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Simultaneous Estimation of Paracetamol and Ibuprofen Using UV Spectrophotometry

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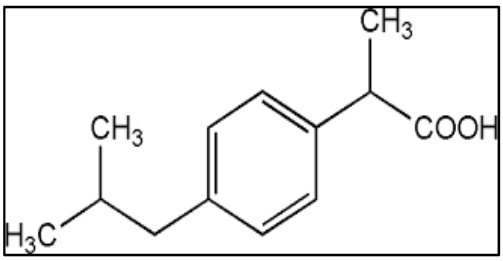
Abstract:

A simple, economical, specific, accurate, and precise UV spectrophotometric method has been developed for the simultaneous estimation of paracetamol and ibuprofen in the pharmaceutical dosage form. The absorption maxima of the paracetamol and ibuprofen were found to be 257nm and 222nm respectively using 0.1N NaOH as solvent. This method obeys Beer's law in the employed concentration range of 10µg/ml and 12µg/ml for Paracetamol and ibuprofen respectively.

Different analytical performance parameters such as linearity. Precision, accuracy, the limit of detection (LOD), and list of quantification (LOQ) were determined according to ICHGuidelines. The accuracy of the method was confirmed by recovery studies of tablet dosage form and was found to be 93.41% and 94.25% for paracetamol and ibuprofen respectively.
The LOD of paracetamol and ibuprofen was found to be 0.198ug/ml and 0.8g/ml respectively and LOQ of paracetamol and ibuprofen was found to be 0.538 g/ml and 0.93µg/ml respectively. The developed method was free from interferences due to excipients present in the formulation and it can be used for routine quality control analysis.
***Keywords**:* Paracetamol, Ibuprofen, Simultaneous equation.

Introduction:

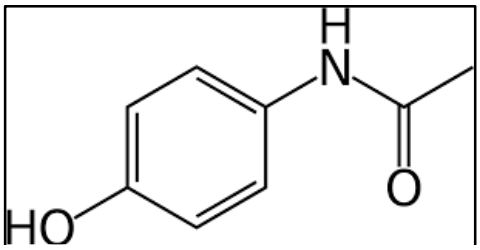
Ibuprofen: Ibuprofen is a nonsteroidal anti-inflammatory drug (NSAID) that is used for treating pain, fever, and inflammation. This includes painful menstrual periods, migraines, and rheumatoid arthritis. It may also be used to close a patent ductus arteriosus in a premature baby. It can be used by mouth or intravenously. It typically begins working within an hour.



Ibuprofen was discovered in 1961 by Stewart Adams and John Nicholson while working at Boots UK Limited and initially marketed as Brufen. It is available under a number of trade names, including Nurofen, Advil, and Motrin. Ibuprofen was first marketed in 1969 in the United Kingdom and in 1974 in the United States. It is on the World Health Organization's List of Essential Medicines. It is available as a generic medication. In 2020, it was the 38th-most commonly prescribed medication in the United States, with more than 16 millionprescriptions.

Common side effects include heartburn and a rash. Compared to other NSAIDs, it may have other side effects such as gastrointestinal bleeding. It increases the risk of heart failure, kidney failure, and liver failure. At low doses, it does not appear to increase the risk of heart attack; however, at higher doses it may. Ibuprofen can also worsen asthma. While whether it is safe in early pregnancy is unclear, it appears to be harmful in later pregnancy, so is not recommended. Like other NSAIDs, it works by inhibiting the production of prostaglandins by decreasing the activity of the enzyme cyclooxygenase (COX). Ibuprofen is a weaker anti-inflammatory agent than other NSAIDs.

Paracetamol: Paracetamol, also known as acetaminophen, is a medication used to treat fever and mild to moderate pain. Common brand names include Tylenol and Panadol. At a standard dose, paracetamol only slightly decreases body temperature it is inferior to ibuprofen in that respect, and the benefits of its use for fever are unclear. Paracetamol (Panadol, Calpol, and Alvedon) is an analgesic and antipyretic drug that is used to temporarily relieve mild-to-moderate pain and fever. It is commonly included as an ingredient in cold and flu medications and is also used on its own.



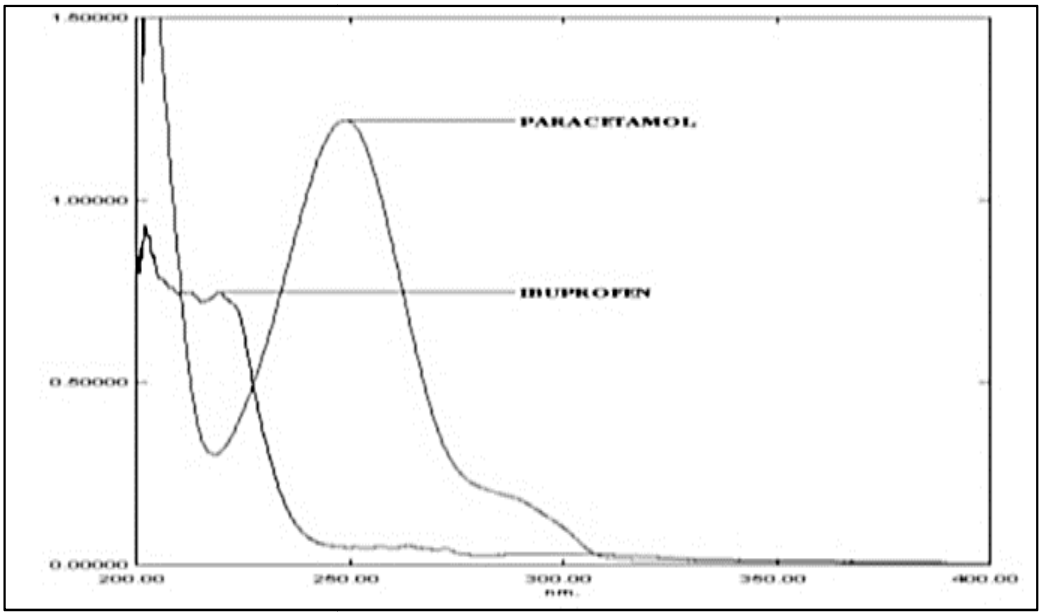
Paracetamol is exactly the same drug as acetaminophen (Tylenol). Paracetamol is the drug's name assigned using the International Non-proprietary Name (INN) generic name system.Paracetamol is effective for post-surgical pain, but it is inferior to ibuprofen. The paracetamol/ibuprofen combination provides a further increase in potency and is superior to either drug alone. The pain relief paracetamol provides in osteoarthritis is small and clinically insignificant. The evidence in its favour for the use in low back pain, cancer pain, and neuropathic pain is insufficient. In the short term, paracetamol is safe and effective when used as directed.] Short term adverse effects are uncommon and similar to ibuprofen, paracetamol is typically safer than NSAIDs for long term use.
Paracetamol is also often used in patients who cannot tolerate NSAIDs like ibuprofen. [28]

Material and Method:

Chemicals and reagents: Paracetamol and Ibuprofen were obtained as a gift samples from a pharmaceutical company. Methanol (HPLC grade) was purchased from K.J. Enterprises Ghatkoper. All other chemicals and reagents were of analytical grade and used without further purification.

Instrumentation: A Shimadzu UV-1900I UV-Vis spectrophotometer equipped with a 1 cm quartz cell was used for all UV spectroscopic measurements. A Mettler Toledo analytical balance was used for weighing the drugs and other chemicals.

Selection of solvent and wavelength: The solubility of ibuprofen and paracetamol was checked in different solvents. Distilled water has been selected as a common solvent for developing spectral characteristics. The absorbance of paracetamol and ibuprofen was found maximum at 257 nm and 222 nm wavelength respectively.



Overlay spectra of ibuprofen and paracetamol at 257 & 222 nm wavelength

Preparation of standard stock solution and study of Beer-Lambert's law: The standard stock solutions of paracetamol and ibuprofen, each of 1000µg/ml were prepared by dissolving 0.025 gm of each drug in 100 ml of distilled water. Aliquots of working stock solutions of paracetamol and ibuprofen were diluted with distilled water solution to get concentration in range of 2- 10µg/ml for both the individual drug. The absorbances of resulting solutions were measured at their respective wavelength.

Simultaneous equation method: If a sample contains two absorbing drugs, each of which absorbs at the λmax of the other, it may be possible to determine both drugs simultaneously using multicomponent analysis UV Spectrophotometric 'Simultaneous Equation Method.Two wavelengths selected for the development of the simultaneous equations are 257 nm and 222nm. The values are means of six estimations. The absorbances and absorptivity at these wavelengths were substituted in equation 1 and 2 to obtain the concentration of both drugs.Where Cx and Cy are concentration of ibuprofen in 12µg/ml. and paracetamol respectively in 10µg/ml. A1 and A2 are the absorbance's of the mixture at 257nm and 222nm respectively.The amounts of paracetamol and ibuprofen were calculated using the simultaneous equation given below.

$$C_x = \frac{A2AY1 - A1AY2}{AX2AY1 - AX1AY2}$$

$$C_y = \frac{A1AX2 - A2AX1}{AX2AY1 - AX1AY2}$$

Where,

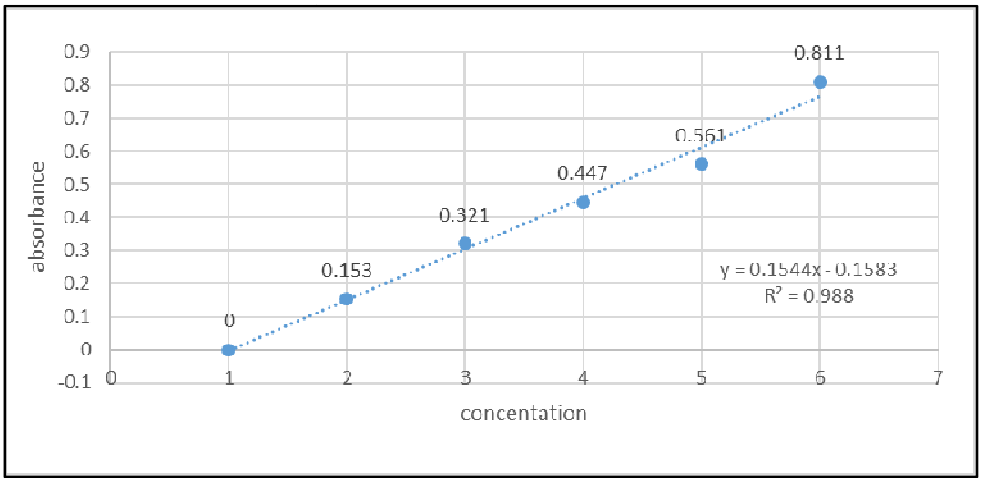
A1 = Absorbance of formulation at 257 nm
A2 = Absorbance of the formulation at 222 nm
ax1 = Absorptivity of Paracetamol at 257 nm.
ax2 = Absorptivity of Paracetamol at 222 nm
ay1 = Absorptivity of Ibuprofen at 257 nm
ay2 = Absorptivity of Ibuprofen at 222 nm
Cx =concentration of Paracetamol

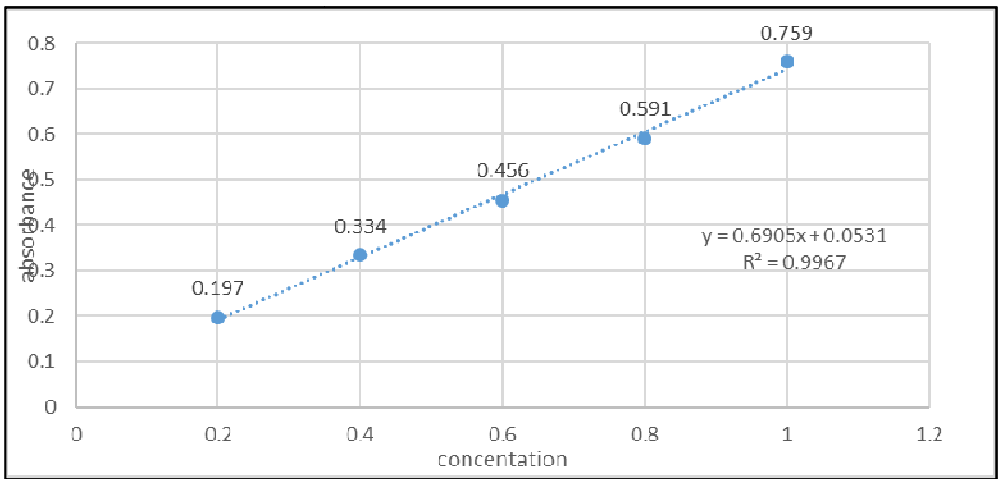
Cy =Concentration of Ibuprofen

Linearity: Calibration graph was found to be linear that is adherence to the system of Beer's law which was Found over the concentration range of 12µg/ml for Ibuprofen and 10µg/ml forParacetamol. Absorbance and concentration were subjected to least square linear regression analysis to calculate the calibration equation and correlation coefficients. The regression data as given in Table 1, showed a good linear relationship.

Table No.1: Linearity of Ibuprofen and Paracetamol

Parameters	Ibuprofen	Paracetamol
Linearity range	12ug/ml	10ug/ml
Correlation coefficient	0.996	0.998
Slope	0.690	0.154
Intercept	0.531	0.158





Precision: To check the degree of repeatability of the method, suitable statistical evaluation was carried out. The concentrations of two drugs were measured three times on the same day at intervals of 1hr and on three different days for intra and inter day study, respectively. The Relative Standard Deviation (% RSD) was found to be less than 2. The results were shown in Table.

Table No.2: Precision of Ibuprofen and Paracetamol

Drug	Concentration (µg/ml)	Intraday precision % RSD(Mean three obs.)	Interday precision % RSD(Mean three obs.)
Ibuprofen	12	1.887	1.496
Paracetamol	10	0.685	0.663

Limit of detection (LOD) and limit of quantification (LOQ):LOD and LOQ of Paracetamol and Ibuprofen were calculated mathematically. The LOD of Paracetamol and Ibuprofen were found to be 0.198µg/ml and 0.82µg/ml respectively. The LOQ of Paracetamol and Ibuprofen were found to be 0.538µg/ml and 0.93µg/ml respectively.

Result and Discussion: Estimation of paracetamol and ibuprofen was achieved by simultaneous equation method by using UV spectrophotometer. The linearity was checked in different concentrations and Beers law obeyed in the concentration range of 10µg/ml and 12µg/ml for both paracetamol and ibuprofen. The slope, intercept and correlation coefficient values of paracetamol at 257nm are the slope, intercept and correlation coefficient values of Ibuprofen at 222nm.The recovery studies were carried out to ensure the reproducibility and reliability of the method by adding known amount of standard drugs and analysis was carried out as per formulation procedure.

Conclusion: The simultaneous equation method utilizing UV spectrophotometry proved to be an effective means of estimating the concentrations of both paracetamol and ibuprofen. The linearity of the method was demonstrated across various concentrations, with Beer's law being obeyed in the concentration range of 10 µg/mL and 12 µg/mL for both drugs. The slope, intercept, and correlation coefficient values for paracetamol at 257 nm were found to be equivalent to those for ibuprofen at 222 nm.

To ensure the reproducibility and reliability of the method, recovery studies were conducted by adding known amounts of standard drugs and analyzing them according to the formulation procedure. The results of these studies indicate that the method is accurate and reliable, making it suitable for routine quality control analysis of paracetamol and ibuprofen in pharmaceutical formulations.

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