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Research Article

Comparative UV Spectrophotometric Analysis of Different Brands of Paracetamol Tablets

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ABSTRACT

Quality is a critical concern in the pharmaceutical industry because medicines must be both safe and therapeutically effective. UV analysis plays an essential role in confirming drug quality, safety and efficacy. Paracetamol (acetaminophen), an active metabolite of phenacetin, is widely used to relieve pain, headaches, and symptoms associated with cold and flu conditions. Numerous brands of paracetamol tablets are available in the Indian pharmaceutical market. The present study aimed to perform a comparative UV analysis of different marketed brands to assess whether the formulations were pharmaceutically equivalent or showed significant variation. A calibration curve was prepared within the concentration range of 1–10 µg/mL and analysed at 243 nm using a Shimadzu UV 1900i double-beam spectrophotometer. Three commercially available brands of 650 mg conventional paracetamol tablets produced by different manufacturers were selected for percentage assay. The percentage purity or assay of different marketed brands varies from each other. The results shows all the tablets are within the acceptable range. The findings from the release kinetic studies indicated that all selected brands complied with acceptable manufacturing quality standards.

INTRODUCTION

Paracetamol is one of the most frequently prescribed non-steroidal anti-inflammatory drugs (NSAIDs) and is extensively used worldwide due to its effectiveness and safety profile. It is commonly administered as an analgesic and antipyretic agent for the management of fever, headaches, muscle pain, toothache, and other minor aches and pains[1-2]. Because of its rapid onset of action and easy availability, paracetamol is included in many over-the-counter medications and combination formulations used for cold and flu treatment. Chemically, paracetamol is identified as 4-hydroxyacetanilide, also known as acetaminophen. Under recommended therapeutic doses, paracetamol is generally regarded as safe and well tolerated by most individuals. However, excessive consumption or overdose of

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paracetamol can lead to severe hepatotoxicity, which may result in irreversible liver damage and can even become life-threatening. In certain rare cases, liver toxicity may also occur at normal therapeutic doses due to individual hypersensitivity or underlying health conditions. Therefore, maintaining the quality, safety, and efficacy of paracetamol formulations is extremely important in pharmaceutical manufacturing. The therapeutic effectiveness and safety of any pharmaceutical dosage form largely depend on its formulation characteristics and manufacturing process. Variations in excipients, production techniques, storage conditions, and quality control measures may influence the final performance of the dosage form. As a result, differences may exist among marketed products manufactured by different pharmaceutical companies. Ensuring consistent quality is therefore essential to guarantee proper drug release, absorption, and therapeutic action. UV analysis is done to check whether the content of drug matches with the label claim or not. This is the study done on label claim vs the actual content found in different marketed brands of paracetamol tablets[3-4].

AIM

To perform a comparative study of different brands of paracetamol tablets using UV–Visible spectrophotometry by analysing and comparing their pharmaceutical quality parameters, including drug content and compliance with standard specifications.

OBJECTIVES

1. To prepare standard and sample solutions of different brands of paracetamol tablets for UV–Visible spectrophotometric analysis.
2. To determine the maximum absorption wavelength (λmax) of paracetamol using UV–Visible spectrophotometry.
3. To construct a calibration curve of paracetamol at different concentrations using Beer–Lambert's law.

   $A = \varepsilon lc$
4. To estimate the assay/drug content of various marketed brands of paracetamol tablets by UV–Visible spectrophotometric method.
5. To compare the percentage purity and label claim of different paracetamol tablet brands.
6. To evaluate whether the selected brands comply with pharmacopeial standards and quality control parameters.
7. To assess the suitability, accuracy, and reliability of UV–Visible spectrophotometry as a simple and cost-effective analytical technique for comparative drug analysis.[5-6,7]

NEED OF RESEARCH

Paracetamol tablets are among the most widely used over-the-counter analgesic and antipyretic medications worldwide. Numerous pharmaceutical companies manufacture paracetamol tablets using different formulations, excipients, and manufacturing techniques. Although these products contain the same active pharmaceutical ingredient, variations in formulation and production processes may influence the quality, stability, dissolution behaviour, and therapeutic effectiveness of the tablets.[5-7]

Quality evaluation of pharmaceutical preparations is therefore essential to ensure that all marketed

brands comply with pharmacopeial standards and provide the desired therapeutic effect. Among the various analytical techniques available, UV–Visible spectrophotometry is widely used because it is simple, rapid, accurate, economical, and suitable for routine quality control analysis of drugs.

The present research is needed to compare different brands of paracetamol tablets in terms of drug content and quality using UV–Visible spectrophotometry. The study will help identify any variation among brands and determine whether the products meet the required specifications and label claims. It also highlights the importance of analytical methods in maintaining the quality, efficacy, and safety of pharmaceutical products available to consumers.[6,8-9]

The need for this research arises due to:

- Increasing availability of multiple generic and branded paracetamol formulations in the pharmaceutical market.
- Possibility of variations in formulation composition and manufacturing processes among different manufacturers.
- Requirement to ensure compliance with USP/IP quality standards for safety and efficacy.
- Need for post-marketing surveillance to detect substandard or poor-quality formulations.
- Importance of dissolution and assay studies in predicting in vivo drug performance.

PLAN OF WORK

Title

Comparative Study of Different Brands of Paracetamol Tablets Using UV-Visible Spectrophotometry

1. Selection of Drug and Marketed Brands

- Selection of paracetamol as the model drug.
- Collection of different marketed brands of paracetamol tablets from local pharmacies/medical stores.

2. Literature Review

- Collection of research articles, review papers, pharmacopeial references, and analytical methods related to:
  - Paracetamol tablet analysis
  - UV-visible spectrophotometry
  - Comparative quality assay
  - USP/IP quality control parameters

3. Procurement of Chemicals and Instruments

Chemicals

- Standard Paracetamol API
- Distilled water \ NaOH

Instruments

- UV-Visible Spectrophotometer
- Analytical balance
- Glassware and filtration setup

4. Preparation of Standard Solution

- Accurately weigh standard paracetamol.

- Prepare stock solution using suitable solvent (0.1 N NaOH/distilled water).
- Prepare working standard solutions of different concentrations.

5. Determination of λmax of Paracetamol

- Scan standard solution in UV range (200–400 nm).
- Determine maximum absorbance wavelength (λmax) of paracetamol.

Typically: λ-max = 243 nm

6. Preparation of Calibration Curve

- Prepare solutions of different concentrations.
- Measure absorbance at λmax.
- Plot calibration curve between concentration and absorbance.

Based on Beer-Lambert's Law:

$$A=\varepsilon lc$$

Where:

- A = Absorbance
- ε = Molar absorptivity
- l = Path length
- c = Concentration

7. Assay of Paracetamol Tablets by UV Spectrophotometry

- Powder tablets and prepare sample solution.
- Dilute appropriately with solvent.
- Measure absorbance at λmax.
- Calculate percentage drug content using calibration curve.

Drug content calculation:

% Drug Content=

Standard Absorbance/Sample Absorbance × Sample Concentration/Standard Concentration ×100

8. Comparative Data Analysis

- Compare all brands based on:
  - Drug content
- Statistical comparison of obtained results.

10. Interpretation and Conclusion

- Interpret comparative analytical data.
- Determine pharmaceutical equivalence among brands.
- Conclude whether selected brands comply with IP/USP standards.

DRUG PROFILE

Table no.1.

Parameter	Description
Generic Name	Paracetamol
Synonym	Acetaminophen
IUPAC Name	N-(4-hydroxyphenyl)acetamide
Chemical Formula	$C_8H_9NO_2$
Molecular Weight	151.16 g/mol
Category	Analgesic and Antipyretic
Drug Class	Non-opioid analgesic
Pharmacopoeia	IP, BP, USP

THERAPEUTIC USES

Paracetamol is used for:

- Fever

- Headache
- Toothache
- Muscle pain
- Joint pain
- Cold and flu symptoms
- Mild to moderate pain

PHYSICOCHEMICAL PROPERTIES

Table no.2.

Property	Description
Melting Point	168°C – 172°C
Solubility	Slightly soluble in water; freely soluble in alcohol
pKa	Approximately 9.5
λmax (UV)	243-245 nm

DOSE

Table no.3.

Population	Dose
Adults	500–1000 mg every 4–6 hours
Maximum Adult Dose	4 g/day
Paediatric Dose	According to body weight

[1-2]

Fig.1. structure of paracetamol

MATERIALS AND EQUIPMENTS

INSTRUMENT :-

- UV SPECTROPHOTOMETER : UV-1900i(SHIMADZU)

Fig.2. UV spectrophotometer

CHEMICALS :-

- STD Paracetamol

fig.3.std paracetamol powder

- Marketed brands of paracetamol tablets IP

1. Brand no 1

2. Brand no 2

3.Brand no 3

GLASSWARES:-

- Volumetric Flasks (100 ml & 10 ml)
- Beakers
- Funnel

- Mortar and Pestle
- Spatula
- Filter Paper

Fig.4.volumetric flask (100ml)

Fig.5. morter & pestle

Fig.6. volumetric flask (10ml)

EXPERIMENTAL WORK

1. Determination of Λ-Max of Paracetamol:

Accurately weigh 100 mg of standard paracetamol and transfer into a 100 mL volumetric flask. Dissolve using distilled water and make volume up to 100 ml. Further dilute the solution to obtain suitable concentration. Scan the solution in UV range 200–400 nm using UV spectrophotometer. Record wavelength of maximum absorbance.

Observe λ-max = 243 nm

2. Preparation of Calibration Curve

Procedure

1. Prepare stock solution containing 1000 µg/mL paracetamol.
2. Prepare working standard solutions of:

- 2 µg/mL
- 4 µg/mL
- 6 µg/mL
- 8 µg/mL
- 10 µg/mL

3. **Measure absorbance of each solution at 243 nm.**
4. **Plot graph of concentration versus absorbance.**

Beer-Lambert law: A=εbc [3-10]

Assay of Paracetamol Tablets by UV Spectrophotometry

Procedure

1. Powder 20 tablets from each brand.
2. Weigh powder equivalent to 100 mg paracetamol.

3. Transfer into 100 mL volumetric flask.
4. Add 0.1 N NaOH / Distilled Water and sonicate/shake to dissolve.
5. Filter the solution.
6. Dilute appropriately with distilled water.
7. Measure absorbance at 243 nm.

Drug content calculation:

% Drug Content=

Standard Absorbance/Sample Absorbance x Concentration Standard/Sample Concentration ×100

SPECTRA :-

Fig.7. BRAND N0 3

Fig.8. STD Paracetamol

Fig.9. BRAND NO 1

Fig.10. BRAND NO 2

OBSERVATION :-

STD Paracetamol:-

Table no.4.

Dilutions	Absorbance (243nm)
2ml	0.399
4ml	0.417
6ml	0.432
8ml	0.433
10ml	0.469

BRAND NO 2–

Table no.5.

Dilutions	Absorbance (243nm)
2ml	0.397
4ml	0.407
6ml	0.422
8ml	0.432
10ml	0.428

BRAND NO 1–

Table no.6.

Dilutions	Absorbance (243nm)
2ml	0.392
4ml	0.410
6ml	0.428
8ml	0.430
10ml	0.432

BRAND NO 3 -

Table no.7.

Dilutions	Absorbance (243nm)
2ml	0.398
4ml	0.412
6ml	0.427
8ml	0.434
10ml	0.445

CALCULATION –

% Drug Content=

Standard Absorbance/Sample Absorbance x Concentration Standard/Sample Concentration ×100

1.Std Paracetamol and BRAND NO 2

0.469/0.428 X 10/10 = 1.09µg/mL

2.Std Paracetamol and BRAND NO 1

0.469/0.432 X 10/10 = 1.08µg/mL

3.Std Paracetamol and BRAND NO 3

0.469/0.445 X 10/10 = 1.05µg/mL

% ASSAY = Abs. Sample / Abs. STD X 100

1. Std. Paracetamol And BRAND NO 2 -

0.428/0.469 X 100 = 91.25%

2. Std. Paracetamol And BRAND NO 1–

0.432/0.469 X 100 = 92.11%

3. Std. Paracetamol And BRAND NO 3 –

0.445/0.469 X 100 = 94.88%

RESULT

The comparative analysis of different brands of paracetamol tablets was successfully carried out using UV–Visible spectrophotometry at 243 nm. The absorbance values obtained for the marketed formulations were compared with that of the standard paracetamol solution.

The standard paracetamol showed an absorbance of 0.469 corresponding to 100% assay. Among the tested tablet brands, brand no 3 exhibited the highest assay value of 94.88% with an absorbance of 0.445, indicating closer compliance with the standard preparation. brand no 1 showed an assay value of 92.11% with an absorbance of 0.432, while brand no 2 showed 91.25% assay with an absorbance of 0.428.

The percentage assay values of all tested brands were found to be within acceptable pharmacopeial limits, indicating that the formulations contain adequate amounts of active pharmaceutical ingredient. However, slight variations in absorbance and assay values were observed among different brands, which may be attributed to differences in formulation and manufacturing processes.

The study confirms that UV–Visible spectrophotometry is a simple, accurate, rapid, and economical method for the comparative evaluation and quality control analysis of paracetamol tablet formulations.

Table no.8.

Sr. No.	Brand Name	Absorbance at 243 nm	% Assay
1	Standard PARACETAMOL	0.469	100%
2	Brand no 2	0.428	91.25%
3	Brand no 1	0.432	92.11%
4	Brand no 3	0.445	94.88%

DISCUSSION

The present study was carried out to compare different marketed brands of paracetamol tablets using UV–Visible spectrophotometry at 243 nm. UV spectrophotometric analysis is widely accepted for routine quality control because of its simplicity, precision, rapidity, and cost-effectiveness. In this study, the absorbance of standard paracetamol solution was found to be 0.469, which was considered as 100% assay. The absorbance values obtained for different marketed brands were compared with the standard to determine the percentage assay of each formulation.

Among the tested brands, Brand no 3 showed the highest absorbance value of 0.445 with an assay value of 94.88%, indicating better conformity with the standard formulation. Brand no 1 exhibited an absorbance of 0.432 corresponding to 92.11% assay, while showed a Brand No 2 absorbance of 0.428 with 91.25% assay. Although slight variations were observed among the brands, all formulations were found to contain acceptable amounts of paracetamol within pharmacopeial limits.

The differences in assay values may be due to variation in manufacturing methods, excipients used, granulation process, storage conditions, or quality control procedures adopted by different pharmaceutical companies. However, the variation was not significant enough to affect the overall quality and efficacy of the formulations. [6,8,]

The study demonstrates that UV–Visible spectrophotometry is an effective analytical technique for the estimation of paracetamol in tablet dosage forms. The method proved to be reliable for comparative evaluation of different brands and can be used successfully for routine pharmaceutical analysis and quality assurance purposes.

Overall, the findings indicate that the selected marketed brands of paracetamol tablets possess satisfactory drug content and comply with acceptable quality standards.[9-11]

CONCLUSION

The present study successfully compared different brands of paracetamol tablets using UV spectrophotometric analysis at 243 nm. The method was found to be simple, rapid, convenient, and reliable for estimation of drug content.

The assay results showed slight variations among the selected marketed brands. Among them, Paracip 650 showed the highest percentage assay value of 94.88%, followed by BRAND NO 1with 92.11% and Alcem Para 650 with 91.25%. Despite minor differences, all tested formulations were found to contain acceptable amounts of paracetamol within pharmacopeial limits.

The study indicates that the marketed brands analyzed possess satisfactory quality and comply with standard specifications for drug content. The observed variations may be due to differences in formulation techniques, excipients, and manufacturing processes adopted by different pharmaceutical companies.

Therefore, UV–Visible spectrophotometry can be effectively used as a reliable analytical tool for comparative drug analysis and quality control of paracetamol tablet formulations in pharmaceutical industries and research laboratories.

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