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Research Article

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ESTIMATION OF CHLORIDES, SULPHATES AND IRON CONTAMINANTS IN BULK DRUGS FROM MGCOP COLLEGE STORE AND INDUSTRIAL SAMPLES USING CONVENTIONAL ANALYTICAL METHODS AND NEPHELO TURBIDOMETRY METHOD

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ABSTRACTS

Pharmaceutical substances contain inorganic impurities like chlorides (Cl-), sulphates (SO42-), and iron (Fe3+), which may compromise drug stability, safety, and efficacy. This research sought to estimate and compare levels of these impurities found in bulk drug samples of Paracetamol and Aspirin obtained from both an MGCOP college store and pharmaceutical industry using both conventional analytical techniques as well as nepheloturbidometry to characterize impurity profiles. Under conventional methodology, qualitative and semiquantitative assessments were completed via visual comparison of turbidity and color intensity with standard solutions. Nepheloturbidometry allowed sensitive yet quantitative detection using light scattering by insoluble complexes formed with specific reagents: AgNO3 for chlorides, BaCl2 for sulfates and NH4SCN for iron. Results revealed higher impurity levels in college store samples compared with industrial counterparts across all tests, particularly chloride and sulphate concentrations in these stores which significantly exceeded industrial counterparts, potentially indicative of storage degradation or less stringent quality control practices. Nepheloturbidometric monitoring proved superior due to enhanced precision and reproducibility making it better suited for routine impurity monitoring. This comparative analysis highlights the significance of advanced analytical techniques for pharmaceutical quality assurance and supports implementation of nepheloturbidometry as an accurate way of impurity estimation. Furthermore, its findings highlight the need for improved storage and handling practices to protect pharmaceutical substances - especially within academic or non-industrial settings.

KEYWORDS: Inorganic impurities, Nepheloturbidometry**,** Paracetamol**,** Aspirin**,** Conventional analytical methods**,** Pharmaceutical quality control**,** Chloride, Sulphate, and Iron estimation.

INTRODUCTION

Quality assurance (QA) in the pharmaceutical industry is integral to product safety, efficacy, and consistency. A key part of QA involves impurity profiling for inorganic impurities like chloride (Cl-), sulphate (SO42-) and iron (Fe3+), which could compromise drug stability and patient safety if unmonitored.[1,2] These impurities could come from raw materials used during manufacture or processing equipment used at manufacture as well as water sources.[3], although even trace levels could adversely alter performance or cause toxicities.[4] Drugs like paracetamol and aspirin are produced globally at large volumes, increasing the risk of impurity-related inconsistencies.[5] To address these impurities, regulatory bodies such as USP, BP and ICH have set strict limits[6,7] with strict detection/quantification methods mandated under USP 231> guidelines as outlined under their Q3D regulations for elemental contaminants.[6] Gravimetric, colorimetric and volumetric analyses can be cost-effective but limited by low sensitivity and variable operator variability.[8,9] Nepheloturbidometry offers an accurate alternative with light scattering to quantify suspended particles formed when reactants (AgNO3 for Cl- ions; BaCl2 for SO42- ions and NH4SCN for Fe3+ ions) react with them.[10-12] This technique offers higher sensitivity, fast results, and minimal reagent use; making it suitable for both laboratory and industrial settings.[13] In addition to supporting detection of calcium and heavy metal ions, this approach also fits well into green chemistry initiatives due to minimal waste.[14] Nepheloturbidometry requires validated protocols in order to achieve accurate measurements. Method validation according to ICH Q2(R1) must take into account parameters like linearity, detection limits and robustness so as to facilitate its routine application in quality control environments.[15]

MATERIAL AND METHODS

Materials used in this research included commercially available formulations of Paracetamol and Aspirin sold commercially; one set came from Mata Gujri College of Pharmacy (MGCOP), Kishanganj and another was obtained from pharmaceutical industries; all APIs came from licensed pharmacies with approved suppliers as part of this supply chain and batch numbers were recorded to guarantee traceability; all samples were then stored under suitable conditions according to pharmacopeial regulations for storage purposes.[16]

Standard substances and certified impurity reference standards for chloride**,** sulphate**,** and iron were used for calibration and validation. Distilled and deionized water was used throughout the analytical procedures.

METHODS

Chloride Estimation

Conventional method involved precipitation of chloride with silver nitrate in nitric acid medium. In nepheloturbidometry, turbidity from AgCl formation was measured at 420 nm. Calibration was done using NaCl solutions (10–100 ppm).[7,8,17]

Sulphate Estimation

Sulphate was precipitated using barium chloride in an acidic medium. The resulting $BaSO_4$ turbidity was measured using nephelometry immediately to avoid settling. Standard potassium sulphate solutions were used for calibration.[9]

Iron Estimation

Iron was reacted with ammonium thiocyanate to form a reddish complex. Absorbance was read at 480 nm for conventional analysis, while nephelometric values were also recorded for comparative evaluation. Calibration was done using 1–10 ppm iron standards.[9,10]

Each method was validated for linearity, sensitivity, and accuracy. Triplicate analyses ensured reproducibility, and results were statistically analyzed and compared across both techniques.

RESULT AND DISCUSSION

(1) According to Conventional Method

(a). Chloride test for Paracetamol

- There are two types of sample one is collected from college store and other is collected from pharmaceutical industry.
- Both samples compare from standard solution and after that the turbidity more present in college store sample as compare to pharmaceutical industries sample.(Figure.1)

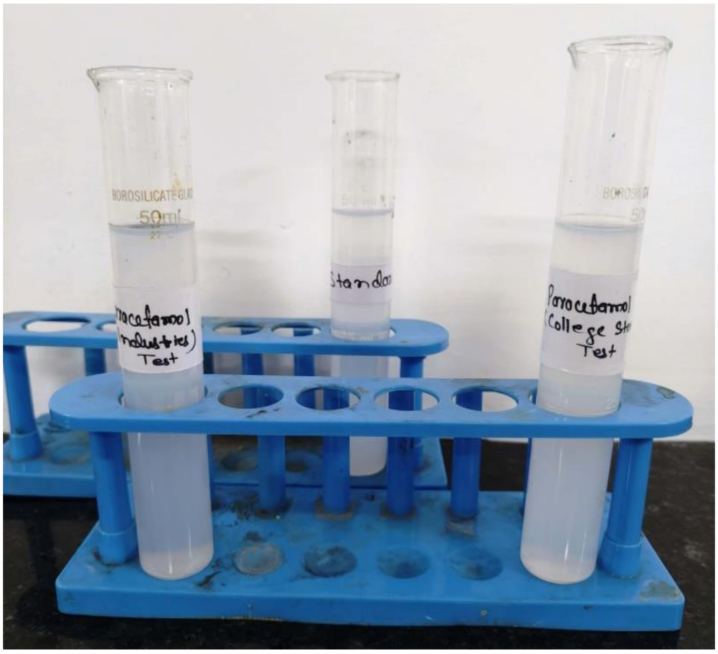


Figure.1 Chloride test for Paracetamol.

(b). Chloride test for Aspirin

- There are two types of sample one is collected from college store and other is collected from pharmaceutical industry.
- We compare both sample from standard solution and after that the turbidity more present in college store sample as compare to pharmaceutical industries sample.(Figure.2)

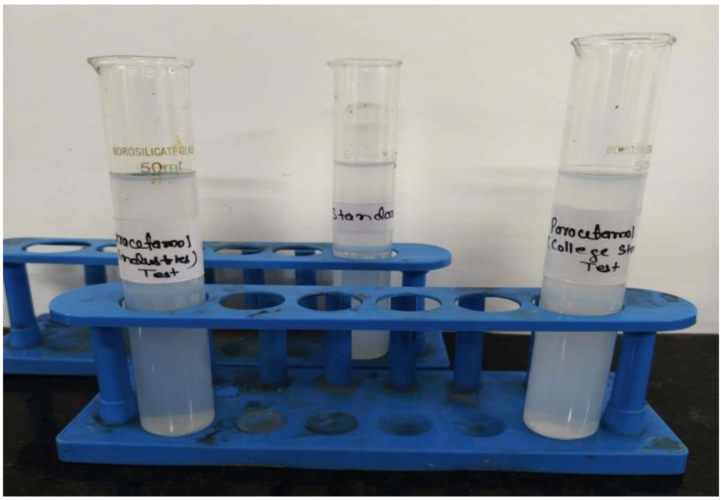


Figure.2 Chloride test for Aspirin.

(c). Sulphate test for Paracetamol

- There are two types of sample one is collected from college store and other is collected from pharmaceutical industry.
- We compare both sample from standard solution and after that the turbidity more present in college store sample as compare to pharmaceutical industries sample. .(Figure.3)

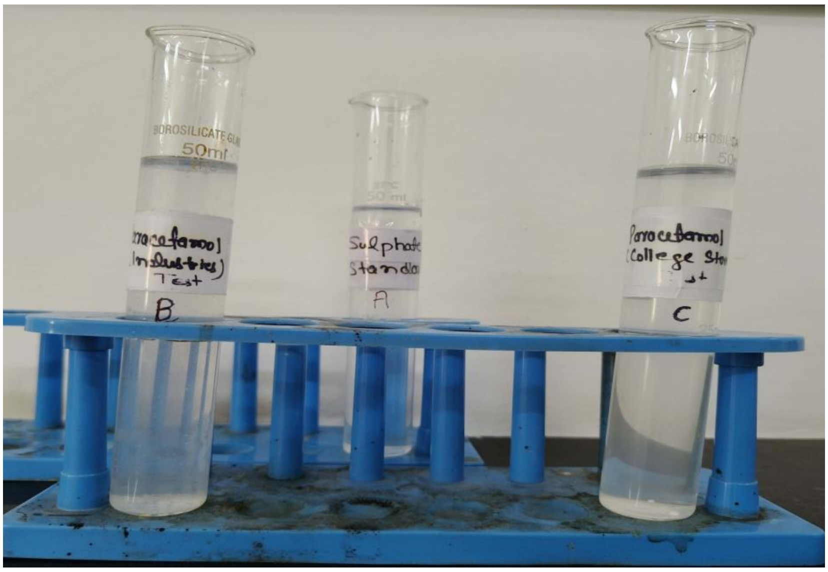


Figure.3 Sulphate test for Paracetamol.

(d). Sulphate test for Aspirin

- There are two types of sample one is collected from college store and other is collected from pharmaceutical industry.
- We compare both sample from standard solution and after that the turbidity more present in college store sample as compare to pharmaceutical industries sample.(Figure.4)

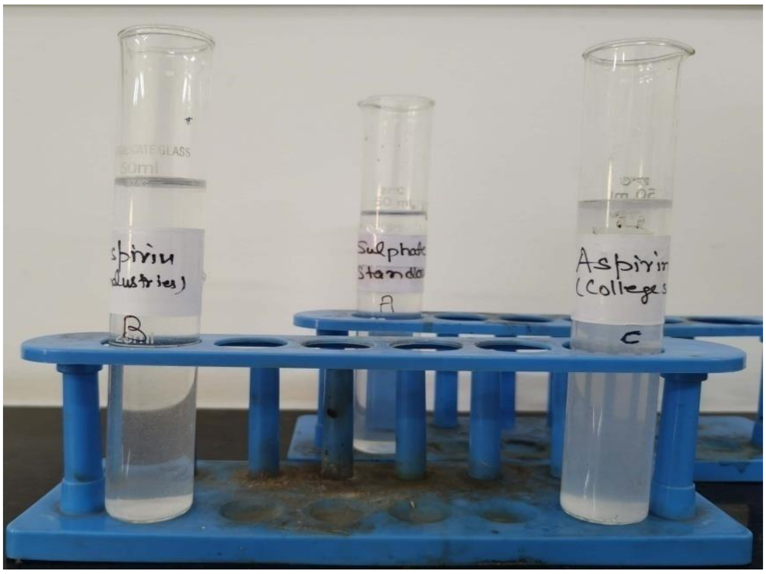


Figure 4: Sulphate test for Aspirin.

(e). Iron test for Paracetamol

- There are two types of sample one is collected from college store and other is collected from pharmaceutical industry.
- We compare both sample from standard solution and after that the turbidity more present in college store sample as compare to pharmaceutical industries sample. (Figure.5)

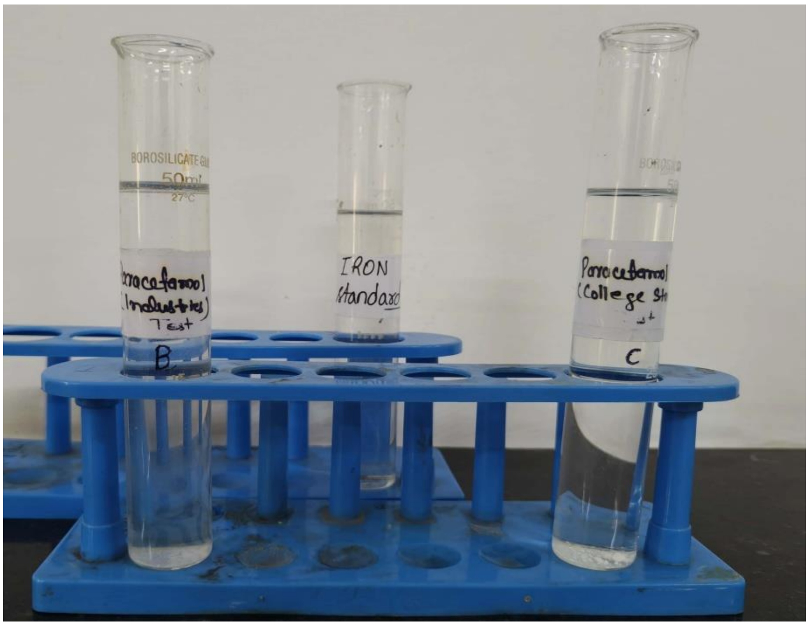


Figure.5 Iron test for Paracetamol.

(f). Iron test for Aspirin

- There are two types of sample one is collected from college store and other is collected from pharmaceutical industry.
- We compare both sample from standard solution and after that the turbidity more present in college store sample as compare to pharmaceutical industries sample.(Figure.6)

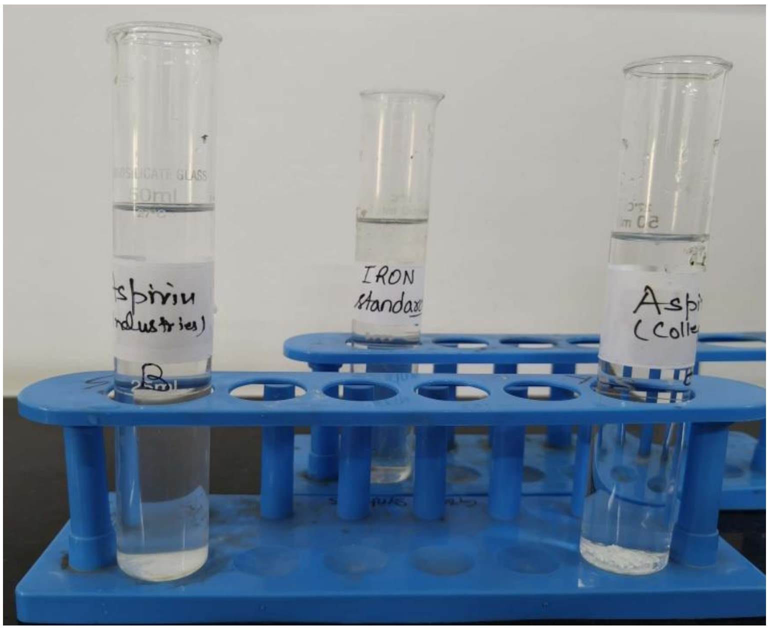


Figure 6: Iron test for Aspirin.

(2) According to Nephelometric Method

(a) Chloride test for Paracetamol. (Figure.7)

Standard Solutions (Std) (Cl^- ion Content mg/ml)	College Store Sample (Cl^- ion Content mg/ml)	Pharmaceutical Industrial Sample (Cl^- ion Content mg/ml)
-001	-024	-012

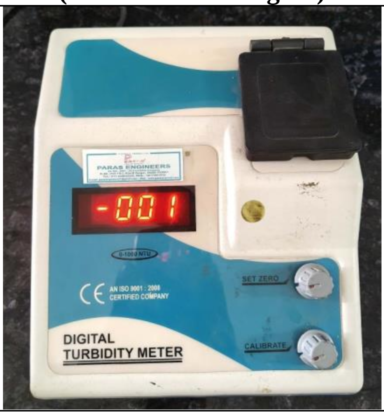
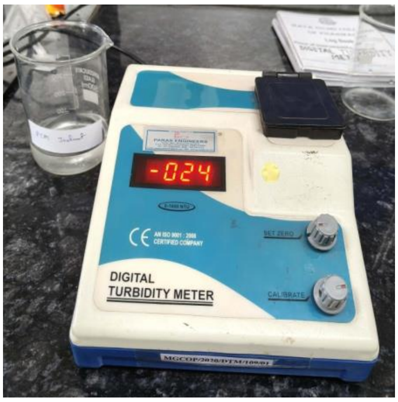
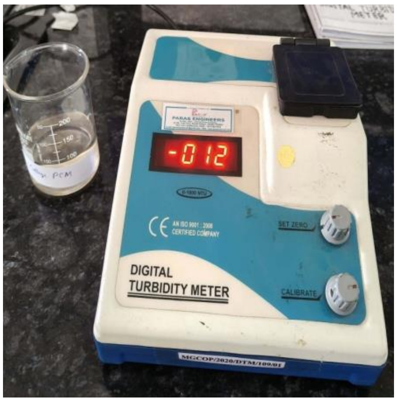
Standard Solutions (Std) (Cl^- ion Content mg/ml)	College Store Sample (Cl^- ion Content mg/ml)	Pharmaceutical Industrial Sample (Cl^- ion Content mg/ml)
		

Figure. 7 Chloride test for Paracetamol According to Nephelometric Method.

(b) Chloride test for Aspirin. (Figure.8)

Standard Solutions (Std) (Cl^- ion Content mg/ml)	College Store Sample (Cl^- ion Content mg/ml)	Pharmaceutical Industrial Sample (Cl^- ion Content mg/ml)
022	029	022

Standard Solutions (Std) (Cl^- ion Content mg/ml)	College Store Sample (Cl^- ion Content mg/ml)	Pharmaceutical Industrial Sample (Cl^- ion Content mg/ml)
		

Figure 8: Chloride test for Aspirin According to Nephelometric Method.

(c) Sulphate test for Paracetamol. (Figure.9)

Standard Solutions (Std) (SO_4ion Content mg/ml)	College Store Sample (SO_4ion Content mg/ml)	Pharmaceutical Industrial Sample (SO_4ion Content mg/ml)
015	022	007

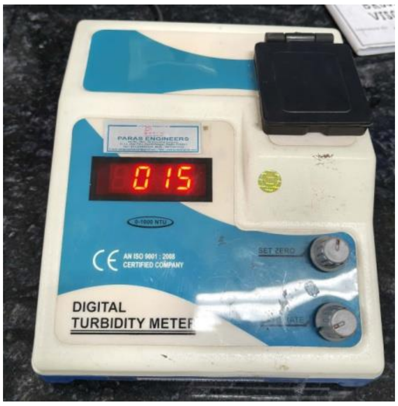
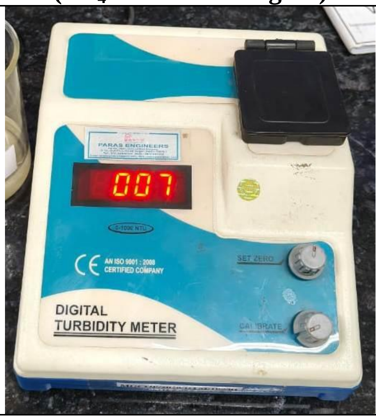
Standard Solutions (Std) (SO_4ion Content mg/ml)	College Store Sample (SO_4ion Content mg/ml)	Pharmaceutical Industrial Sample (SO_4ion Content mg/ml)
		

Figure. 9: Sulphate test for Paracetamol According to Nephelometric Method.

(d) Sulphate test for Aspirin. (Figure.10)

Standard Solutions (Std) (SO_4ion Content mg/ml)	College Store Sample (SO_4ion Content mg/ml)	Pharmaceutical Industrial Sample (SO_4ion Content mg/ml)
018	029	007

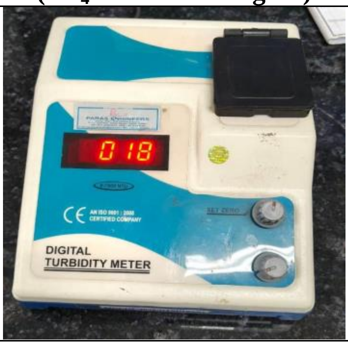
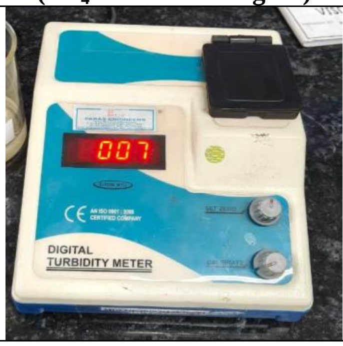
Standard Solutions (Std) (SO_4ion Content mg/ml)	College Store Sample (SO_4ion Content mg/ml)	Pharmaceutical Industrial Sample (SO_4ion Content mg/ml)
		

Figure 10: Sulphate test for Aspirin According to Nephelometric Method.

CONCLUSION

The evaluation of sulphate, chloride and iron contamination in the paracetamol as well as aspirin samples using the standard method showed significant differences between college stores and pharmaceutical industrial sources. Paracetamol purchased from the college store contained 0.024 mg/ml chloride, compared to 0.012 mg/ml for the sample from pharmaceutical aspirin had 0.029 mg/ml, and 0.022 mg/ml respectively. Both of the drugs in the college store had 0.022 mg/ml of sulphate, as which is in contrast to 0.007 mg/ml for pharmaceutical samples. The results suggest more impurity levels for college-level samples possibly due to poor storage conditions excipients of lower quality or poor quality control. The pharmaceutical industry samples complied with higher quality and regulatory standards. The results highlight the importance of regular impurity tests and encourage the use of specialized techniques such as the nepheloturbidometry. A better monitoring system and oversight from the regulatory authorities are crucial in non-commercial or academic areas for storage of drugs to ensure effectiveness, safety, and conformity with pharmacopeial standards.

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