PALGO JOURNAL OF MEDICINE AND MEDICAL SCIENCES

ISSN 2476-8340
DOI : https://doi.org/10.65756/pjmms.202604.005
Volume 11 Issue 1, March 2026.Page 22-29
http://www.palgojournals.org/PJMMS/Index.htm
Corresponding Author's Email: janzulu2003@yahoo.com

QUALITY ASSESSMENT OF DIFFERENT BRANDS OF PARACETAMOL TABLETS SOLD IN LUSAKA, ZAMBIA

Dr. Jenipher Zulu[1], Kanyata Kanyata[3], Martha Chulu[1], Namakau Kaywala[1], Thelma Ngoma[2], Lutunti Chilwesa[3], Rosaline Sinkala[2], Dr Richard Kunda[4]

Department of Pharmacy, School of Health Sciences, Levy Mwanawasa Medical University, Lusaka, Zambia[1]
Department of Nutrition and Dietetics, School of Health Sciences, Levy Mwanawasa Medical University, Lusaka, Zambia[2]
Department of Behavioral Science and Counselling, School of Health Sciences, Levy Mwanawasa Medical University, Lusaka, Zambia[3]
Dean, School of Health Sciences, Levy Mwanawasa Medical University, Lusaka, Zambia[4]

Accepted 14, April, 2026.

Background: Paracetamol also known as acetaminophen is one of the world's most widely used over-the-counter (OTC) analgesics and antipyretics. Ensuring its quality and safety is essential for effective healthcare delivery. In low and middle-income countries like Zambia, substandard or counterfeit medicines pose serious risks to public health, leading to therapeutic failure, drug resistance, and potential toxicity.
Objective: This study aimed to evaluate and compare the quality of five brands of 500 mg paracetamol tablets sold in Lusaka, Zambia, by assessing physicochemical properties and quantifying active pharmaceutical ingredient (API) content.
Methods: A descriptive cross-sectional laboratory study design was employed. Tablets of five Paracetamol brands coded as PCM 1810 to 1814 were purposively sampled. Standard pharmacopeial tests (weight variation, friability, moisture absorption), visual inspection, identification and UV–Vis spectrophotometry–based assay were conducted according to British Pharmacopoeia (BP) and World Health Organization (WHO) guidelines.
Results: All brands passed visual inspection and weight variation. Moisture absorption ranged from 0% to 0.21%, and was within pharmacopeial limits. Friability was acceptable (<1%) for all brands. Disintegration times were within 30 minutes. API content ranged from 84.1% (Pharmadol) to 98.4% (Regamol), with four brands falling within the accepted 90–110% API range.
Conclusion: While most brands met pharmacopeial quality standards, one brand exhibited substandard API content. Enhanced regulatory oversight through routine risk-based post-marketing surveillance, stricter batch release verification, targeted market sampling of high-risk products, and enforcement of Good Manufacturing Practice (GMP) compliance is recommended to ensure drug quality and protect public health in Zambia.

Keywords : Paracetamol,Quality Assessment,API Content,Pharmacopeial Standards,Drug Quality,Market Surveillance.

1.0 INTRODUCTION

Access to high-quality essential medicines is a fundamental component of effective healthcare systems (WHO, 2017; Bigdeli et al., 2013; Wirtz et al., 2017; Zulu, 2017), significantly influencing individual and public health outcomes as well as national productivity. However, the proliferation of substandard, degraded, and counterfeit medicines continues to undermine therapeutic efficacy, promote drug resistance, and contribute to increased morbidity and mortality. Poor-quality medicines may contain insufficient levels of active pharmaceutical ingredients (APIs), harmful impurities, or both, resulting in reduced therapeutic benefit and potentially adverse health outcomes (WHO, 1996, 2007). Paracetamol (acetaminophen) remains a cornerstone in the management of pain and fever globally, widely used in both over-the-counter and prescription settings. Its clinical effectiveness is primarily attributed to inhibition of prostaglandin synthesis via cyclooxygenase enzymes, alongside central modulation of serotonergic pathways (Ayoub, 2021). Due to its wide availability, frequent use, and perceived safety including in paediatric populations ensuring its quality, safety, and bioavailability is of critical importance.

Although paracetamol is chemically stable in solid dosage forms, it is susceptible to degradation through hydrolysis and oxidation under adverse environmental conditions, producing potentially toxic intermediates such as *p*-aminophenol and *p*-benzoquinoneimine. Factors such as moisture, temperature, light exposure, and excipient interactions can accelerate these degradation pathways, particularly in tropical climates (Taylor et al., 2021; Risha et al., 2013). This highlights the importance of maintaining stringent quality control throughout manufacturing, storage, and distribution. To ensure the

quality of pharmaceutical products, international pharmacopeial standards, including those outlined in the British Pharmacopoeia and WHO monographs, specify a range of tests for solid dosage forms. These include weight variation (to ensure dosage uniformity), friability (to assess mechanical strength), disintegration (to evaluate readiness for absorption), and assay of API content, commonly performed using analytical techniques such as UV–Visible spectrophotometry and high-performance liquid chromatography (HPLC). In addition, newer analytical approaches such as thin-layer chromatography (TLC), near-infrared (NIR), and Raman spectroscopy are increasingly utilized due to their rapidity and minimal reagent requirements (Mankulu et al., 2022; Sahle et al., 2012).

Generic medicines play a vital role in improving access, affordability, and equity in healthcare systems. However, their widespread use necessitates rigorous quality assurance and regulatory oversight to ensure therapeutic equivalence and patient safety (Anonymous, 2015; FDA, 2020). In many low- and middle-income countries, including Zambia, regulatory monitoring is often constrained by limited resources, increasing the risk of substandard or counterfeit medicines entering the supply chain (Nasarin et al., 2011; Sahle et al., 2012; Mikre et al., 2020). Studies conducted in countries such as Bangladesh, Pakistan, Yemen, Saudi Arabia, the Democratic Republic of Congo, and Ethiopia have reported variable compliance of paracetamol products with pharmacopeial standards, with some brands failing key quality parameters such as friability and API content despite passing other tests (Auditi et al., 2015; Ahktar et al., 2022; Alsaifi and Alyahawi, 2018; Mankulu et al., 2022).

In Zambia, there is a paucity of published data on the quality of paracetamol brands available on the market. Anecdotal reports have suggested consumer dissatisfaction with certain products; however, no systematic laboratory-based evaluations have been documented. This lack of evidence presents a challenge for regulatory authorities such as the Zambia Medicines Regulatory Authority (ZAMRA) and the Food and Drugs Laboratory Trust (FDLT) in ensuring medicine quality and safeguarding public health. Ensuring the quality of widely used medicines such as paracetamol is essential for reducing avoidable morbidity and mortality, maintaining public confidence in healthcare systems, and supporting economic productivity through effective disease management. Furthermore, demonstrating the quality of generic medicines reinforces trust in their use, a strategy strongly endorsed by international health authorities. Therefore, this study aimed to determine and compare the physicochemical quality and API content of five brands of 500 mg paracetamol tablets available in Lusaka, Zambia. Specifically, the study evaluated tablet quality through weight variation, friability, and moisture absorption tests; assessed labelling and packaging compliance; and quantified API content against established pharmacopeial standards.

2.0 MATERIALS AND METHODS

Ethical approval was sought and granted by the Levy Mwanawasa Medical University Ethics Committee. As a laboratory-based study, no human participants were involved. Authorization to carry out laboratory tests was obtained from the University Teaching Hospital (UTH) Food and Drugs Laboratory. This descriptive cross-sectional analytical study was conducted in laboratories at the UTH Food and Drugs Laboratory in Lusaka. It adhered to standard pharmacopeial methodology. Five brands of 500 mg paracetamol tablets were purposively purchased from registered pharmacies in Lusaka city. Table 1 shows a summary of the different sampled paracetamol, expiry date and traceable manufacturer.

Table 1: Paracetamol Brands included in the study

S/N	BRAND CODE	MILIGRAM (mg)	SAMPLE NUMBER	EXPIRY DATE
1	PCM 1810	500mg	1810	02/2027
2	PCM 1811	500mg	1811	06/2026
3	PCM 1812	500mg	1812	09/2025
4	PCM 1813	500mg	1813	08/2026
5	PCM 1814	500mg	1814	06/2026

From each brand, 20 tablets were sampled following WHO recommendations (Oga et al., 2010), yielding a total sample size of 100 tablets. The inclusion criterion favored all paracetamol brands with ≥6 months before expiry and manufacturing date within past 3 years. While the exclusion included all paracetamol brands that were expired or near-expiry (<6 months). Table 2 below illustrates the analytical testing procedures for paracetamol.

Table 2: Analytical Testing Procedures for Quality Evaluation of Paracetamol Tablets

Test Parameter	Analytical Principle	Procedure Summary	Acceptance Criteria (BP/USP Standards)
Sample Selection	Representative sampling ensures validity of results	Five brands of 500 mg paracetamol tablets were randomly purchased; 20 tablets per brand were analysed	Not applicable
Organoleptic Properties	Visual inspection detects physical defects	Tablets examined for colour, shape, texture, and packaging integrity under normal lighting	Uniform appearance; absence of cracks, chips, or discoloration

Continuation of Table 2

Weight Variation	Ensures uniformity of dosage units	Individual weights of 20 tablets measured using an analytical balance; mean weight and % deviation calculated	±5% deviation for tablets ≥250 mg
Friability	Assesses resistance to abrasion during handling	Pre-weighed tablets rotated at 25 rpm for 4 minutes in a friabilator; % weight loss calculated	≤1% weight loss
Dissolution Test	Evaluates rate and extent of drug release into solution	USP dissolution apparatus used; samples withdrawn at specified intervals and analysed spectrophotometrically	≥70–80% drug release within specified time of 30–45 min
Moisture Absorption	Assesses stability under humid conditions	Tablets exposed to controlled humidity; weight gain measured over time	Minimal weight variation within acceptable limits
API Assay (UV–Vis Spectrophotometry)	Based on Beer–Lambert law (absorbance proportional to concentration)	Tablets powdered and dissolved; absorbance measured at **296 nm**; concentration determined using calibration curve (Y = mx + c)	95–105% of labelled claim

2.1 Testing Procedures

2.1.1. Weight Variation

Each tablet's mass was recorded individually and collectively. Percent deviation from mean mass was computed, with failure criteria if more than two tablets differed beyond ±5% of the mean weight (BP standards).

2.1.2. Visual Inspection

Appearance, shape, color uniformity, absence of physical defects, intact packaging, and accurate labeling (brand name, manufacturer, batch number, expiry date, API strength) were assessed visually.

2.1.3. Moisture Absorption

Selected tablets were weighed and kept under ambient Lusaka conditions (~25–30°C, RH ~60–75%) for 10 days. Final weight determined percent moisture gain. Moisture gain beyond 0.5% indicates increased risk of hydrolysis and degradation (Shende et al., 2012).

2.1.4. Friability Test

10 tablets per brand were tested in a friabilator (Electrolab EF-2 Friabilator (India) rotating at 25 RPM for 4 minutes, per pharmacopeial standard. Acceptable loss defined as ≤1% (BP).

2.1.5. Identification Test

5 g powdered tablet sample dissolved in hot 75% ethanol, filtered and evaporated. Residue reacted with 25% $FeCl_3$; presence of paracetamol confirmed by intense blue color.

2.1.6. UV–Vis Spectrophotometric Assay

Calibration curve prepared from reference paracetamol standard, measuring absorbance at 296.6 nm (e= Y=0.0037x + 0.5498). Tablet samples were prepared similarly and API content (% label claim) calculated. The make and model for the UV-vis Spectrophotometer is Shimadzu UV-1800 / UV-1900 (Japan).

3.0 RESULTS

3.1 Visual Analysis and Description of five (5) Paracetamol Samples

The 5 brands of Paracetamol that were found on the Lusaka market were brand coded as PCM 1810 to 1814. These commercially available tablets contain 500 mg of paracetamol. Various observed parameters carried out on the tablet brands showed that all the 5 samples of different brands passed the test. Paracetamol samples were analyzed using a UV-vis Spectrophotometer and descriptions for each brand is as shown below;

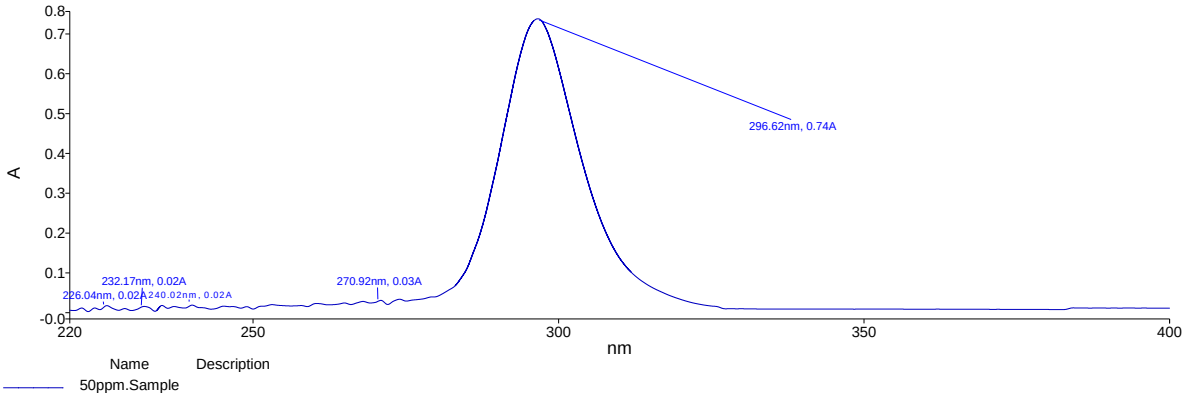


Figure 1: *Showing description for PCM 1810* **Source:** *Laboratory sample results (2023)*

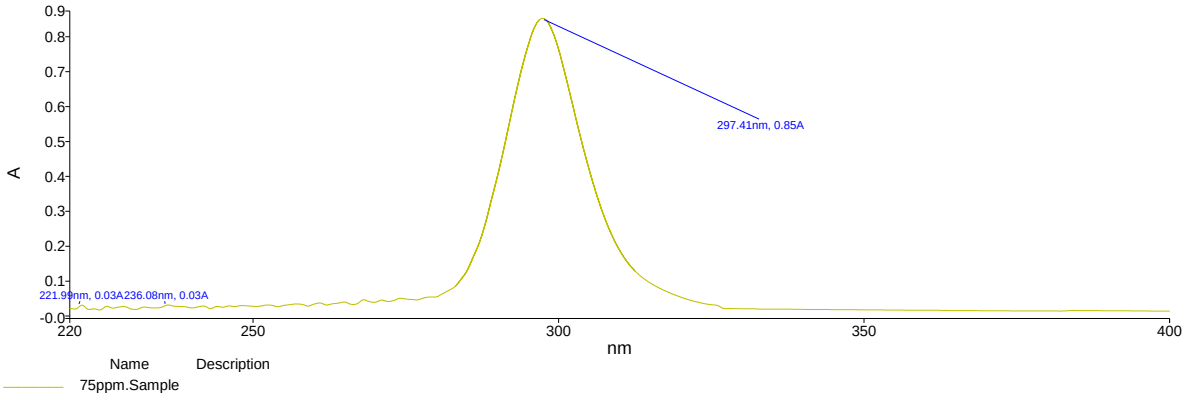


Figure 2: *Showing description for PCM 1811* **Source:** *Laboratory sample results (2023)*

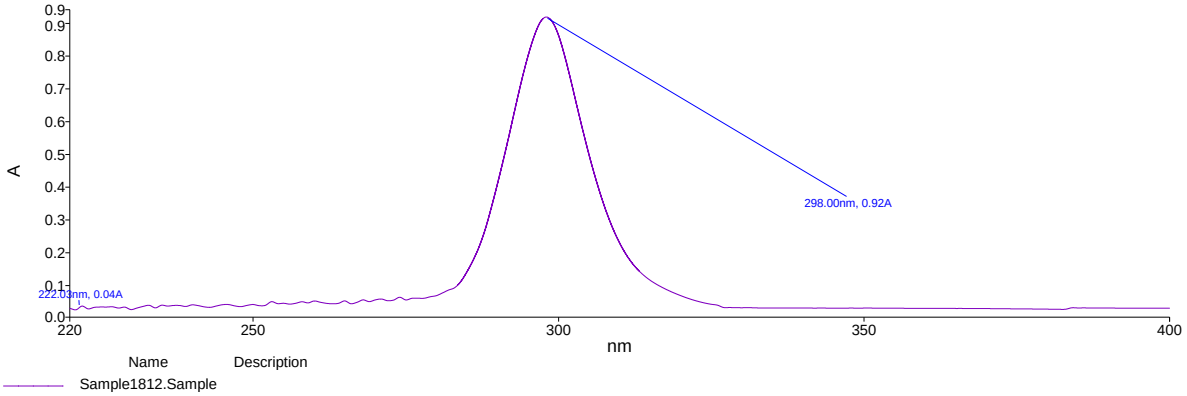


Figure 3: *Showing description for PCM sample 1812* ***Source:*** *Laboratory sample results (2023)*

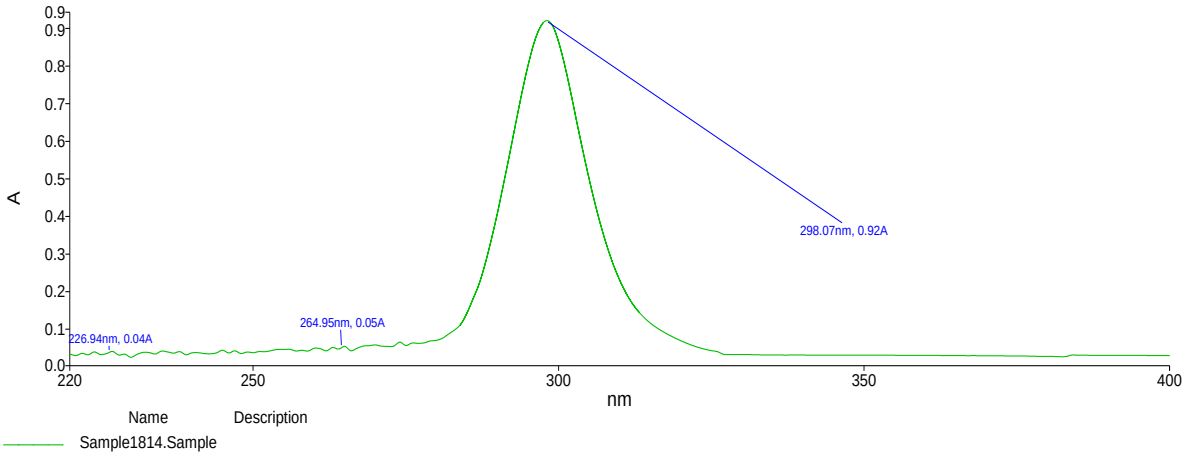


Figure 4: *Showing description for PCM sample 1813* ***Source:*** *Laboratory sample results (2023)*

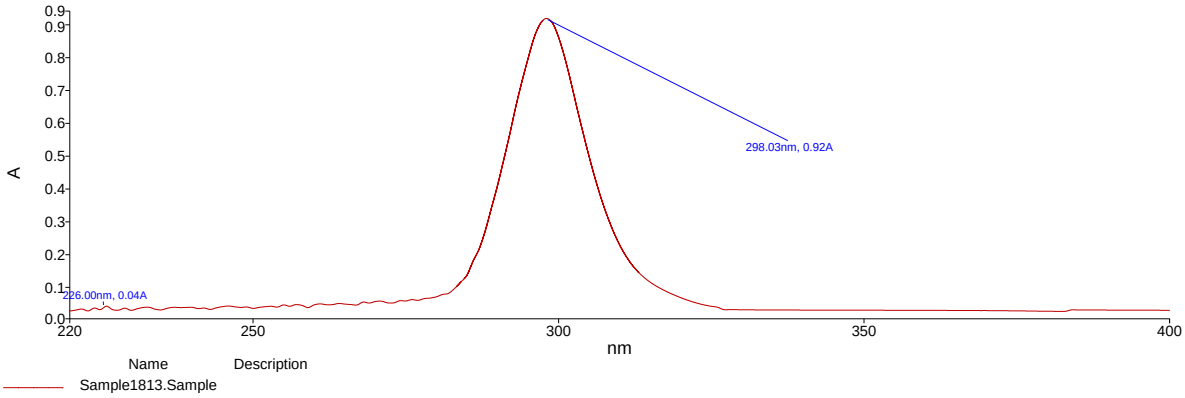


Figure 5: *Showing description for PCM sample 1814* ***Source:*** *Laboratory sample results (2023)*

3.2 Moisture absorption tendencies of paracetamol brands

To test moisture absorption tendencies, the experiment was conducted in accordance with the pharmacopoeia standards. The moisture absorption tendencies of the paracetamol brands were ascertained. The absorbance of these solutions was determined using UV Spectrophotometer at maximum wavelength of 296.6 nm and plotted against concentration. Below are the results of the Standard Plot Curve and calculations.

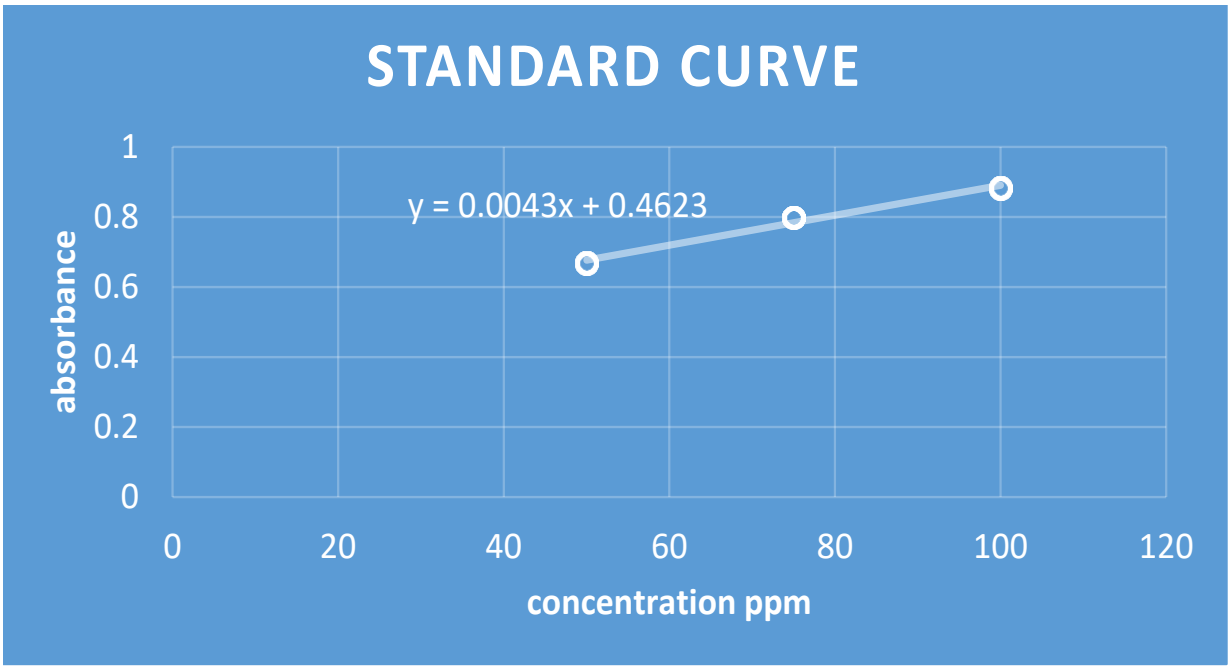


Figure 6: *Standard curve for moisture*. Source: *Laboratory data (2023)*

For Paracetamol Samples absorbance calculation at 296.6 Standard Paracetamol Solution, the stock solution (100ug/ml) of paracetamol was prepared by dissolving accurately about 100mg of drug in 10 ml 0.1N HCI and the volume made up to 100ml with 0.1N HCI. Each 100 ml contains: Paracetamol PB 1,000 mg, Water for injections BP q.s

3.2 Calculation of API Content of Paracetamol

The calculation of the Active Pharmaceutical Ingredient (API) content of Paracetamol is typically performed using a validated analytical method, most commonly UV–Visible spectrophotometry or High-Performance Liquid Chromatography (HPLC). The paracetamol sample (crushed tablets) was accurately weighed and dissolved in a suitable solvent to prepare a test solution. This solution was then filtered to remove any insoluble excipients. A reference standard solution of pure paracetamol, prepared at a known concentration, was analysed under the same conditions.

The absorbance (in UV spectrophotometry) or peak area (in HPLC) of both the sample and the standard is measured. The API content is then calculated by comparing the response of the sample to that of the reference standard, considering factors such as dilution, sample weight, and purity of the standard. Table 3 below shows a summary of the API content analysis of paracetamol brands.

The final result is expressed as a percentage of the labeled claim, indicating whether the amount of paracetamol present in the sample complies with pharmacopeial specifications.

Table 3: API Content of Paracetamol Tablet Brands

Brand Code	Label Claim (mg)	% of Label Claim (%)	BP Limit (90–105%)	Compliance Status
PCM 1810	500	91.9%	90–105%	Pass
PCM 1811	500	84.1%	90–105%	Fail
PCM 1812	500	98.4%	90–105%	Pass
PCM 1813	500	94.7%	90–105%	Pass
PCM 1814	500	95.8%	90–105%	Pass

3.4 Friability and physical quality of paracetamol brands

The Friability test was conducted and measured. Friability test measures the ability of the tablets to withstand abrasion during handling. It determines the physical strength of compressed and uncoated tablets upon exposure to mechanical shock and attrition. Conventional compressed tablets that lose less than 0.5% to 1% of weight are considered acceptable (Saleem, et al., 2014).

From the result on Table 1, the five (5) brands of paracetamol complied with the requirement for friability since their values fall within 0% - 0.5%.

Moisture absorption plays remarkable negative role in pharmaceutical products particularly for solid dosage forms. It is evident that product brands PCM 1810, 1811 and 1813 did not absorb moisture after 10 days of exposure to the environment. The moisture absorption levels of the other two (1812 and 1814) brands (0.01 – 0.21%) were within the acceptable levels for solid dosage. Physical and chemical stability of some drugs are affected by moisture as it increases the rate of drug decomposition, causes agglomeration of powders and granules and discoloration. Moisture accelerates the hydrolysis of drug as well as facilitates reaction with other excipients thereby affecting stability and shelf life of the final product (Shende, et al., 2012).

4.0 DISCUSSION

4.1 General Findings

The present study demonstrated that the majority of evaluated brands complied with key pharmacopeial quality control parameters, including uniformity of weight, friability, and identification tests. These findings suggest that, at a basic manufacturing level, most products met acceptable standards for physical integrity and identity. Similar observations have been reported in comparable studies, where solid oral dosage forms generally comply with physical quality tests even when chemical content may vary (Yeow et al., 2019; WHO, 2023).

Additionally, the presence of tamper-evident packaging and accurate labeling across all sampled brands reflects adherence to good manufacturing and distribution practices. Moisture absorption levels were also within acceptable pharmacopeial limits, indicating that storage conditions and packaging were largely adequate to protect product stability. However, while these parameters are essential, they do not guarantee therapeutic equivalence, which is more closely linked to API content and dissolution characteristics (USP, 2022; WHO, 2023).

4.2 API Deficiency

The finding that PCM 1814 exhibited API content below 90% is of significant concern, as it falls outside the acceptable pharmacopeial range (typically 90–110%). This deviation suggests potential issues related to manufacturing processes, such as inaccurate weighing, inadequate mixing, or poor granulation and compression techniques. Given that moisture absorption remained within acceptable limits, degradation due to environmental exposure is less likely, pointing instead to formulation or process-related deficiencies.

Substandard API levels may lead to therapeutic failure, particularly in conditions requiring consistent dosing. This is especially critical in high-burden settings where medicines such as paracetamol are widely used for symptomatic relief. Studies have shown that substandard medicines contribute to treatment failure, increased morbidity, and the potential development of drug resistance in certain therapeutic classes (Ozawa et al., 2018; WHO, 2023).

In contrast, the remaining brands demonstrated API content within a relatively narrow range (~92–98%), indicating better manufacturing consistency and quality assurance systems. These findings are consistent with studies conducted in countries such as Bangladesh and Saudi Arabia, where most brands complied with assay requirements but occasional outliers were identified (Auditi et al., 2015; Alsaifi and Alyahawi, 2018).

4.3 Comparison to Other Regions

When compared to findings from other regions, the results of this study align with global trends in medicine quality. For instance, a study conducted in Karachi, Pakistan reported that most paracetamol brands complied with United States Pharmacopeia (USP) specifications for quality control tests (Akhtar et al., 2022). Similarly, research in Yemen

demonstrated high compliance rates, with only minor deviations observed in friability testing (Alsaifi and Alyahawi, 2018). In contrast, studies from parts of Sub-Saharan Africa, including the Democratic Republic of Congo, have reported occasional failures in mechanical properties such as hardness and friability, as well as variability in API content (Mankulu et al., 2022). These variations highlight disparities in manufacturing quality, regulatory enforcement, and supply chain integrity across different regions.

Overall, the observed variability across studies underscores the importance of continuous post-market surveillance, particularly in low- and middle-income countries where regulatory systems may face resource constraints (WHO, 2023; Newton et al., 2019).

4.4 Implications and Conclusion

The detection of a substandard product in this study underscores the critical need for strengthened regulatory oversight in Zambia. The Zambia Medicines Regulatory Authority should prioritize routine API assay testing, random market surveillance, and enforcement of stringent quality assurance measures.

The findings indicate that four of the five evaluated brands complied with pharmacopeial standards, suggesting generally acceptable product quality in the sampled market. However, the identification of PCM 1811 as substandard raises concerns regarding patient safety and therapeutic effectiveness. This highlights the necessity for ongoing monitoring and prompt regulatory action to prevent the circulation of substandard medicines.

Ensuring medicine quality is essential for maintaining public trust in healthcare systems and safeguarding treatment outcomes. Strengthening pharmacovigilance systems and promoting collaboration between regulatory authorities, manufacturers, and healthcare providers will be key to achieving this goal (WHO, 2023).

5.0 Study Limitations

1. The relatively small sample size (five brands) limits the generalizability of the findings.
2. Disintegration testing was not performed, which is an important parameter for assessing drug release.
3. In-vitro tests may not directly correlate with in-vivo bioavailability or therapeutic equivalence.
4. Thin-layer chromatography (TLC) analysis was not conducted, limiting confirmatory identification.
5. The use of purposive sampling restricts extrapolation of findings beyond the study setting.

6.0 Recommendations

1. For Regulatory Authorities

- Strengthen post-marketing surveillance systems, with emphasis on routine API content analysis.
- Regularly publish lists of approved and quality-assured pharmaceutical products.

2. For Manufacturers

- Enhance quality control processes, particularly during weighing, granulation, and compression stages.
- Conduct stability studies under local environmental conditions (temperature and humidity).

3. For Healthcare Providers and the Public

- Encourage the use of medicines from manufacturers with established quality records.
- Promptly report suspected therapeutic failure or adverse drug reactions to regulatory authorities.

4. Future Research

- Conduct bioequivalence studies to establish in-vivo therapeutic equivalence.
- Expand sampling to include both rural and urban settings for broader representation.
- Investigate dissolution profiles and drug release kinetics for deeper quality assessment.

Acknowledgments

The authors express their gratitude to the University Teaching Hospital (UTH) Food and Drugs Laboratory and the Zambia Medicines Regulatory Authority for their support. Ethical approval was granted by Levy Mwanawasa Medical University. Appreciation is also extended to participating pharmacies in Lusaka and laboratory personnel for their technical assistance.

Disclaimer

The findings of this study are based on samples obtained from specific batches and may not be representative of all batches produced by the manufacturers.

REFERENCES

Ahktar, H., Ali, M., Ahmad, S. A., Humayoon, R., Ahmed, K. Z., & Hassan, H. S. (2022). Assessment of in vitro quality tests of paracetamol brands 500 mg in Karachi, Pakistan. *Journal of Pharmaceutical Research International*, 34(46A), 11–21. https://doi.org/10.9734/jpri/2022/v34i46A36372

Akhtar, N., et al. (2022) Quality evaluation of paracetamol tablets available in Karachi. Pakistan Journal of Pharmaceutical Sciences. https://doi.org/10.36721/PJPS.2022.35.2

Alsaifi, A., & Alyahawi, A. (2018). Quality assessment of different brands of paracetamol tablets in Yemeni market. Universal Journal of Pharmaceutical Research, 3(4). https://doi.org/10.22270/ujpr.v3i4.182

Anonymous (2015). Access to new medicines in Europe: technical review of policy initiatives and opportunities for collaboration and research. WHO Regional Office for Europe.

Auditi, K., Mohammed, N., Mohammad, S., Emdadul, H., & Ibrahim, M. (2015). Quality analysis of different marketed brands of paracetamol available in Bangladesh. *International Current Pharmaceutical Journal*, 4, 432–435.

Ayoub, S. S. (2021). Paracetamol (acetaminophen): A familiar drug with an unexplained mechanism of action. *Temperature (Austin)*, 8(4), 351–371. https://doi.org/10.1080/23328940.2021.1886392

Bigdeli, M., Peters, D. H., Wagner, A. K., & World Health Organization. (2013). *Medicine access and utilization in developing countries: Equity and health systems.* Geneva: World Health Organization.

FDA (2020). Generic Bioequivalence Standards and Guidelines. U.S. Food and Drug Administration.

Mankulu, J. K., Ive, E.-E. K., Kagheni, E. M., Mavanga, T. M., Opota, D. O., & Mana, D. K. (2022). Pharmaco-technical and chemical study of paracetamol sold in Kinshasa-DR Congo: Comparative quality assessment of five brands. *Open Journal of Applied Sciences*, 12, 501–516. https://doi.org/10.4236/ojapps.2022.124035

Mikre, W., Ashenef, A., & Mekenonnen, N. (2020). Comparative evaluation of the in vitro and in vivo characteristics of different brands of paracetamol tablets. *Ethiopian Pharmaceutical Journal*, 18, 41–52.

Nasarin, N., Asaduzzaman, M., Mowla, R., Rizwan, F., & Alam, A. (2011). A comparative study of physical parameters of selected ketorolac tromethamine tablets available in the market of Bangladesh. *Journal of Applied Pharmaceutical Sciences*, 1, 101–103.

Newton, P. N., Bond, K. C., Newton, P., Bond, K., Abiola, V., Ade-Abolade, K., ... & White, L. (2019). Global access to quality-assured medical products: the Oxford Statement and call to action. *The Lancet Global Health*, *7*(12), e1609-e1611.. https://doi.org/10.1016/S2214-109X(20)30073-2

Oga, F., Tarfa, F., & Jolaosho, O. (2010). An assessment of the quality of various brands of paracetamol tablets sold in the Nigerian capital city. *International Journal of Biological and Chemical Sciences*, 4, 115–121.

Risha, C., Vervet, J., Vergote, G., Bortel, L., & Remon, J. (2013). Drug formulations intended for the global market should be tested for stability under tropical climatic conditions. *European Journal of Clinical Pharmacology*, 59, 135–141.

Sahle, S., Ayenew, A., & Wabe, N. (2012). Comparative quality evaluation of paracetamol tablet marketed in Somali region of Ethiopia. *International Journal of Pharmaceutical Sciences and Research*, 3, 540–550.

Saleem, M., Shahin, M., Srinivas, B., & Beguro, A. (2014). Evaluation of tablets by friability apparatus. *International Journal of Research in Pharmacy and Chemistry*, 4(4), 837–840.

Shende, P., Shrawne, C., & Gaud, R. S. (2012). Multi-layer Tablet: Current scenario and recent advances. *International journal of drug delivery*, *4*(4), 418.

Taylor, R. B., Shakoor, O., Behrens, R. H., Everard, M., Low, A. S., Wangboonskul, J., ... & Kolawole, J. A. (2021). Pharmacopoeial quality of drugs supplied by Nigerian pharmacies. *The Lancet*, 357, 1933–1936.

United States Pharmacopeia (USP) (2022) USP–NF General Chapters. Rockville, MD: USP Convention.

WHO (1996). Fake drugs: A scourge of the system. *WHO Drug Information*, 9, 127–129.

WHO (2007). WHO Global Surveillance and Monitoring System for Substandard and Falsified Medical Products.

Wirtz, V. J., Hogerzeil, H. V., Gray, A. L., Bigdeli, M., de Joncheere, C. P., Ewen, M. A., … Reich, M. R. (2017). Essential medicines for universal health coverage. *The Lancet, 389*(10067), 403–476. https://doi.org/10.1016/S0140-6736(16)31599-9

World Health Organization (WHO) (2023) Substandard and falsified medical products. Geneva: WHO. https://doi.org/10.4060/xxxx

World Health Organization (2017). *WHO model list of essential medicines, 20th list.* Geneva: World Health Organization. Retrieved from https://www.who.int/publications/i/item/WHO-MVP-EMP-IAU-2017.06

Yeow TP, Aun ES-Y, Hor CP, Lim SL, Khaw CH, Aziz NA (2019) Challenges in the classification and management of Asian youth-onset diabetes mellitus- lessons learned from a single centre study. PLoS ONE 14(1): e0211210. https://doi.org/10.1371/journal.pone.0211210

Zulu, J. (2017). *Qualitative assessment of dextrose five percent intravenous infusion used in Lusaka* (Doctoral dissertation, The University of Zambia).