007/s11250-010-9730-z

Kan, C. A., & Petz, M. (2000). Residues of veterinary drugs in eggs and their distribution between yolk and white. Journal of Agricultural and Food Chemistry, 48(12), 6397–6403. https://doi.org/10.1021/jf000145p

Mbodi, F. E., Nguku, P., Okolocha, E., & Kabir, J. (2014). Determination of chloramphenicol residues in commercial chicken eggs in the Federal Capital Territory, Abuja, Nigeria. Food Additives & Contaminants: Part A, 31(11), 1834–1839. https://doi.org/10.1080/19440049.2014.962625

Olatoye, O. I., Ojomo, T. O., & Adeseko, Y. J. (2019). Antibiotics use and gentamicin residues in commercial poultry and chicken eggs from Oyo and Lagos States, Nigeria. *Revue d'élevage et de médecine vétérinaire des pays tropicaux*, *72*(4), 161–165. https://doi.org/10.19182/remvt.31510

World Health Organization. (2017). WHO guidelines on use of medically important antimicrobials in food-producing animals.

https://www.who.int/publications/i/item/9789241550130

World Organisation for Animal Health. (2024). Terrestrial Animal Health Code: Chapter 6.10. Responsible and prudent use of antimicrobial agents in veterinarymedicine.*https://www.woah.org/fileadmin/Home/eng/Health_standards/tahc/2024/en_chapitre_antibio_use.htm*

Wu, Q., Shabbir, M. A. B., Peng, D., Yuan, Z., & Wang, Y. (2021). Microbiological inhibition-based method for screening and identifying of antibiotic residues in milk, chicken egg and honey. Food Chemistry, 363, Article 130074. https://doi.org/10.1016/j.foodchem.2021.130074

EDITOR-IN-CHIEF
Prof. E. Mclenna [Australia]