OPEN ACCESS

Orapuh Journal

ORIGINAL ARTICLE

Journal of Oral & Public Health

Verification of an analytical method and in vitro comparative study of the dissolution kinetics of generic amoxicillin 500 mg capsules manufactured by the local pharmaceutical industry in the Democratic Republic of the Congo

Mayangi, M. M.[1], Mbinze, K. J.[1], Mana, K. D.[1], Bayebila, M. T.[1], Ntambwe, N. M.[2], Mankulu, K. J.[1], Mbenza, P. A.[1], & Nsangu, M. J.[1]

[1]*Laboratory of Drug Analysis, Faculty of Pharmaceutical Sciences, University of Kinshasa, Kinshasa XI, Democratic Republic of the Congo*
[2]*National Laboratory of Quality Control, Congolese Pharmaceutical Regulatory Authority, Kinshasa, Democratic Republic of the Congo*

ARTICLE INFO

Received: *08 January 2026*
Accepted: *02 February 2026*
Published: *05 February 2026*

Keywords:
Drug analysis, dissolution kinetics, analytical method, amoxicillin

Peer-Review: *Externally peer-reviewed*

Correspondence to:
Jocelyn Mankulu Kakumba
jocelyn.mankulu@unikin.ac.cd

To cite:
Mayangi, M. M., Mbinze, K. J., Mana, K. D., Bayebila, M. T., Ntambwe, N. M., Mankulu, K. J., Mbenza, P. A., & Nsangu, M. J. (2026). Verification of an analytical method and in vitro comparative study of the dissolution kinetics of generic amoxicillin 500 mg capsules manufactured by the local pharmaceutical industry in the Democratic Republic of the Congo. *Orapuh Journal, 7*(2), e1413 https://dx.doi.org/10.4314/orapj.v7i2.13

ISSN: *2644-3740*

Published by Orapuh, Inc. (info@orapuh.org)

Editor-in-Chief: Prof. V. E. Adamu
Orapuh, F. Gaye R., Sukuta, Greater Banjul, The Gambia, editor@orapuh.org.

ABSTRACT

Introduction
Strengthening the local pharmaceutical industry in the Democratic Republic of the Congo to produce affordable, effective, and high-quality medicines contributes to improved health outcomes and economic development. The government grants a monopoly to local manufacturers for the production of certain generic medicines, such as amoxicillin. These products are required to meet established quality, safety, and efficacy standards to adequately address population health needs.

Purpose
The objective of this study was to evaluate the interchangeability of different brands of amoxicillin produced by local manufacturers in the Democratic Republic of the Congo with a reference (innovator) product through comparative in vitro dissolution testing.

Methods
Two generic products manufactured by local pharmaceutical companies and one innovator product were evaluated. For each product, one batch was randomly purchased from authorised wholesalers. Analyses were conducted using high-performance liquid chromatography in accordance with the United States Pharmacopeia–National Formulary (USP–NF, 2024). Twelve dosage units were analysed to establish dissolution profiles. Comparative dissolution testing was performed at different pH conditions (1.2, 4.5, and 6.8) using a paddle-type dissolution apparatus. Quantification was carried out by UV spectrophotometry, and dissolution profiles were compared using the difference factor (f_1) and similarity factor (f_2). Acceptable ranges were 0–15 for f_1 and 50–100 for f_2.

Results
All samples complied with the USP–NF 2024 specifications. However, dissolution recovery rates differed across sampling points. The fit factor analysis demonstrated interchangeability with the reference product only at pH 1.2, while no similarity was observed at pH 4.5 and 6.8.

Conclusion
The findings indicate potential concerns regarding the efficacy and interchangeability of locally manufactured generic amoxicillin products compared with the innovator product. Manufacturers should re-evaluate their formulations, considering all factors influencing dissolution performance. In addition, regulatory authorities should strengthen post-marketing surveillance to ensure the quality of pharmaceutical products.

INTRODUCTION

The COVID-19 health crisis demonstrated the critical need for the African region to reassess its dependence on global supply chains for medical products (World Health Organization [WHO], 2024). Health emergencies, disease outbreaks, and conflict situations have further highlighted the importance of African leaders prioritising the establishment and expansion of local pharmaceutical production at both national and regional levels. This approach reduces the risk of supply chain disruptions and brings production closer to end users (World Health Assembly [WHA], 2021).

The success of local pharmaceutical production is closely linked to the manufacture of high-quality, safe, and effective medicines. However, the marketing of locally produced medicines in Africa remains a major challenge, largely due to the high prevalence of substandard and falsified products. Between 2013 and 2017, such products accounted for 42% of WHO alerts, contributing to numerous preventable deaths (VillageReach, 2024).

Medicines are not ordinary consumer goods, as they directly affect human survival. They therefore require strict guarantees of quality, safety, and efficacy, ensured through rigorous compliance with pharmaceutical regulations across the entire supply chain, including production, distribution, and dispensing. Regulatory frameworks mandate quality verification before marketing authorisation is granted (Planchon, 2021).

The use of substandard medicines poses serious risks to consumers and results in significant economic losses for both manufacturers and national economies. The consequences of falsified medicines are particularly severe, as they directly compromise patient health and safety (Bakker-'t Hart et al., 2021; Vogler et al., 2021).

In the Democratic Republic of the Congo (DRC), Ministerial Decree No. 1250/CAB/MIN/SPHP/010/CJ/OBK/2024 of 6 May 2024 renewed the temporary suspension of imports of certain medicines for a period of 36 months across the national territory (Government of the Democratic Republic of the Congo, 2024). This decree grants a monopoly for the manufacture of selected generic medicines to the local pharmaceutical industry. Among these medicines is amoxicillin, a widely used antibiotic that is frequently consumed in its low-cost generic form, both through self-medication and by prescription. As such, it must meet established quality, safety, and efficacy standards to adequately serve population health needs.

Despite this regulatory framework, cases of counterfeiting have been reported, including incidents involving Clamoxyl at the western border of the DRC in Lufu in 2023. In addition, several studies have reported increasing antimicrobial resistance, raising concerns about the quality, safety, and efficacy of amoxicillin products available on the market (Kimuntu Kim, 2023; Mbuya et al., 2020).

Amoxicillin faces not only counterfeiting challenges but also quality defects that affect its dissolution performance. A study conducted by Kalenda Tshilombo et al. (2017) as part of official and peripheral market surveillance assessed the quality of amoxicillin-based antibiotics in several major cities in the DRC, including Kinshasa, Lubumbashi, Matadi, and Kolwezi. Of the 65 samples collected from both authorised and unauthorised distributors, 40% were found to be substandard, with some samples showing an absence of active pharmaceutical ingredient. Similarly, Kassaye et al. (2013), in their evaluation of the in vitro dissolution profiles of different brands of amoxicillin capsules available on the Ethiopian market, demonstrated that most generic brands (62.5%) were not interchangeable with the innovator product.

The objective of this study is to evaluate the interchangeability of different brands of amoxicillin produced by local manufacturers in the Democratic Republic of the Congo with a reference (innovator) product through comparative in vitro dissolution testing. Given the limited availability of scientific evidence on the interchangeability of locally manufactured immediate-release products, this study represents one of the first investigations in the country to examine the comparative dissolution characteristics of locally produced amoxicillin and to assess its interchangeability with the innovator product.

METHODS

Equipment

Dissolution testing was performed using an Agilent 708-DS dissolution testing system (Waldbronn, Germany). Qualitative and quantitative analyses were carried out using an Agilent Infinity II high-performance liquid chromatography (HPLC) system (Waldbronn, Germany). Additional equipment included a Mettler Toledo analytical balance and microbalance (Greifensee, Switzerland), a Metrohm pH meter (Herisau, Switzerland), a Cary 60 UV–Visible spectrophotometer (Waldbronn, Germany), and Chromafil Xtra 0.45 µm syringe filters (Düren, Germany).

https://dx.doi.org/10.4314/orapj.v7i2.13

The chromatographic conditions were set in accordance with the United States Pharmacopeia–National Formulary (USP–NF, 2024) as follows:

a. **LC mode:** UV detection at 230 nm
b. **Column:** 4 mm × 25 cm, 10 µm, L1
c. **Flow rate:** 1.5 mL/min
d. **Injection volume:** 10 µL
e. **Buffer:** Potassium dihydrogen phosphate (6.8 g/L) dissolved in water and adjusted to pH 5.0 ± 0.1 using potassium hydroxide TS
f. **Mobile phase:** Acetonitrile and buffer in a ratio of 1:24

Chemicals and Reagents

HPLC-grade acetonitrile, hydrochloric acid (37%), sodium acetate powder, potassium dihydrogen phosphate, and sodium hydroxide pellets were obtained from Merck (USA). Monobasic potassium phosphate was sourced from Jeongwang (South Korea). Potassium hydroxide (45%) was obtained from VWR (Belgium), and anhydrous acetic acid (99.5%) was purchased from Sigma-Aldrich (USA). Amoxicillin reference standard (RS; Lot R106H0, 869 µg/mg) was supplied by the United States Pharmacopeia (USP, Spain).

Sampling

During the study period, approximately twenty pharmaceutical manufacturing laboratories were identified in the Democratic Republic of the Congo (DRC). Of these, only two were found to be producing amoxicillin 500 mg capsules, both located in the city of Kinshasa. All locally manufactured generic amoxicillin 500 mg capsules (ECH-P 500 mg, batch 08-25, expiry date December 2027; and ECH-C 500 mg, batch 4M503, expiry date May 2027), as well as the innovator product (Clamoxyl® 500 mg capsules, batch CJ6F, expiry date September 2026, manufactured by GlaxoSmithKline, United Kingdom), were randomly purchased directly from authorised wholesalers representing the manufacturers.

To avoid potential storage-related quality issues associated with certain retail pharmacies in Kinshasa, samples were obtained exclusively from wholesalers. As this was a post-marketing comparative dissolution study, a single batch of each product was analysed.

For confidentiality purposes, locally manufactured products were coded as follows:

A. **Manufacturer sample 1:** ECH-C
B. **Manufacturer sample 2:** ECH-P

Preparation of Dissolution Media

Acid buffer solution (pH 1.2):
In a 1000 mL volumetric flask, 250 mL of 0.2 M potassium chloride (KCl) was mixed with 425 mL of 0.2 M hydrochloric acid (HCl). The solution was then made up to volume with distilled water.

Acetate buffer solution (pH 4.5):
A quantity of 2.99 g of sodium acetate (CH_3COONa) was dissolved in 14 mL of 2 N acetic acid, and the volume was adjusted to 1000 mL with distilled water.

Phosphate buffer solution (pH 6.8):
In a 1000 mL volumetric flask, 250 mL of 0.2 M potassium dihydrogen phosphate (KH_2PO_4) was mixed with 112 mL of 0.2 M sodium hydroxide (NaOH), and the solution was made up to volume with distilled water.

Preparation of Reference Solution

An amount of amoxicillin USP reference standard equivalent to 2 mg was accurately weighed and transferred into a 10 mL volumetric flask. The powder was dissolved in the dissolution medium and diluted to volume with the same medium, yielding a final concentration of 0.2 mg/mL. The absorbance of this solution was measured at 272 nm using a UV–Visible spectrophotometer.

Preparation of Test Solutions for Dissolution Studies

For dissolution testing, one amoxicillin 500 mg capsule was placed into each dissolution vessel containing 900 mL of dissolution medium, previously equilibrated and maintained at 37.0 ± 0.5°C. Aliquots of 10 mL were withdrawn at 15, 30, 45, and 60 minutes. The withdrawn volume was immediately replaced with fresh dissolution medium to maintain a constant volume.

Each sample was immediately filtered through a 0.45 µm syringe filter. Subsequently, 4 mL of the filtered solution was diluted to 10 mL with the corresponding dissolution medium, resulting in a final concentration of 0.2222 mg/mL of amoxicillin. Absorbance was measured at 272 nm using a UV–Visible spectrophotometer.

Methods

Analyses were conducted in accordance with the USP–NF 2024 monograph for amoxicillin. Prior to routine analysis, a verification of the analytical method was performed to confirm its suitability for use in the national quality control laboratory, considering laboratory conditions, equipment, and personnel, as recommended by USP General Chapter ⟨ 1226⟩ (USP, 2024). The evaluated verification parameters included selectivity, trueness,

precision (repeatability and intermediate precision), accuracy, and linearity.

Dissolution tests were carried out under the operating conditions presented in **Table 1** to establish dissolution profiles for both generic and innovator products. Comparative analysis of dissolution profiles was performed using the fit factor approach, which includes the similarity factor (f_2) and the difference factor (f_1). This method is recommended by regulatory authorities for dissolution profile comparison (Naing, 2024).

The equations for calculating f_1 and f_2 were applied as described by Endashaw et al. (2024), where n represents the number of sampling points, R_t the percentage dissolved of the reference product at time t, and T_t the percentage dissolved of the test product at time t. Acceptable ranges were 0–15 for f_1 and 50–100 for f_2 (Akhtar et al., 2023).

Accuracy was assessed using the relative standard deviation (RSD), calculated as follows:

RSD (%) = (Standard deviation / Mean) × 100

The RSD was required not to exceed 20% at the first sampling point and 10% at subsequent time points.

Table 1:
Operating Conditions for Comparative Dissolution Testing of Amoxicillin 500 mg Capsules

Operating Parameter	Operating Condition
Dissolution media	Buffer solutions at pH 1.2, pH 4.5, and pH 6.8
Temperature of dissolution medium	37.0 ± 0.5°C
Volume of dissolution medium	900 mL
Paddle rotation speed	75 rpm
Sampling times	15, 30, 45, and 60 minutes
Volume sampled at each time point	10 mL
Assay method	UV–Visible spectrophotometry
Number of dosage units tested	12

Statistical Analysis

Collected data were summarised using descriptive statistical parameters. Statistical analyses were performed using R software (version 3.6.3; CRAN) and Microsoft Excel 2013 (Microsoft Corporation, Redmond, WA, USA).

RESULTS

Verification of the USP–NF 2024 Method for the Analysis of Amoxicillin 500 mg Capsules

Following system suitability testing and evaluation of response factor consistency to ensure the reliability of the analytical system, the USP–NF 2024 method was verified for selectivity, precision, trueness, accuracy, and linearity. The results obtained are presented below.

Selectivity

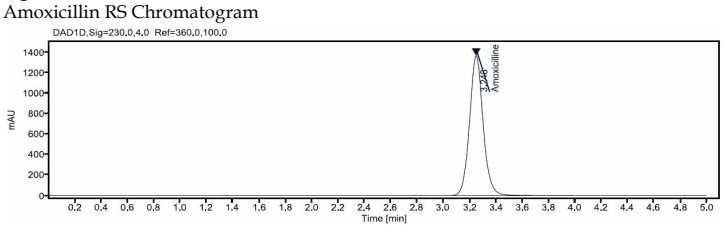
Selectivity was assessed by comparing the chromatographic peak obtained from the amoxicillin reference standard with chromatograms of the buffer blank and acetonitrile blank. The results are presented in **Table 2**, while the chromatogram of the reference standard is shown in **Figure 1**. No interfering peaks were observed at the retention time of amoxicillin, confirming that the method is selective and capable of identifying amoxicillin without interference.

Table 2:
Selectivity Test Results

No.	Product	Average Retention Time (min)	Average Peak Area	Main Peak	Criterion	Decision
1	Reference standard	3.26	8293.11	Present	–	–
2	Blank (buffer)	No peak	No peak	Absent	–	–
3	Blank (acetonitrile)	No peak	No peak	Absent	–	–

Specificity assessment: Identifiable
Decision: Acceptable

Figure 1:
Amoxicillin RS Chromatogram



Precision, Trueness, and Accuracy

The precision of the method was evaluated at two levels: repeatability and intermediate precision. The coefficient of variation (CV) was used as the measure of precision. Results for all concentration levels demonstrated low data dispersion, with CV values below 2% for both repeatability and intermediate precision, indicating excellent method precision.

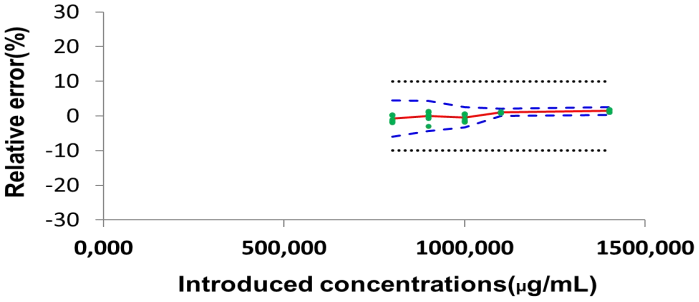
Trueness was evaluated by calculating the bias between the measured concentrations and the nominal concentrations, followed by determination of recovery. In accordance with ICH Q2(R2) recommendations (International Council for Harmonisation [ICH], 2023), the method demonstrated good trueness, with relative bias values below 2% and recovery values within the acceptable range of 98%–102%.

Accuracy was assessed by determining tolerance intervals at each concentration level. The resulting accuracy profile **(Figure 2)** showed that tolerance intervals were well within acceptance limits, confirming the accuracy of the method.

Table 3:
Summary of Precision, Trueness, and Accuracy Results

Concentration (µg/mL)	800	900	1000	1100	1400
Precision					
Repeatability variance	15.71	71.52	76.26	0.11	23.39
Repeatability SD	3.96	8.46	8.73	0.33	4.84
Repeatability CV (%)	0.50	0.94	0.88	0.03	0.34
Intermediate precision variance	75.63	164.37	122.96	5.34	37.24
Intermediate precision SD	8.70	12.82	11.09	2.31	6.10
Intermediate precision CV (%)	1.09	1.42	1.11	0.21	0.43
Trueness					
Mean measured concentration (µg/mL)	794.57	900.75	996.96	1112.38	1421.52
Bias (µg/mL)	−6.04	0.06	−3.80	11.54	20.52
Relative bias (%)	−0.76	0.01	−0.38	1.05	1.47
Recovery (%)	99.25	100.01	99.62	101.05	101.47
Accuracy					
Lower tolerance limit (%)	−5.9	−4.3	−3.3	0.1	0.4
Upper tolerance limit (%)	4.4	4.3	2.5	2.1	2.6
Lower tolerance limit (µg/mL)	753.4	862.3	968.1	1101.3	1405.6
Upper tolerance limit (µg/mL)	835.8	939.2	1025.9	1123.5	1437.4

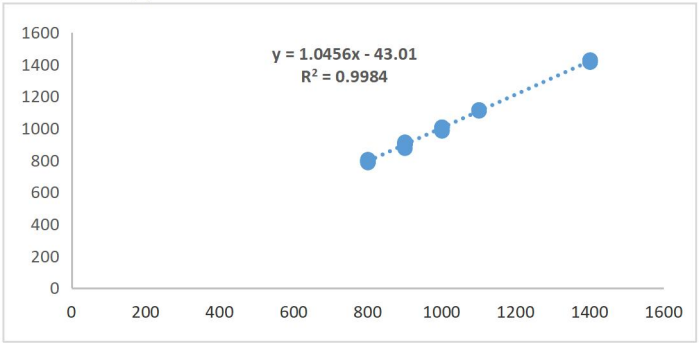
Figure 2:
Accuracy Profile



Linearity

Linearity was evaluated using a minimum of five concentration levels across three analytical series, with one range analysed per day. The calibration curve exhibited a slope of approximately 1, indicating proportionality between the introduced and measured concentrations across the tested range. The linearity profile is presented in **Figure 3**.

Figure 3:
Method linearity profile



Based on these verification results, the USP–NF 2024 method for amoxicillin analysis was deemed suitable for application in the national quality control laboratory, considering the laboratory environment, equipment, and operators. This validation enabled progression to the quality control of the tested samples.

Quality Control of Generic and Innovator Products

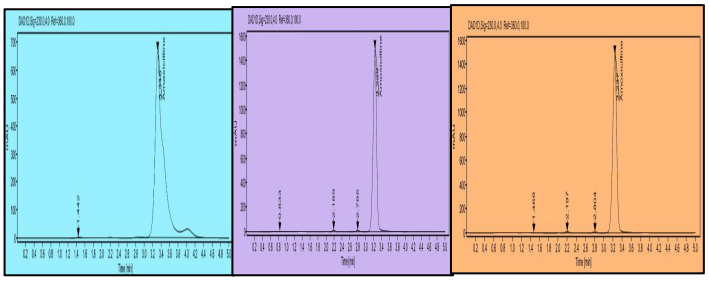
Identification and assay of amoxicillin were performed for all samples. Results are presented in **Table 4**. Retention times for generic products were consistent with that of the innovator product, with differences below ±0.5 minutes. Assay results complied with USP–NF 2024 specifications for both innovator and generic products, with CV values below 1.76%.

Table 4:
Quality Control Results for Amoxicillin in Generic and Innovator Products

Test	Innovator Product	ECH-C	ECH-P	Specification	Observation
Identification (average retention time, min)	3.32	3.23	3.23	Difference ≤ ±0.5 min	Compliant
Assay (% of label claim, n = 3)	104.9 ± 1.75	98.8 ± 1.08	97.0 ± 1.40	90.0–120.0%	Compliant

Chromatograms of the innovator product (Clamoxyl®), ECH-C, and ECH-P are presented in **Figure 4**.

Figure 4:
Chromatograms of Clamoxyl (blue), ECH-C (yellow), and ECH-P (green)



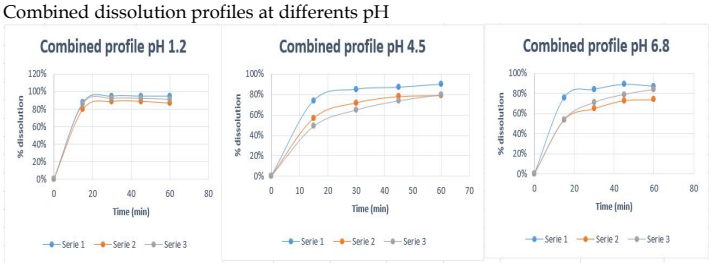
Evaluation of Dissolution Profiles at pH 1.2, 4.5, and 6.8

All prerequisites for comparative dissolution testing and calculation of similarity factors were satisfied. In accordance with WHO recommendations, coefficients of

variation were below 20% at the first sampling point and below 10% at subsequent sampling points.

Combined dissolution profiles for the innovator product (Series 1), ECH-C (Series 2), and ECH-P (Series 3) at different pH conditions are illustrated in **Figure 5**.

Figure 5:
Combined dissolution profiles at differents pH



Series 1: Innovator product; Series 2: ECH-C; Series 3: ECH-P

Evaluation of Dissolution Using f_1 and f_2 Factors

Dissolution percentages and dissolution ratios at different pH levels are presented in **Table 5**. The difference factor (f_1) and similarity factor (f_2) values calculated for each condition are shown in **Table 6**.

Table 5:
Dissolution Percentages and Ratios for Generic and Innovator Products at Different pH Levels

Dissolution time	pH 1.2					pH 4.5					pH 6.8				
	ECH-P	ECH-C	Clam	ECH-P/Clam*	ECH-C/Clam**	ECH-P	ECH-C	Clam	ECH-P/Clam*	ECH-C/Clam**	ECH-P	ECH-C	Clam	ECH-P/Clam*	ECH-C/Clam**
15 min	8	8	8	9	9	5	4	7	7	66	5	54	7	71	71
	0	6	8	1	8	7	9	4	7		4		6		
30 min	8	9	9	9	9	7	6	8	8	76	6	71	8	77	85
	9	2	5	4	7	2	5	5	5		5		4		
45 min	8	9	9	9	9	7	7	8	9	85	7	79	8	82	89
	9	2	5	4	7	8	4	7	0		3		9		
60 min	8	9	9	9	9	7	8	9	8	89	7	84	8	85	97
	7	1	5	2	2	9	0	0	8		4		7		

* ECH-P/Clam: Ratio of ECH-P to Clamoxyl®
** ECH-C/Clam: Ratio of ECH-C to Clamoxyl®

Table 6:
Fit Factor (f_1 and f_2) Results

pH 1.2	Time	RSD (%)			Average Percentage of Dissolution			f1		f2	
		Innovator product	ECH-C	ECH-P	Innovator product	ECH-C	ECH-P	I/ECH-C	II/ECHP	I/ECH-C	I/ECH-P
	15 min	7,01	3.75	9.14	88	8 6	8 0				
	30 min	3.79	3.51	5.06	95	9 2	8 9	3	8	74	57
	45 min	3.27	2.54	4.71	95	9 2	8 9				
	60 min	3.76	2.34	3.86	95	9 1	8 7				
pH 4.5	15 min	4.68	8.98	6.73	74	4 9	5 7				
	30 min	5.30	4.34	9.02	85	6 5	7 2	20	1 5	37	44
	45 min	4.31	4.12	6.26	87	7 4	7 8				
	60 min	3.92	5.47	5.34	90	8 0	7 9				
pH 6.8	15 min	7.62	8.86	7.00	76	5 4	5 4				
	30 min	6.69	7.19	6.38	84	7 1	6 5	14	2 1	44	37
	45 min	6.61	4.11	5.58	89	7 9	7 3				
	60 min	7.53	4.18	5.52	87	8 4	7 4				

At pH 1.2, similarity criteria were met for both generic products. However, at pH 4.5 and 6.8, f_2 values were below the acceptable threshold, indicating a lack of dissolution profile similarity with the innovator product.

DISCUSSION

Before conducting comparative dissolution tests on the generic and innovator products, preliminary analyses were carried out to ensure compliance with specifications. These analyses were performed in accordance with the *USP–NF 2024* monograph. After verifying system suitability and assessing differences in response factors to confirm that the analytical system was adequate and consistent for data analysis, the amoxicillin assay method was validated. This was particularly important, as the *USP–NF 2024* monograph method for amoxicillin analysis was being applied for the first time at the National Quality Control Laboratory.

All evaluated validation parameters, including selectivity, trueness, precision, accuracy, and linearity, demonstrated that the *USP–NF* method for amoxicillin determination is suitable for use at the National Quality Control Laboratory, taking into account the working environment, available equipment, and operators.

The identification of amoxicillin in both the generic products and the innovator product was confirmed, as the retention times were consistent and the chromatograms obtained were superimposable with that of the amoxicillin reference substance. The assay results for amoxicillin content in the generic and innovator products complied with the *USP–NF 2024* pharmacopoeial specifications, as all values fell within the acceptable limits.

Once compliance with *USP–NF 2024* specifications was established, dissolution testing was performed. The results

are presented in **Table 5** and illustrated in **Figure 5**. The findings allow the following observations to be made:

i. **At pH 1.2**, the dissolution profiles of ECH-P and the innovator product are comparable and nearly identical, with average dissolution percentages of approximately 88% at 15 minutes and 95% at later time points. A similar pattern was observed for ECH-C, whose average dissolution percentages were significantly higher than those of ECH-P. However, the dissolution percentages of both generic products remained lower than those of the innovator product. The precision of the method was satisfactory, as the relative standard deviation (RSD) values at the first sampling point and subsequent time points were below 10%.

ii. **At pH 4.5**, the dissolution profiles of ECH-P and the innovator product showed a similar pattern but were not directly comparable. Average dissolution percentages for ECH-P were approximately 74% at 15 minutes, 85% at 30 minutes, 87% at 45 minutes, and 90% at 60 minutes. The innovator product demonstrated significantly higher dissolution percentages than ECH-P at all time points. The average dissolution percentages of ECH-C were also significantly higher than those of ECH-P but remained lower than those of the innovator product. The method demonstrated good precision, with RSD values below 10% at both the initial and subsequent sampling points.

iii. **At pH 6.8**, the dissolution profiles of ECH-P and the innovator product were not comparable and did not converge. The innovator product consistently exhibited significantly higher dissolution percentages than ECH-P. Although ECH-C showed better dissolution performance than ECH-P, its dissolution percentages remained lower than those of the innovator product, and the dissolution curves between ECH-C and the innovator product did not converge. Method precision remained acceptable, with RSD values below 10% across all sampling points.

In addition, the ratios between the dissolution percentages of the generic and innovator products were evaluated **(Table 6)**. This ratio is commonly used to assess similarity between dissolution profiles. Although acceptance criteria may vary among regulatory authorities, a dissolution percentage ratio between 80% and 120% is generally considered acceptable. The results showed that:

i. At **pH 1.2**, both generic products yielded satisfactory dissolution percentage ratios.

ii. At **pH 4.5**, the dissolution percentage ratios for both generic products were below 80% up to 45 minutes, while the ECH-P/innovator ratio remained below 80% up to 60 minutes.

iii. At **pH 6.8**, the ECH-P/innovator ratio remained below 80% throughout the test period, whereas the ECH-C/innovator ratio exceeded 80% only at 60 minutes.

The dissolution percentage ratio is a simplified metric that compares dissolution values at specific time points. However, it is possible for this ratio to fall within acceptable limits while similarity factors f_1 and f_2 remain unsatisfactory, indicating significant differences between dissolution profiles (International Council for Harmonisation [ICH], 2024; ICH, 2025).

Overall, the results indicate notable differences in dissolution profiles between products manufactured by local industries and the innovator product. While similarity was observed at pH 1.2, non-similarity was evident at pH 4.5 and pH 6.8. This finding is of concern, particularly because amoxicillin is primarily absorbed in the small intestine. Such lack of similarity may lead to reduced efficacy, variability in bioavailability, and increased therapeutic risk.

Comparable findings have been reported in previous studies. In Burkina Faso, Zoungrana Some (2021) demonstrated that two out of eight generic amoxicillin capsule brands assessed could not be considered interchangeable with the innovator product. Similarly, a comparative evaluation conducted in Sri Lanka by Abeysinghe et al. (2023) found that several generic brands showed significant differences from the innovator product, potentially affecting in vivo bioavailability and bioequivalence.Conversely, other in vitro studies have reported satisfactory biopharmaceutical performance for certain generic products. In Nigeria, Vaikosen et al. (2024) demonstrated that the in vitro bioequivalence results of multiple amoxicillin capsule brands met standard requirements, suggesting that these products could be used as alternatives to the innovator product.

The observed non-similarity in dissolution profiles may be attributed to several factors, including formulation differences between generic and innovator products, variations in manufacturing processes, differences in product quality, and polymorphism, as amoxicillin may exist in different crystalline forms. Additionally, stability issues affecting one or more products could influence dissolution performance and ultimately compromise product safety and efficacy.

CONCLUSION

The in vitro comparative dissolution test is an important tool for evaluating the quality and bioequivalence of generic and innovator pharmaceutical products. In this study, the dissolution profiles of amoxicillin-based products manufactured by local industries in the Democratic Republic of the Congo (DRC) were compared with those of the innovator product, Clamoxyl.

i. The physicochemical control method for amoxicillin 500 mg capsules, based on the *USP–NF 2024* monograph, was first verified and demonstrated to be accurate and suitable for application at the National Quality Control Laboratory.
ii. The results showed that all the generic products tested, as well as the innovator product, met the *USP–NF 2024* pharmacopoeial requirements for physicochemical quality control. However, comparative analysis of the dissolution profiles revealed that similarity with the reference product was observed only at pH 1.2. At pH 4.5 and 6.8, a lack of similarity was evident. This finding is of particular concern, given that amoxicillin is primarily absorbed in the small intestine. Furthermore, the evaluation of dissolution percentage ratios at different pH levels did not demonstrate complete similarity across all sampling points.
iii. In light of these observations, it is recommended that:
iv. Further studies be conducted to elucidate the causes of the observed dissimilarities, including investigations involving multiple production batches and optimisation of formulation parameters to improve dissolution profile similarity.
v. The formulation and manufacturing processes be reassessed if subsequent studies confirm these findings.
vi. Regulatory authorities enhance their involvement by placing greater emphasis on the demonstration of bioequivalence between generic and innovator products prior to granting marketing authorisation, and by strengthening post-marketing surveillance of sensitive medicines, such as antibiotics, to ensure sustained pharmaceutical quality under real-world conditions and across successive batches.

Ethical Approval: Nil required.

Conflicts of Interest: None declared.

ORCID iDs:

Mayangi, M. M.[1]: Nil identified.
Mbinze, K. J.[1]: Nil identified.
Mana, K. D.[1]: Nil identified.
Bayebila, M. T.[1]: Nil identified.
Ntambwe, N. M.[2]: Nil identified.
Mankulu, K. J.[1]: Nil identified.
Mbenza, P. A.[1]: Nil identified.
Nsangu, M. J.[1]: Nil identified.

REFERENCES

Abeysinghe, M., *et al.* (2023). Comparative evaluation of quality of different brands of amoxicillin capsules available in community pharmacies in Jaffna, Sri Lanka. *[Journal name not specified]*.

Akhtar, H., *et al.* (2023). *In vitro* assessment and application of kinetics models on dissolution profiles of several brands of clopidogrel (75 mg) available in Karachi, Pakistan. *Annals of Jinnah Sindh Medical University*, *9*(2), 49–55.

Autorité Congolaise de Réglementation Pharmaceutique (ACOREP). (2020, March 5). *Décret portant création, organisation et fonctionnement d'un établissement public dénommé Autorité Congolaise de Réglementation Pharmaceutique (ACOREP)*. https://www.leganet.cd/Legislation/JO/2020/jo.01.04.2020.pdf

Bakker-'t Hart, I. M. E., Ohana, D., & Venhuis, B. J. (2021). Current challenges in the detection and analysis of falsified medicines. *Journal of Pharmaceutical and Biomedical Analysis*, *197*, 113948. https://doi.org/10.1016/j.jpba.2021.113948

Endashaw, E., *et al.* (2024). Dissolution profile evaluation of selected brands of amoxicillin–clavulanate potassium 625 mg tablets retailed in Hawassa Town, Sidama Regional State, Ethiopia. *AAPS Open*, *10*(1), Article 3. https://doi.org/10.1186/s41120-024-00091-2

International Council for Harmonisation of Technical Requirements for Pharmaceuticals for Human Use (ICH). (2024). *ICH M13A: Guideline on bioequivalence for immediate-release solid oral dosage forms*.

International Council for Harmonisation of Technical Requirements for Pharmaceuticals for Human Use (ICH). (2025). *ICH M13B: Guideline on bioequivalence for immediate-release solid oral dosage forms – Additional strengths biowaiver (Step 2b)*.

Kalenda Tshilombo, N., *et al.* (2017). Investigation de la qualité d'antibiotiques à base d'amoxicilline dans le

cadre de la surveillance du marché officiel et périphérique de quelques villes de la République démocratique du Congo. In *Actes du 12ème Congrès francophone sur les sciences séparatives et les couplages (AFSEP)*.

Kassaye, L., & Genete, G. (2013). Evaluation and comparison of *in vitro* dissolution profiles for different brands of amoxicillin capsules. *African Health Sciences*, *13*(2), 369–375.

Kimuntu Kim, P. (2023, October 16). *Importante quantité d'antibiotique contrefait Clamoxyl saisie à Lufu, frontière entre la RDC et l'Angola* [Post on X]. https://x.com/KimKimuntu/status/1713733638787891467

Mbuya, K. J., *et al.* (2020). Profil bactériologique des infections urinaires diagnostiquées aux Cliniques Universitaires de Lubumbashi, RDC. *IOSR Journal of Dental and Medical Sciences*, *19*(4), 1–8.

Naing, M. D., & Tsume, Y. (2024). Dissolution profiles of BCS Class II drugs generated by the gastrointestinal simulator alpha have an edge over the compendial USP II method. *European Journal of Pharmaceutics and Biopharmaceutics*, *203*, 114436.

Organisation mondiale de la santé. (2021, May 31). *Renforcer la production locale de médicaments et d'autres technologies sanitaires pour en améliorer l'accès*. Soixante-quatorzième Assemblée mondiale de la Santé. https://apps.who.int/gb/ebwha/pdf

Organisation mondiale de la santé, Comité régional de l'Afrique. (2024). *Cadre pour renforcer la production locale de médicaments, de vaccins et d'autres technologies sanitaires dans la région africaine de l'OMS (2025–2035)*. https://www.afro.who.int/sites/default/files/2024-09/AFR-RC74-6

Planchon, V. (2022). *Réglementation de la publicité en faveur des produits de santé en France* (Doctoral thesis). Université de Lille.

United States Pharmacopeial Convention. (2024). *USP–NF 2024: General chapter ⟨ 1226⟩ Verification of compendial procedures*.

Vaikosen, E., *et al.* (2024). Spectroscopic determination and *in vitro* bioequivalence studies of different amoxicillin capsule brands. *Asian Journal of Research in Biochemistry*, *14*(3), 26–33. https://doi.org/10.9734/ajrb/2024/v14i3284

VillageReach. (2024, March 6). *Améliorer l'accès à des médicaments de qualité grâce à la collaboration entre les secteurs public et privé*. https://www.villagereach.org/fr/2024/03/06/ameliorer-lacces-a-des-medicaments-de-qualite-grace-a-la-collaboration-public-prive

Vogler, S., *et al.* (2021). Policies to encourage the use of biosimilars in European countries and their potential impact on pharmaceutical expenditure. *Frontiers in Pharmacology*, *12*, 625296. https://doi.org/10.3389/fphar.2021.625296

Zoungrana Some, W. (2021). *Évaluation in vitro de la bioéquivalence des différentes marques d'amoxicilline gélules commercialisées au Burkina Faso* (Master's thesis). Université Joseph Ki-Zerbo.