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Evaluating the Efficacy and Stability of Expired Ciprofloxacin: A Comprehensive Assessment

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Abstract
Medications that have exceeded their shelf life may degrade, become ineffective, or potentially harmful. Drug manufacturers and certain health organizations generally recommend discarding medications once the expiration date on the packaging has passed. However, it is important to note that the expiration date does not always definitively indicate that a drug has spoiled. The expiration date of antibiotics is significant as by this date the customer ensures the drug is effective, stable and safe. After this date, the active ingredient may destroy, leading to reduction in effectiveness and failure to treat infections, which can be reason for antibiotic resistance. This study aims to compare the antimicrobial activity of expired ciprofloxacin as example for antibiotics against standard bacterial strains with that of non-expired ciprofloxacin, Findings from this study could inform guidelines on the safe use of expired antibiotics. The study used several bacterial strains (*Staphylococcus aureus, Escherichia coli, Salmonella and Shigella Flexenari*) and the consistency in results across all strains supports the conclusion that expired Ciprofloxacin may still be effective. The study did not evaluate the long-term degradation kinetics of Ciprofloxacin only a single time point (expired and non-expired) was compared. In addition, a larger sample size and multiple batches of expired Ciprofloxacin would improve reliability. Further laboratory research was needed to evaluate the effectiveness of expired antibiotics, especially in countries facing medication shortages or during emergencies and patients should avoid using expired antibiotics without professional consultation, even if they appear to be effective, to reduce the risk of reduced potency or bacterial resistance. In addition, Provide clear regulatory guidance from health authorities (e.g., Ministries of Health or Food and Drug Administrations) on the safe use of certain expired medications when necessary.

Key words: Ciprofloxacin, Antibiotics, Drug Efficacy, Drug Stability, Pharmaceutical Quality

الملخص

الأدوية التي تجاوزت تاريخ صلاحيتها قد تتعرض للتحلل، مما يؤدي إلى فقدان فعاليتها أو احتمال تحولها إلى مواد ضارة. توصي شركات تصنيع الأدوية وبعض الجهات الصحية عادةً بالتخلص من الأدوية عند انتهاء تاريخ الصلاحية المدون على العبوة. ومع ذلك، من المهم الإشارة إلى أن تاريخ الصلاحية لا يعني بالضرورة أن الدواء قد أصبح غير صالح للاستخدام بشكل قاطع. وتعتبر صلاحية المضادات الحيوية ذات أهمية خاصة، إذ يضمن المستهلك حتى هذا التاريخ أن الدواء فعال ومستقر وآمن. بعد هذا التاريخ، قد يتحلل المكون الفعّال، مما يؤدي إلى انخفاض الفعالية وفشل علاج العدوى، وهو ما قد

يسهم في ظهور مقاومة للمضادات الحيوية. تهدف هذه الدراسة إلى مقارنة النشاط المضاد للميكروبات لدواء سيبروفلوكساسين **Ciprofloxacin** منتهي الصلاحية كمثال على المضادات الحيوية ضد سلالات بكتيرية معيارية، مع النشاط المضاد للسيبروفلوكساسين **Ciprofloxacin** غير منتهي الصلاحية. يمكن أن تسهم نتائج هذه الدراسة في وضع إرشادات حول الاستخدام الآمن للمضادات الحيوية منتهية الصلاحية. استخدمت الدراسة عدة سلالات بكتيرية (*Staphylococcus aureus, Escherichia coli, Salmonella and Shigella Flexenari*)، وأظهر التناسق في النتائج عبر جميع السلالات أن السيبروفلوكساسين منتهي الصلاحية قد يظل فعالاً. ومع ذلك، لم تقيّم الدراسة ديناميكية تحلل السيبروفلوكساسين على المدى الطويل، بل قارنت فقط بين نقطتين زمنيتين (منتهي الصلاحية وغير منتهي الصلاحية). كما أن زيادة حجم العينة واستخدام دفعات متعددة من السيبروفلوكساسين منتهي الصلاحية من شأنه أن يعزز موثوقية النتائج. هناك حاجة إلى مزيد من الأبحاث المخبرية لتقييم فعالية المضادات الحيوية منتهية الصلاحية، خاصةً في البلدان التي تعاني من نقص الأدوية أو خلال حالات الطوارئ. وينبغي على المرضى تجنب استخدام المضادات الحيوية منتهية الصلاحية دون استشارة مختصين، حتى وإن بدت فعّالة، وذلك لتقليل مخاطر انخفاض الفعالية أو تطور مقاومة بكتيرية. بالإضافة إلى ذلك، يُوصى بتوفير إرشادات تنظيمية واضحة من الجهات الصحية المختصة (مثل وزارات الصحة أو هيئات الغذاء والدواء) بشأن الاستخدام الآمن لبعض الأدوية منتهية الصلاحية عند الضرورة.

الكلمات المفتاحية: سيبروفلوكساسين، المضادات الحيوية، فعالية الدواء، استقرار الدواء، جودة المستحضرات الصيدلانية

Introduction

Drug expiration refers to the date after which a medication may no longer be suitable for use as intended (Dowson, Michael, 1994). Consumers can identify a drug's shelf life by looking for the expiration date on its pharmaceutical packaging. Medications that have exceeded their shelf life may degrade, become ineffective or potentially harmful (Shlibak & Dalla, 2020; Shlibak et al., 2021). Drug manufacturers and certain health organizations generally recommend discarding medications once the expiration date on the packaging has passed. However, it is important to note that the expiration date does not always definitively indicate that a drug has spoiled. Consumers and organizations occasionally use expired medications for treatment, either to save costs or due to limited access to unexpired drugs. Medical authorities face challenges in advising on the safe use of drugs beyond their printed expiration dates, as clear information is often scarce. Expiration dates on drug labels represent the manufacturer's guarantee of full efficacy and safety up to that point, but they do not necessarily indicate when a drug becomes ineffective or unsafe. Many medications remain effective for years after their expiration dates, though it is difficult for researchers, physicians, and others to determine the extent to which a drug's efficacy diminishes or its safety declines over time. The American Medical Association has raised concerns that expiration dates may significantly underestimate the actual shelf life of drugs. The Shelf Life Extension Program (SLEP), managed by the FDA for the U.S. Department of Defense over 20 years, has provided extensive data on this issue. SLEP is likely the most comprehensive source of pharmaceutical stability data available. A report summarizing extended stability profiles for 122 drug products (3,005 lots) found that 88% of the lots were extended at least one year beyond their original expiration dates, with an average extension of 66 months (American Medical, 2001). However, the additional stability period varied widely. SLEP data supports the idea that many drugs, if stored properly, can remain effective past their expiration dates. Due to variability between lots, ensuring the stability and quality of extended drugs requires periodic testing and systematic evaluation of each lot. (Regenthal R, *et al*. 2002).

The active ingredient in a medication must remain within a specific range to ensure optimal efficacy without causing toxicity. Over time, the active substance degrades, leading to a loss of effectiveness. The expiration date is determined by the time it takes for the active ingredient to fall below the recommended level for optimal efficacy, assuming proper storage conditions. (Smith, J. 2020).

Medical authorities generally agree that expired medications are safe to use, even years after their expiration dates. While a drug's effectiveness may decrease over time, much of its original potency often remains, even a decade later. Exceptions include nitroglycerin, insulin, and liquid antibiotics, which may not last as long. Storing medications in cool environments, such as a

refrigerator, can help maintain their potency for many years. (Cantrell et al., 2012 Dalla, 2020; Dalla et al., 2025; Alsharif et al., 2026). Solid dosage forms, like tablets and capsules, tend to remain stable even beyond their expiration dates. However, drugs in liquid form or as reconstituted suspensions, particularly those requiring refrigeration (e.g., amoxicillin suspension), may lose potency if used after expiration. This loss of effectiveness can pose significant health risks, especially when treating infections with antibiotics, as it may lead to antibiotic resistance. Injectable drugs or solutions should be discarded if they appear cloudy, discolored, or form a precipitate (Davido et al., 2024; Alapid et al., 2025; Alsharif et al., 2026). A study by Khanchandani on the efficacy, safety concerns, and disposal practices of expired medications among healthcare professionals revealed that 89.39% of participants understood that expiration dates depend on both manufacturing and storage conditions. Additionally, 91% correctly identified that drugs should ideally be stored in cool, dry, and dark environments. While most participants agreed that using expired drugs is unsafe, 89.39% were specifically aware that insulin, liquid antibiotics, and nitroglycerin should not be used past their expiration dates. A US FDA study, which tested over 100 prescription and over-the-counter drugs, found that approximately 90% of them remained safe and effective up to 15 years beyond their expiration dates. According to Loel Dawis, the expiration date chief, with a few exceptions like nitroglycerin, insulin, and liquid antibiotics, most drugs are likely as durable as those tested by the agency. (khanchandani et al., 2015).

Pharmaceutical Stability Testing: Principles and Methodologies

Pharmaceutical stability testing is a foundational component of drug development and quality assurance, designed to ensure that medicinal products maintain their identity, strength, purity, and safety throughout their intended shelf life under defined storage conditions (Kommanaboyina & Rhodes, 1999; Bajaj et al., 2012; Ben Dall et al., 2024; Soliman et al.,2026). Conducted in accordance with International Council for Harmonisation (ICH) and World Health Organization (WHO) guidelines, stability studies employ three primary methodological approaches: real-time, accelerated, and cyclic stress testing. Real-time stability evaluations monitor products under recommended long-term storage conditions over extended periods, with periodic sampling (e.g., 0, 3, 6, 12, and 24 months) to track active pharmaceutical ingredient (API) potency, degradation impurities, physicochemical attributes, and microbial limits (Anderson & Scott, 1991; Bajaj et al., 2012; Abdulla et al., 2025; Abozid et al., 2025). Accelerated stability testing subjects formulations to elevated temperature and humidity to rapidly induce degradation, enabling early shelf-life prediction, formulation screening, and reduced development timelines while minimizing inter-assay variability (Kommanaboyina & Rhodes, 1999; Anderson & Scott, 1991). Cyclic temperature stress testing, though less routinely applied to marketed products, simulates diurnal thermal fluctuations encountered during distribution and storage. Typically conducted over 24-hour cycles repeated for a minimum of 20 cycles, this method assesses product resilience under realistic market conditions, with temperature ranges selected based on product-specific degradation kinetics and labeled storage requirements (Kommanaboyina & Rhodes, 1999; Carstensen, 2000; Alshintari et al., 2025). Collectively, these methodologies provide the scientific basis for establishing expiration dates and ensuring therapeutic reliability from manufacturing to patient administration. Stability and Clinical Considerations for Fluoroquinolones and Ciprofloxacin

Among antimicrobial agents, fluoroquinolones represent a synthetically derived class of broad-spectrum bactericidal antibiotics that exert their therapeutic effect by inhibiting bacterial DNA gyrase and topoisomerase IV, thereby disrupting DNA replication and cellular division (Emmerson & Jones, 2003; Campoli et al., 1988; Alshintari et al., 2023). Ciprofloxacin, a second-generation fluoroquinolone, demonstrates potent activity against Gram-negative pathogens, including Pseudomonas aeruginosa, and retains efficacy against select Gram-positive organisms (LeBel, 1988; Rehman et al., 2019). Clinically, it is indicated for urinary

tract, respiratory, gastrointestinal, and soft-tissue infections, as well as for prophylaxis in bioterrorism-related exposures such as inhalational anthrax (Meyerhoff et al., 2004; Mohamed et al., 2020; Alshintari et al., 2023). Despite its widespread clinical utility, ciprofloxacin's stability profile is susceptible to environmental stressors, and its degradation pathways particularly hydrolysis and photolysis can influence both potency and safety over time. Additionally, ciprofloxacin acts as a moderate inhibitor of cytochrome P450 1A2, necessitating careful management of drug–drug interactions and monitoring for adverse effects, including gastrointestinal disturbances, QT interval prolongation, dysglycemia, and photosensitivity (Rudolph et al., 2021; Blondeau, 1999; Cozzani et al., 2016).

Evidence on Post-Expiration Antimicrobial Potency

The clinical validity of labeled expiration dates has been increasingly scrutinized, particularly in the context of pharmaceutical supply chain disruptions and emergency preparedness. The U.S. Food and Drug Administration's Shelf Life Extension Program (SLEP) has demonstrated that a substantial proportion of properly stored pharmaceuticals retain acceptable potency well beyond their manufacturer-assigned expiration dates (Lyon et al., 2006; Cantrell et al., 2012; Alshintari et al., 2025). Systematic evaluations indicate that approximately 88–90% of tested drug lots maintain ≥90% of labeled potency for several years post-expiration (Lyon et al., 2006; Ramachandran, 2016). Specific to fluoroquinolones, a recent investigation of 242 expired ciprofloxacin lots reported complete retention of antimicrobial efficacy, suggesting exceptional chemical stability under controlled storage conditions (Davido et al., 2024; Ramachandran, 2016). Epidemiological assessments from resource-limited settings further indicate that solid dosage forms constitute a high proportion of expired medications in circulation, yet no consistent evidence of acute toxicity has been documented when such products are appropriately stored (Tura et al., 2022; Przyswa, 2013). While regulatory agencies generally advise against routine use of expired pharmaceuticals, conditional deployment is recognized during public health emergencies or supply shortages, provided stability, potency, and safety are rigorously verified. Although existing literature supports the extended stability of certain pharmaceuticals, comprehensive, standardized evaluations of expired ciprofloxacin's antimicrobial efficacy under real-world storage conditions remain limited. Given its critical role in treating multidrug-resistant infections and its frequent inclusion in national emergency stockpiles, systematic validation of post-expiration potency is both clinically and logistically imperative. This study aims to (1) comparatively assess the antimicrobial activity of expired versus non-expired ciprofloxacin against standardized bacterial reference strains, and (2) generate empirical data to inform regulatory frameworks and public health guidelines regarding the conditional use of expired antibiotics. By elucidating the stability efficacy relationship of ciprofloxacin beyond its labeled shelf life, this research seeks to optimize pharmaceutical resource utilization, enhance emergency preparedness, and provide evidence-based recommendations for the safe deployment of stockpiled antimicrobials during crises.

2.Materials and Methods

Before going to lab work to determine the effectiveness of both samples against bacterial growth, a question form was designed to explore the awareness of general people towards the expired drugs and what they think about using the expired drugs, this question form contain a number of questions that were answered by a random sample of people (101 participants). The social media and direct contacting were used to collect the answers from (9-5-2025) to (26-5-2025). The results of this question form are presented in result.

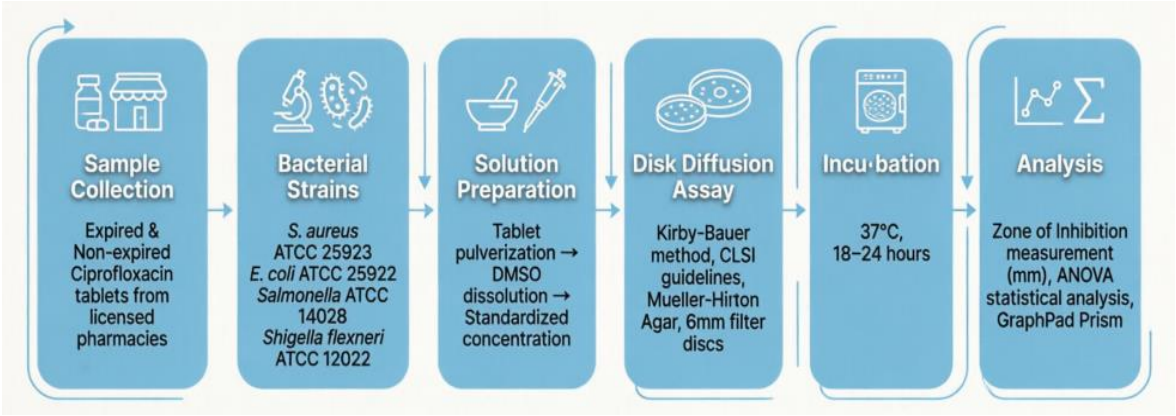

Figure 1. The research methodology

Figure 1 illustrates the comprehensive research methodology employed to evaluate the antibacterial efficacy of expired versus non-expired ciprofloxacin. The experimental workflow encompasses six sequential stages, sample collection from licensed pharmacies, utilization of four standardized bacterial strains (S. aureus ATCC 25923, E. coli ATCC 25922, Salmonella ATCC 14028, and Shigella flexneri ATCC 12022), solution preparation through tablet pulverization and DMSO dissolution, Kirby-Bauer disk diffusion assay on Mueller-Hinton Agar, incubation at 37°C for 18-24 hours, and final analysis through zone of inhibition measurement followed by ANOVA statistical analysis using GraphPad Prism software. This systematic approach ensures standardized evaluation of antimicrobial activity in accordance with Clinical and Laboratory Standards Institute (CLSI) guidelines.

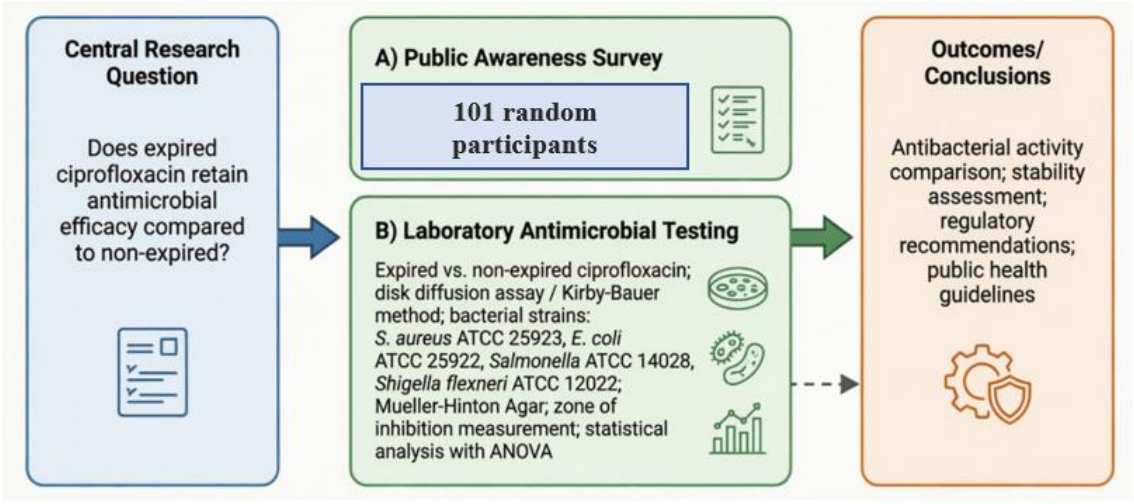

Figure 2. The research conceptual diagram

Figure 2 above illustrates the dual-methodology approach employed to evaluate expired ciprofloxacin efficacy, combining a public awareness survey of 216 participants to assess knowledge, disposal practices, and information sources with comprehensive laboratory antimicrobial testing. The experimental component utilizes the Kirby-Bauer disk diffusion method to compare zones of inhibition between expired and non-expired ciprofloxacin against four standardized bacterial strains (S. aureus ATCC 25923, E. coli ATCC 25922, Salmonella ATCC 14028, and Shigella flexneri ATCC 12022) on Mueller-Hinton Agar, with statistical analysis performed using ANOVA. The integrated findings from both components inform evidence-based conclusions regarding antibacterial activity comparison, drug stability assessment, and provide the foundation for regulatory recommendations and public health guidelines on the conditional use of expired antibiotics.

2.1 Test Samples, Chemicals, and Reagents

Commercial ciprofloxacin tablets (expired and within labeled shelf-life) were obtained from licensed pharmacies and stored under controlled ambient conditions until analysis. High-performance liquid chromatography (HPLC)-grade methanol, acetonitrile, and ultrapure water were utilized for sample processing. Dimethyl sulfoxide (DMSO; analytical grade) served as the solvent for antibiotic disc preparation. All reagents were verified for purity and stored according to manufacturer specifications.

2.2. Bacterial Strains and Culture Media

Reference bacterial strains were procured from authenticated culture collections:
Staphylococcus aureus (ATCC 25923)
Escherichia coli (ATCC 25922)
Salmonella enterica subsp. *enterica* (ATCC 14028)
Shigella flexneri (ATCC 12022)
Cultures were maintained on Mueller-Hinton Agar (MHA) and propagated in Nutrient Broth. Prior to susceptibility testing, inoculum density was standardized to a 0.5 McFarland turbidity standard (~$1–2 \times 10^8$ CFU/mL). All culture media and glassware were sterilized by autoclaving at 121°C for 15 minutes.

2.3. Preparation of Antibiotic Test Solutions

Expired and non-expired ciprofloxacin tablets were finely pulverized and accurately weighed using an analytical balance. The powdered material was dissolved in DMSO to achieve a standardized concentration suitable for disk diffusion testing. Solutions were vortexed, filtered if necessary, and stored at 4°C until use to prevent degradation.

2.4. Antimicrobial Susceptibility Testing (Disk Diffusion Assay)

In vitro antibacterial activity was evaluated using the Kirby-Bauer disk diffusion method in accordance with Clinical and Laboratory Standards Institute (CLSI) guidelines. MHA plates were uniformly inoculated with standardized bacterial suspensions using sterile cotton swabs. Sterile 6-mm filter paper discs were impregnated with aliquots of the expired and non-expired ciprofloxacin test solutions in DMSO. DMSO-only discs served as negative controls. Discs were aseptically placed on the surface of inoculated agar plates and gently pressed to ensure contact. Plates were incubated at 37°C for 18–24 hours. Following incubation, zones of inhibition (ZOI) were measured in millimeters using a calibrated digital caliper. All experiments were performed in independent triplicates to ensure reproducibility.

2.6. Statistical Analysis

Data are presented as mean ± standard deviation (SD). Differences in ZOI between expired and non-expired ciprofloxacin across bacterial strains were analyzed using one-way analysis of variance (ANOVA), followed by appropriate post-hoc comparisons. Statistical analyses were conducted using GraphPad Prism software (version 8.0). A p-value < 0.05 was considered statistically significant.

3. Results

3.1 Description of Study Participants

The background characteristics of the participants are summarized in Table (3.1). A total of 216 people in this study were recruited for the study, the age ranges was between (18-60 years), included 20 males and 195 females. And Most of the participants enrolled in this study were at the university level, 84,7%, while the percentage of high qualification was 9.7%

Table 1 Demographic characteristics of participants

Variable	frequency	percent
Age (18 – 25) (26 – 45) (40 – 60)	124	54.4%
	86	39.8%
	6	2.8%
Gender Male Female	20	9.3%
	195	90.7%
Education level Intermediate level University level High degree Diploma	11	5.1%
	183	84.7%
	21	9.7%
	1	0.5%

As one of the aims of this study was exploring the response of participants towards the checking of the expired date of the medicines before use.The results indicate that the vast majority of participants (71.3%) always check the expiration date of the medicine before using it, which reflects a high health awareness of the importance of this procedure in preventing health risks associated with the use of expired medicines.
On the other hand, 26.4% of participants only do this sometimes, indicating that there is a significant percentage of people who may forget or neglect this procedure occasionally. As for the small percentage who never or rarely do it,

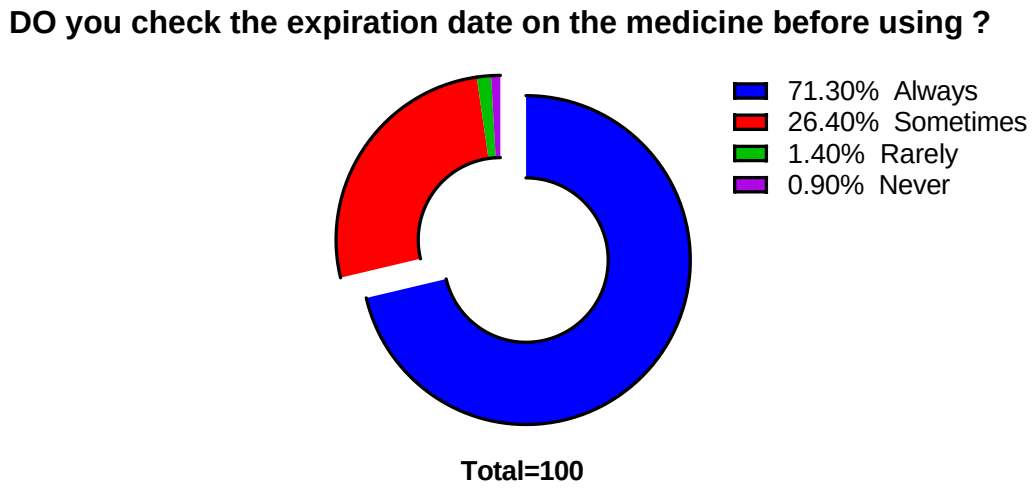

Figure 3. Answer for the question regarding checking the expiration date or not

The data showed that 38% of participants are taking expired medications becomes harmful or toxic wherease,34.7% believed that medications lose their effectiveness after their expiration date only 6% of participants believed there was no significant effect, while 21.3% were unsure of the results.

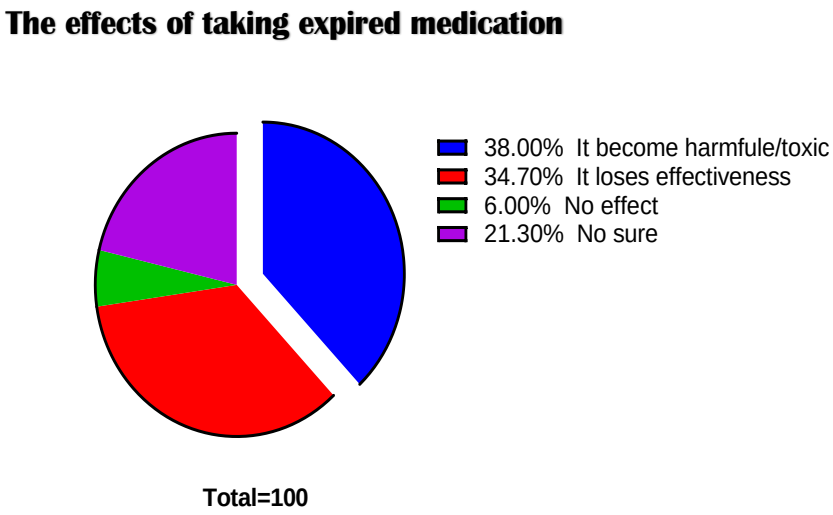

Figure 4. Report on the effects of taking expired medication.

Report on the use of expired medications

This table presents the results of a survey conducted on the use of medications past their expiration date. Data was collected from 215 individuals. 81.9% of participants indicated that they would not use medications past their expiration date, indicating a high awareness of the potential risks. 4.7% of participants expressed a willingness to use expired medications.13.5% of participants believed that the decision depends on the type of medication.

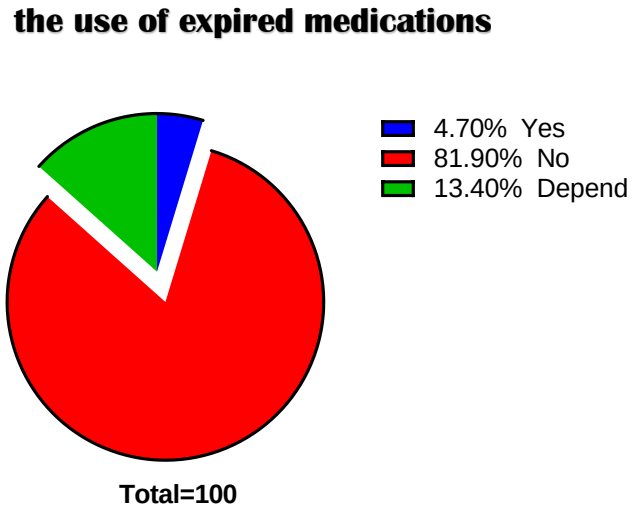

Figure 5. Report on the use of expired medications

Report on handing expired medications

This data presents the results of a survey conducted on how individuals handle expired medications.

Data was collected from 214 individuals. 90.2% of participants indicated that they throw expired medications in the trash, reflecting a common behavior.2.3% flush them down the toilet, 6.5% prefer to return them to the pharmacy, and only 0.9% continue to use them.

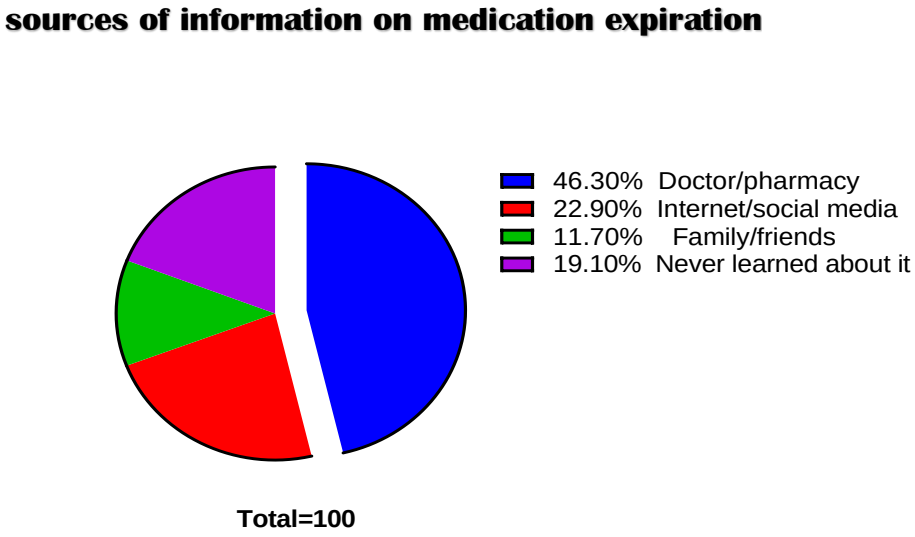

Figure 6. Handling of expired medication

Report on individuals sources of information on medication expiration

This report presents the results of a survey conducted on the information sources individuals rely on to learn about medication expiration. Data was collected from 205 individuals. The results indicate that most participants rely on doctors and pharmacists as their primary sources of information on medication expiration. while,46.3% of participants indicated that they learn about medication expiration from doctors or pharmacists, demonstrating the importance of professional guidance. on the other hand,22.9% rely on the internet and social media as a source of information, reflecting the growing influence of technology. only, 11.7% obtain information from family and friends, while 19% have not learned anything about the subject.

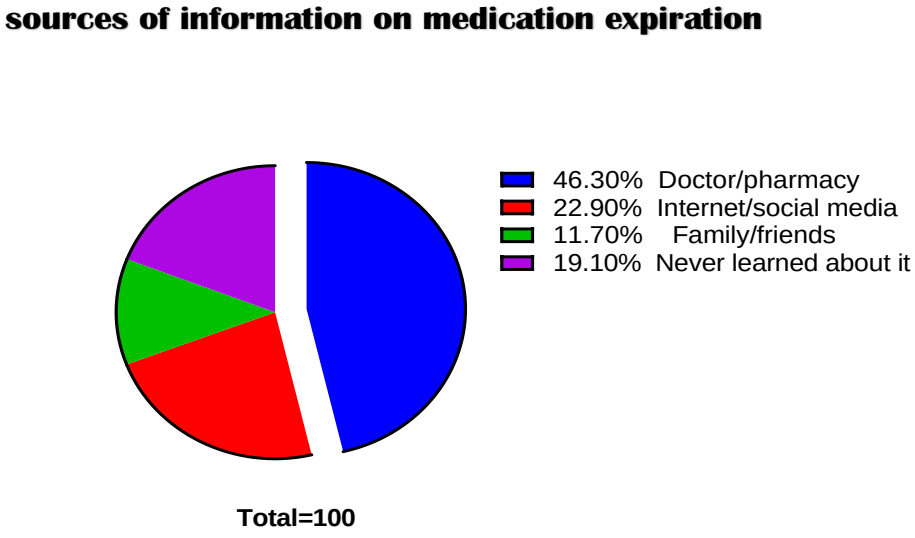

Figure 7. Report on individuals sources of information on medication expiration

Study of antibacterial activity

In order to explore the difference in effectiveness as antibiotic study of the antibacterial activity of both samples expires and non-expired Ciprofloxacin was done, the data displayed in figure

3-7 showed that there is not significant difference in the inhibition of growth for all bacterial strains used.

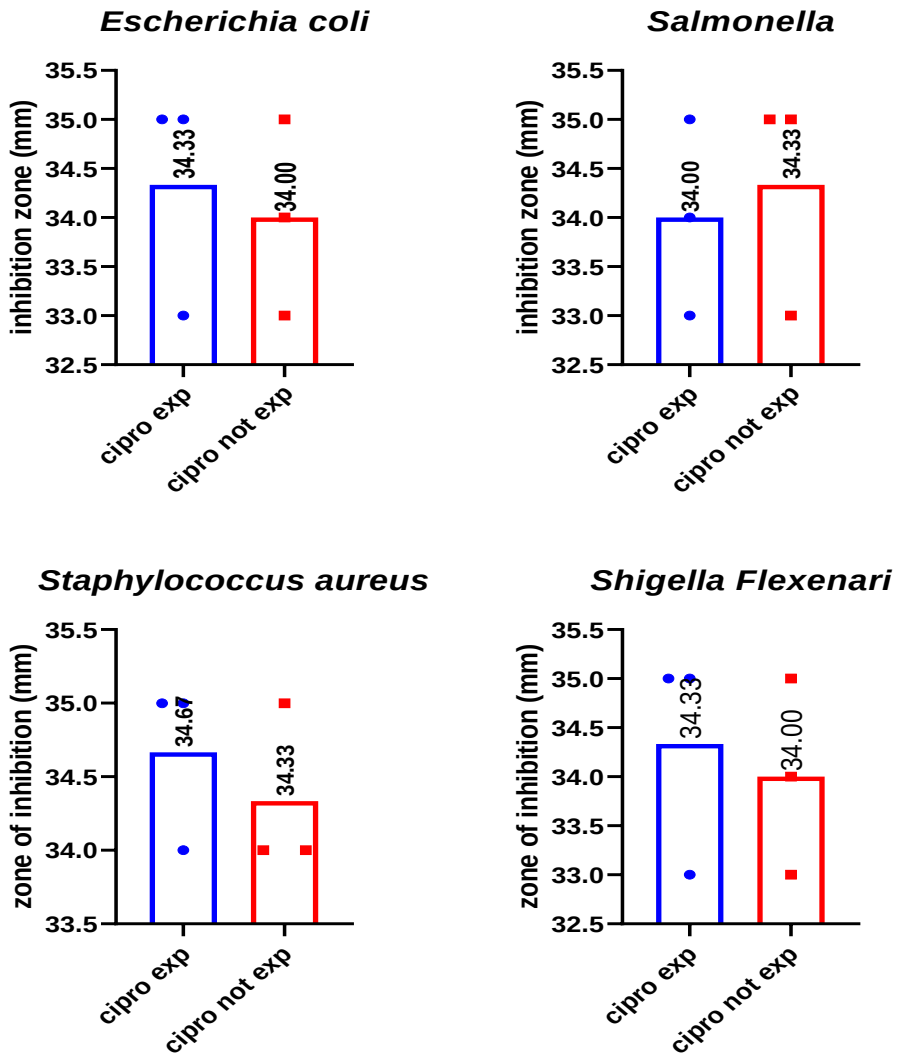

Figure 8. The antibacterial activity of Ciprofloxacin both expired and non-expired on different bacterial strains.

Discussion

This study aimed to explore the awareness and behaviors of individuals toward expired medications. The findings indicate a generally good level of health awareness among most participants. The results showed that 71.3% of participants always check the expiration date before using medication, which aligns with the findings of Patil et al. (2014), where about 68% of respondents reported checking the expiration date regularly. This indicates growing public awareness of the importance of this practice in preventing health risk. Regarding the perceived risks of using expired medications, 38% of participants believed that expired medications become harmful or toxic, while 34.7% thought that the drugs merely lose their effectiveness. These findings are consistent with Alrasheed et al. (2018), who found that participants in Saudi Arabia were generally aware that expired drugs could be ineffective or even harmful, though their understanding of the exact consequences varied. Behaviorally, 81.9% of participants in this study stated that they do not use expired medications, which is a higher percentage than

reported by Shruthi et al. (2012) in India, where only 62% avoided such use. This difference may reflect cultural factors or successful awareness campaigns at the local level. Concerning the methods of disposal, the vast majority (90.2%) of participants reported discarding expired medications in the trash similar to findings by Seehusen and Edwards (2006) in the United States, where 82% of people disposed of medications through household waste, despite environmental concerns. Only a small percentage (6.5%) in the present study returned medications to the pharmacy, which is the recommended method (Ben Dalla et al., 2025).
This points to the need for greater education on environmentally safe disposal practices and for establishing medicine take-back programs. In terms of sources of information, this study found that 46.3% of participants rely on doctors and pharmacists for information about medication expiration, followed by 22.9% who depend on the internet and social media. These results are comparable to the findings of Abahussain et al. (2006) in Bahrain, where pharmacists were the primary source of drug related information for the public. However, the fact that 19% of participants had never learned about the topic highlights a clear knowledge gap that must be addressed through more accessible and structured awareness campaigns (Dalla, 2026).
In general, the results of this study reflect a satisfactory level of awareness and responsible behavior concerning the use of expired medications. Nonetheless, certain gaps remain, particularly in disposal practices and the accessibility of reliable information. These findings emphasize the need for enhanced educational efforts and stronger public health policies to promote the safe use and disposal of medications.
In order to explore the difference in effectiveness as antibiotic study of the antibacterial activity of both samples expires and non-expired Ciprofloxacin was done, the data displayed in figure 3-7 showed that there is no significant difference in the inhibition of growth for all bacterial strains used. The absence of substantial difference suggests that Ciprofloxacin may retain its antibacterial effects even after its expiration date. This could be due to the drug's characteristic chemical stability, where degradation over time does not substantially reduce its potency. Previous studies on fluoroquinolones (the antibiotic class to which Ciprofloxacin belongs) have shown that some antibiotics remain effective beyond their labeled expiry dates when stored under proper conditions (e.g., low humidity, controlled temperature). If the expired Ciprofloxacin was stored in ideal conditions (e.g., away from moisture, light and extreme temperatures), degradation may have been insignificant. The study used several bacterial strains (*Staphylococcus aureus, Escherichia coli , Salmonella and Shigella Flexenari*) and the consistency in results across all strains supports the conclusion that expired Ciprofloxacin may still be effective. The study did not evaluate the long-term degradation kinetics of Ciprofloxacin—only a single time point (expired vs. non-expired) was compared. In addition, A larger sample size and multiple batches of expired Ciprofloxacin would improve reliability. Moreover, Nonexistence of Minimum Inhibitory Concentration (MIC) Testing as Zone inhibition assays (as implied by the figures) may not fully capture subtle differences in antibiotic potency. Some studies (e.g., Glass et al., 2016, JAMA) have found that certain antibiotics remain effective decades after expiration, while others lose potency. The results of the study was in agreement with, a review (Davido, B ,*et al*. 2024) found that 242 lots of expired ciprofloxacin tablets retained 100% of their active substance when stored correctly, with no significant degradation in antibacterial efficacy for up to 55 months post-expiration. Another study (Getahun, H, *et al*. 2024) showed that Expired ciprofloxacin tablets (500 mg) collected from hospitals passed pharmacopeia standards for identity and assay (100% compliance),

Conclusion

This study examined both public awareness and scientific evaluation concerning the use of expired ciprofloxacin. Survey results revealed a generally high level of health awareness, with most participants routinely checking expiration dates and avoiding the use of expired medications. However, improper disposal practices such as throwing medications in household

trash were common, highlighting a need for better public education on environmental safety**.** Laboratory testing of expired versus non-expired ciprofloxacin showed no significant difference in antibacterial activity across multiple bacterial strains (e.g., *Staphylococcus aureus, E. coli, Salmonella, and Shigella*). These findings support existing literature suggesting that ciprofloxacin, particularly when stored correctly, retains its potency well beyond its expiration date. While this does not justify routine use of expired antibiotics, it provides valuable insight into the drug's stability, particularly in emergency or resource-limited situations.

Recommendation

1- Encourage further laboratory research to evaluate the effectiveness of expired antibiotics, especially in countries facing medication shortages or during emergencies.
2- Provide clear regulatory guidance from health authorities (e.g., Ministries of Health or Food and Drug Administrations) on the safe use of certain expired medications when necessary.Strengthen public awareness campaigns to highlight the differences between drug forms such as solid forms (like tablets) that may remain stable longer, versus liquid forms (like insulin or reconstituted antibiotics) which degrade more rapidly.
3- Avoid using expired antibiotics without professional consultation, even if they appear to be effective, to reduce the risk of reduced potency or bacterial resistance.

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