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# A Comparative Study of Physicochemical Parameters and Quality Standards of Selected Homoeopathic Mother Tinctures Procured from Retail Pharmacies of Bhopal, Madhya Pradesh

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**Abstract**

**Background**: The physicochemical consistency of homoeopathic mother tinctures is important because these hydroalcoholic preparations constitute primary pharmaceutical products and, for many medicines, starting materials for subsequent potencies. Variability in raw material, extraction, alcohol strength, manufacturing practice and storage may affect the finished product.

**Objective**: To comparatively evaluate selected physicochemical parameters and quality standards of commonly available homoeopathic mother tinctures procured from retail pharmacies of Bhopal, Madhya Pradesh.

**Materials and Methods**: A cross-sectional comparative laboratory study was structured using 30 retail samples comprising five mother tinctures—Arnica montana Q, Rauwolfia serpentina Q, Nux vomica Q, Calendula officinalis Q and Andrographis paniculata Q. Three coded manufacturers (A, B and C) and two batches per manufacturer were included for each medicine. Samples were assessed for organoleptic properties, clarity/sediment, pH, specific gravity, weight per millilitre, total solids, alcohol content and TLC/HPTLC identity, with interpretation against the applicable Homoeopathic Pharmacopoeia of India (HPI) monograph or validated reference specifications.

**Results**: In the illustrative dataset, 27 of 30 samples (90.0%) met all evaluated quality criteria. Chromatographic identity was concordant in all samples. Three samples showed a deviation requiring repeat verification: AM-C2 showed reduced total solids, RS-C1 showed reduced alcohol content and NV-B2 showed an atypical pH. Brand A showed 100% complete conformity, Brand B 90% and Brand C 80%. Density-related parameters displayed relatively low inter-brand variability, whereas total solids and alcohol content showed greater discriminatory value.

**Conclusion**: A combined physicochemical and chromatographic approach provides a practical framework for comparative post-market quality assessment of homoeopathic mother tinctures.

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Routine surveillance of retail products and batch-wise verification of key pharmacopoeial parameters may strengthen pharmaceutical quality assurance.

**Keywords:** Homoeopathic mother tinctures; physicochemical parameters; quality standards; HPI; pH; specific gravity; total solids; alcohol content; HPTLC; Bhopal.

## 1. INTRODUCTION

Homoeopathic mother tinctures are primary liquid preparations manufactured from authenticated plant, animal or other source materials according to pharmacopoeial procedures. In plant-derived preparations, the raw drug is commonly extracted with a prescribed hydroalcoholic menstruum, and the resulting tincture contains a complex mixture of volatile and non-volatile constituents. The quality of the finished preparation therefore depends not only on botanical identity but also on drug strength, moisture status of the raw material, solvent composition, extraction method, filtration, storage and packaging.

Quality assessment of mother tinctures is particularly important because physical appearance alone cannot establish pharmaceutical consistency. Two preparations may be similar in colour and odour while differing in alcohol content, extractive matter or chromatographic fingerprint. Official pharmacopoeial standards consequently combine identity, purity and strength parameters. The Pharmacopoeia Commission for Indian Medicine & Homoeopathy (PCIM&H), Ministry of AYUSH, develops official standards and describes pharmacopoeial monographs as legally recognised standards that employ physicochemical and instrumental methods for ensuring identity, purity and strength [1,2].

Routine physicochemical parameters such as pH, specific gravity or weight per millilitre, total solids and alcohol content provide useful indicators of manufacturing consistency. Alcohol strength affects solvent polarity, extraction efficiency and stability; total solids reflect the non-volatile extractive fraction; and deviations in pH or density may indicate changes in composition, processing or storage. These tests are relatively economical and therefore especially suitable for teaching and quality-control laboratories [3,4].

Chromatographic fingerprinting adds a second level of quality assurance by examining chemical identity and characteristic constituent patterns. HPTLC has been used for the standardisation of Nux vomica mother tincture, comparative estimation of reserpine in Rauwolfia serpentina, qualitative assessment of Calendula officinalis and validation of marker-based or fingerprint methods for several homoeopathic mother tinctures [5-10]. Recent analytical work continues to support the integration of pharmacopoeial physicochemical testing with validated chromatographic methods [10,11].

Retail-market comparison is relevant because patients and practitioners may purchase the same named mother tincture from different manufacturers and batches. A local comparative

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assessment can identify whether products show acceptable consistency and can highlight parameters that merit closer monitoring. Bhopal, being a major educational and healthcare centre of Madhya Pradesh with numerous homoeopathic retail pharmacies, provides an appropriate setting for such a pharmaceutical quality-control study. The present work therefore focuses on a comparative, batch-based evaluation rather than on therapeutic efficacy.

## 2. AIM AND OBJECTIVES

Aim: To comparatively assess the physicochemical parameters and quality standards of selected homoeopathic mother tinctures procured from retail pharmacies of Bhopal, Madhya Pradesh.

- To procure and code commonly available mother tinctures from multiple retail pharmacies and manufacturers in Bhopal.
- To compare organoleptic characteristics, clarity and sedimentation among coded retail samples.
- To determine pH, specific gravity, weight per millilitre, total solids and alcohol content using standard laboratory procedures.
- To assess chromatographic identity through TLC/HPTLC according to the applicable HPI monograph or a validated published method.
- To compare manufacturer-wise and batch-wise consistency within each selected mother tincture.
- To determine the proportion of samples showing complete conformity with the selected quality criteria and identify parameters responsible for any observed deviation.

## 3. MATERIALS AND METHODS

### 3.1 Study design and study area

A cross-sectional comparative laboratory study design was used. Retail products were conceptualised as being procured from licensed homoeopathic pharmacies located in Bhopal, Madhya Pradesh. Laboratory evaluation was designed for the Department of Homoeopathic Pharmacy using pharmacopoeial quality-control procedures. The study involved finished pharmaceutical products only and did not include human participants, animals or clinical intervention.

### 3.2 Sample size and sampling framework

The total sample size was 30 bottles. Five commonly marketed mother tinctures were selected. For each medicine, products from three manufacturers were coded A, B and C, and two different batches per manufacturer were included. Each mother tincture therefore contributed six independent retail samples (5 medicines × 3 manufacturers × 2 batches = 30 samples). Manufacturer coding was retained during analysis to avoid promotional or reputational interpretation of the model dataset.

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**Table 1. Sampling framework**

| Mother tincture | Code | Brands | Batches/brand | Samples | Primary comparison |
|---|---|---|---|---|---|
| Arnica montana Q | AM | A, B, C | 2 | 6 | Inter-brand and batch consistency |
| Rauwolfia serpentina Q | RS | A, B, C | 2 | 6 | Inter-brand and batch consistency |
| Nux vomica Q | NV | A, B, C | 2 | 6 | Inter-brand and batch consistency |
| Calendula officinalis Q | CO | A, B, C | 2 | 6 | Inter-brand and batch consistency |
| Andrographis paniculata Q | AP | A, B, C | 2 | 6 | Inter-brand and batch consistency |

### 3.3 Inclusion and exclusion criteria

Inclusion criteria comprised sealed commercial mother tinctures bearing readable product name, batch number and manufacturing/expiry information; products within labelled shelf life; and two distinct batches for each coded manufacturer wherever available. Expired, damaged, leaking, unlabelled or improperly stored packs were excluded. Duplicate bottles from the same batch were not treated as separate market samples.

### 3.4 Analytical parameters

Testing was aligned with the applicable individual HPI monograph and general pharmacopoeial procedures. Where a parameter was not specified in an accessible monograph, a validated published standardisation method was used as a methodological reference rather than as a substitute regulatory specification. Each quantitative measurement was planned in triplicate and the bottle-level mean was used for analysis.

**Table 2. Physicochemical and identity parameters evaluated**

| Parameter | Method/instrument | Reported as | Quality significance |
|---|---|---|---|
| Organoleptic profile | Visual examination under uniform light; characteristic odour | Colour, clarity, odour | Initial identity and gross physical consistency |

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| | | | |
|---|---|---|---|
| | noted | | |
| Sediment | Standing observation against contrasting background | Absent / present | Possible precipitation, instability or contamination signal |
| pH | Calibrated digital pH meter | pH units | Batch consistency; compositional/stability indicator |
| Specific gravity | Pycnometer/specific-gravity bottle at controlled temperature | Dimensionless | Density and solvent/extractive consistency |
| Weight per mL | Gravimetric determination using calibrated volumetric apparatus | g/mL | Finished-product density check |
| Total solids | Measured aliquot evaporated to dryness to constant mass | % w/v or monograph expression | Non-volatile extractive matter |
| Alcohol content | Pharmacopoeial distillation/density or validated alcoholometric method | % v/v | Menstruum strength and extraction/stability control |
| TLC/HPTLC identity | Silica gel plate; monograph/validated mobile phase and visualization | Concordant / non-concordant fingerprint | Chemical identity and characteristic profile |

### 3.5 Quality assurance and calibration

The pH meter was calibrated with standard buffers before use. Volumetric glassware and density vessels were examined for cleanliness and integrity. Analytical-grade reagents were used. Triplicate determinations were planned for quantitative parameters. For chromatographic work, sample application volume, chamber saturation, solvent front and visualization conditions were standardised. A reference standard or authenticated comparator was used whenever required by the selected method. Any out-of-range screening result was to be repeated before final classification.

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### 3.6 Outcome definition and statistical analysis

Complete conformity was defined as meeting all evaluated sample-specific physicochemical, visual and chromatographic criteria. Results were summarized as mean ± standard deviation and range. Manufacturer-wise and medicine-wise conformity were expressed as proportions. Coefficient of variation (CV%) was calculated within each medicine for the main quantitative parameters to describe the relative spread across the six sampled batches. Because only two independent batches per manufacturer were included, formal manufacturer ranking by inferential statistics was not considered methodologically appropriate; interpretation therefore emphasized descriptive batch consistency and pharmacopoeial conformity.

## 4. RESULTS

Thirty coded retail samples were included. In the illustrative dataset, 27 samples (90.0%) fulfilled all selected quality criteria. All 30 samples were visually characteristic at initial examination and showed a chromatographic pattern considered concordant with the applicable reference profile. Three samples showed one isolated physicochemical deviation that would require repeat laboratory confirmation before any regulatory conclusion.

**Table 3. Overall physicochemical profile of the selected mother tinctures (six samples per medicine)**

| Mother tincture | pH | Specific gravity | Weight/mL (g/mL) | Total solids | Alcohol (% v/v) | Complete conformity |
|---|---|---|---|---|---|---|
| Arnica montana Q | 5.34 ± 0.04 | 0.937 ± 0.002 | 0.935 ± 0.002 | 1.82 ± 0.14 | 45.1 ± 0.3 | 5/6 (83.3%) |
| Rauwolfia serpentina Q | 6.04 ± 0.03 | 0.876 ± 0.002 | 0.874 ± 0.002 | 1.40 ± 0.03 | 75.4 ± 1.6 | 5/6 (83.3%) |
| Nux vomica Q | 5.71 ± 0.30 | 0.879 ± 0.002 | 0.877 ± 0.002 | 2.22 ± 0.03 | 76.6 ± 0.3 | 5/6 (83.3%) |
| Calendula officinalis Q | 5.54 ± 0.03 | 0.952 ± 0.002 | 0.950 ± 0.002 | 2.05 ± 0.03 | 40.1 ± 0.3 | 6/6 (100.0%) |
| Andrographis paniculata Q | 5.83 ± 0.04 | 0.906 ± 0.002 | 0.904 ± 0.002 | 2.76 ± 0.03 | 62.1 ± 0.3 | 6/6 (100.0%) |

**Table 4. Sample-wise results and quality classification (illustrative dataset)**

| Sample | Mother tincture | pH | SG | Wt/mL | Total solids | Alcohol % | TLC/HPTLC | Status |
|---|---|---|---|---|---|---|---|---|
| AM-A1 | Arnica montana | 5.29 | 0.934 | 0.932 | 1.91 | 45.5 | Concordant | Complies |
| AM-A2 | Arnica | 5.35 | 0.935 | 0.933 | 1.88 | 45.2 | Concordant | Complies |

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| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | montana | | | | | | | |
| AM-B1 | Arnica montana | 5.37 | 0.937 | 0.935 | 1.83 | 44.7 | Concordant | Complies |
| AM-B2 | Arnica montana | 5.32 | 0.936 | 0.934 | 1.87 | 45.1 | Concordant | Complies |
| AM-C1 | Arnica montana | 5.40 | 0.939 | 0.937 | 1.90 | 45.4 | Concordant | Complies |
| AM-C2 | Arnica montana | 5.34 | 0.940 | 0.938 | 1.52 | 44.8 | Concordant | Does not comply |
| RS-A1 | Rauwolfia serpentina | 5.98 | 0.873 | 0.871 | 1.44 | 76.5 | Concordant | Complies |
| RS-A2 | Rauwolfia serpentina | 6.04 | 0.874 | 0.872 | 1.41 | 76.2 | Concordant | Complies |
| RS-B1 | Rauwolfia serpentina | 6.06 | 0.876 | 0.874 | 1.36 | 75.7 | Concordant | Complies |
| RS-B2 | Rauwolfia serpentina | 6.01 | 0.875 | 0.873 | 1.40 | 76.1 | Concordant | Complies |
| RS-C1 | Rauwolfia serpentina | 6.09 | 0.878 | 0.876 | 1.43 | 71.9 | Concordant | Does not comply |
| RS-C2 | Rauwolfia serpentina | 6.03 | 0.879 | 0.877 | 1.37 | 75.8 | Concordant | Complies |
| NV-A1 | Nux vomica | 5.51 | 0.876 | 0.874 | 2.26 | 77.0 | Concordant | Complies |
| NV-A2 | Nux vomica | 5.57 | 0.877 | 0.875 | 2.23 | 76.7 | Concordant | Complies |
| NV-B1 | Nux vomica | 5.59 | 0.879 | 0.877 | 2.18 | 76.2 | Concordant | Complies |
| NV-B2 | Nux vomica | 6.38 | 0.878 | 0.876 | 2.22 | 76.6 | Concordant | Does not comply |
| NV-C1 | Nux vomica | 5.62 | 0.881 | 0.879 | 2.25 | 76.9 | Concordant | Complies |
| NV-C2 | Nux vomica | 5.56 | 0.882 | 0.880 | 2.19 | 76.3 | Concordant | Complies |
| CO-A1 | Calendula officinalis | 5.49 | 0.949 | 0.947 | 2.09 | 40.5 | Concordant | Complies |
| CO-A2 | Calendula officinalis | 5.55 | 0.950 | 0.948 | 2.06 | 40.2 | Concordant | Complies |
| CO-B1 | Calendula officinalis | 5.57 | 0.952 | 0.950 | 2.01 | 39.7 | Concordant | Complies |
| CO-B2 | Calendula | 5.52 | 0.951 | 0.949 | 2.05 | 40.1 | Concordant | Complies |

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| | officinalis | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| CO-C1 | Calendula officinalis | 5.60 | 0.954 | 0.952 | 2.08 | 40.4 | Concordant | Complies |
| CO-C2 | Calendula officinalis | 5.54 | 0.955 | 0.953 | 2.02 | 39.8 | Concordant | Complies |
| AP-A1 | Andrographis paniculata | 5.77 | 0.903 | 0.901 | 2.80 | 62.5 | Concordant | Complies |
| AP-A2 | Andrographis paniculata | 5.83 | 0.904 | 0.902 | 2.77 | 62.2 | Concordant | Complies |
| AP-B1 | Andrographis paniculata | 5.85 | 0.906 | 0.904 | 2.72 | 61.7 | Concordant | Complies |
| AP-B2 | Andrographis paniculata | 5.80 | 0.905 | 0.903 | 2.76 | 62.1 | Concordant | Complies |
| AP-C1 | Andrographis paniculata | 5.88 | 0.908 | 0.906 | 2.79 | 62.4 | Concordant | Complies |
| AP-C2 | Andrographis paniculata | 5.82 | 0.909 | 0.907 | 2.73 | 61.8 | Concordant | Complies |

### 4.1 Manufacturer-wise comparison

**Table 5. Manufacturer-wise complete conformity**

| Coded manufacturer | Samples tested | Completely conforming | Conformity % |
|---|---|---|---|
| Brand A | 10 | 10 | 100.0 |
| Brand B | 10 | 9 | 90.0 |
| Brand C | 10 | 8 | 80.0 |

Brand A showed complete conformity in all ten sampled bottles. Brand B showed one sample requiring verification (NV-B2) and Brand C showed two (AM-C2 and RS-C1). These observations represent only the sampled batches and should not be interpreted as a definitive manufacturer ranking.

### 4.2 Relative variability of quantitative parameters

**Table 6. Coefficient of variation across six samples of each mother tincture**

| Mother tincture | pH CV% | SG CV% | Weight/mL CV% | Total solids CV% | Alcohol CV% |
|---|---|---|---|---|---|
| Arnica montana Q | 0.65 | 0.23 | 0.23 | 7.47 | 0.65 |
| Rauwolfia | 0.58 | 0.24 | 0.24 | 2.08 | 2.09 |

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| | | | | | |
|---|---|---|---|---|---|
| serpentina Q | | | | | |
| Nux vomica Q | 5.32 | 0.24 | 0.24 | 1.31 | 0.38 |
| Calendula officinalis Q | 0.63 | 0.22 | 0.22 | 1.42 | 0.73 |
| Andrographis paniculata Q | 0.60 | 0.23 | 0.23 | 1.05 | 0.47 |

Specific gravity and weight per millilitre showed low relative variability in the model data, indicating good density consistency across batches. Total solids showed greater variability, particularly in Arnica montana because of the deliberately modelled low-solids sample. Alcohol variation was most evident in Rauwolfia serpentina due to the modelled low-alcohol sample. These findings illustrate why total solids and alcohol strength can be more discriminating than gross appearance alone.

### 4.3 Samples requiring repeat verification

**Table 7. Observed deviations in the illustrative dataset**

| Sample | Observed deviation | Quality implication | Recommended action |
|---|---|---|---|
| AM-C2 | Reduced total solids | Possible weak extraction, dilution or batch variability | Repeat total-solids determination; verify exact monograph and batch record |
| RS-C1 | Alcohol content below expected range | Possible solvent-strength/process/storage variation | Repeat alcohol estimation; inspect closure and manufacturing record |
| NV-B2 | Atypical pH | Possible compositional, stability or analytical variation | Recalibrate pH meter and repeat; compare with reference batch/monograph |

## 5. DISCUSSION

The comparative framework demonstrates the value of evaluating several complementary quality parameters rather than relying on a single physical characteristic. In the model dataset, all samples were visually acceptable and chromatographically concordant, yet three bottles showed physicochemical deviations. This is consistent with the broader principle of pharmacopoeial quality assurance, in which identity, purity and strength are evaluated through a combination of tests rather than appearance alone [1,2].

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Density-related parameters were relatively stable across the sampled products. Specific gravity and weight per millilitre are simple measurements, but they are sensitive to the overall composition of the hydroalcoholic system and can reveal major formulation inconsistencies. Their low CV values in the illustrative dataset suggest that these measurements are useful as rapid batch checks but may be less sensitive than total solids or marker-based analysis for detecting subtle differences among otherwise similar products.

Total solids represent the non-volatile residue of a mother tincture and can vary with raw-drug quality, drug strength, extraction efficiency and dilution. The modelled reduction in AM-C2 therefore warrants repeat testing. Physicochemical standardisation work on homoeopathic preparations has similarly used total solids alongside pH, specific gravity and chromatographic profiling to establish a multidimensional quality profile [4,9]. Biswas et al. demonstrated this approach for Apis mellifica by comparing an in-house and commercial mother tincture using sediment, specific gravity, pH, total solids, UV-visible spectra and HPTLC [9].

Alcohol content is another critical parameter because the ethanol-water ratio determines the extraction environment for many plant constituents and contributes to product stability. The modelled reduction in RS-C1 would therefore be pharmaceutically meaningful if confirmed. Earlier comparative work on Rauwolfia serpentina showed that marketed and in-house mother tinctures may differ in chemical marker content, and HPTLC was able to differentiate reserpine levels among products [6]. Such findings support the interpretation of alcohol strength as an important process-control parameter rather than merely a labelling characteristic.

The atypical pH modelled in NV-B2 illustrates the role of pH as a consistency indicator. pH does not independently prove identity or therapeutic quality, but an unexpected shift can signal altered solvent composition, degradation, raw-material variation or analytical error and should therefore trigger repeat measurement. In Nux vomica, HPTLC-based studies have demonstrated the value of combining routine pharmaceutical assessment with chemical fingerprinting and marker evaluation, particularly for alkaloids such as brucine and strychnine [5,8].

Chromatographic concordance across all model samples is relevant because HPTLC and TLC provide chemical pattern information not obtainable from pH or density. Shanbhag and Jayaraman established an HPTLC fingerprint approach for Nux vomica [5], Sharma et al. applied HPTLC to Calendula officinalis [7], and Kumar et al. later developed and validated HPTLC fingerprints for sixteen mother tinctures lacking established standards [10]. In 2026, marker-based HPTLC and UPLC approaches for Swertia chirayita and Andrographis paniculata further demonstrated how validated chemical markers can strengthen homoeopathic drug standardisation [11].

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The present comparative design is also consistent with the broader emphasis on quality control in homoeopathic pharmacy. Uikey and Soni highlighted the importance of purity, genuineness and systematic quality-control procedures for ensuring reliable homoeopathic medicines [12]. For a teaching department, the current framework is practical because the basic physicochemical tests are accessible, while TLC/HPTLC introduces students to modern identity and fingerprint analysis.

The model manufacturer-wise differences must be interpreted cautiously. A 100%, 90% or 80% conformity proportion from only ten samples per coded manufacturer is a description of sampled bottles, not a market-wide performance estimate. Any non-conformity observed in real laboratory work should be confirmed through repeat testing, verified against the exact HPI monograph and, where regulatory action is contemplated, referred to an appropriately recognised testing laboratory.

## 6. LIMITATIONS

- The numerical results are illustrative/model data because original laboratory observations were not provided. They must not be represented as measured findings until replaced or verified.
- The proposed design includes only two independent batches per manufacturer for each medicine, which is adequate for an exploratory comparative project but insufficient for definitive manufacturer ranking.
- Only selected routine physicochemical and chromatographic identity parameters are included. Microbial limits, pesticide residues, heavy metals, aflatoxins and quantitative marker assays were outside the proposed scope.
- Retail storage history before purchase cannot always be fully reconstructed and may influence alcohol loss, sediment formation or stability.
- Exact conformity limits must be taken from the applicable current HPI monograph for each drug and not inferred from the illustrative values shown in this draft.

## 7. CONCLUSION

Comparative evaluation of selected physicochemical parameters provides a practical and academically relevant method for examining the quality consistency of homoeopathic mother tinctures available in the retail market. In the illustrative 30-sample framework, most products showed complete conformity, while a small number demonstrated isolated variation in total solids, alcohol content or pH. The combined use of organoleptic examination, pH, density measurements, total solids, alcohol estimation and TLC/HPTLC identity offers a stronger quality assessment than any single test. Routine batch-wise monitoring, strict adherence to current HPI

requirements and confirmatory testing of any deviation are recommended for reliable pharmaceutical quality assurance.

## 8. RECOMMENDATIONS

- Future studies should include a larger number of retail outlets, manufacturers and independent batches.
- Exact HPI monograph specifications should be recorded prospectively for each selected mother tincture before sample testing.
- Validated HPTLC densitometry or HPLC/UPLC marker quantification should be added where suitable markers are available.
- Real-world surveillance studies should incorporate microbial limits and, where indicated, heavy metals, pesticide residues and aflatoxin testing.
- Out-of-specification findings should be repeated from the same bottle and, if confirmed, verified using a second bottle from the same batch before interpretation.
- Laboratory worksheets should retain calibration records, raw readings, chromatograms and calculations to ensure traceability.

## 9. DECLARATIONS

Ethical consideration: The study concerns commercially available pharmaceutical products and does not involve human participants or experimental animals. Institutional requirements regarding laboratory/project approval should nevertheless be followed.

Conflict of interest: To be declared by the authors. Manufacturer identities should remain coded in academic reporting unless disclosure is scientifically and legally justified.

Funding: To be declared by the authors.

Data availability: Raw laboratory worksheets, instrument readings and chromatographic records should be retained by the investigators and made available according to institutional or journal requirements.

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