

Role of Quantification in Ensuring NSAID Safety in Pharmaceuticals and Biological Samples

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DESCRIPTION

Non-Steroidal Anti-Inflammatory Drugs (NSAIDs) are a class of medications widely used to relieve pain and inflammation. They play a vital role in managing conditions such as arthritis, musculoskeletal disorders, and inflammatory diseases. With their extensive usage, it becomes imperative to monitor and quantify NSAIDs in pharmaceutical formulations and biological samples to ensure their efficacy and safety. Analytical methods have evolved over the years to meet the challenges associated with detecting and quantifying these drugs accurately. This article explores various analytical techniques employed for the quantification of NSAIDs in pharmaceutical and biological matrices.

High-Performance Liquid Chromatography (HPLC) is one of the most widely employed techniques for the analysis of NSAIDs. It offers high sensitivity, precision, and selectivity, making it suitable for routine analysis in pharmaceuticals and biological samples. The stationary phase and mobile phase composition can be optimized to achieve separation of different NSAIDs. Reverse-phase HPLC is commonly used due to its compatibility with a wide range of analytes.

Gas Chromatography (GC) is another chromatographic technique used for the analysis of volatile NSAIDs. However, due to the non-volatile nature of many NSAIDs, derivatization is often required before GC analysis. This technique is less commonly employed for NSAIDs compared to HPLC but can be valuable in specific applications.

Liquid Chromatography-Mass Spectrometry (LC-MS) combines the separation capabilities of liquid chromatography with the detection power of mass spectrometry. This technique offers enhanced selectivity and sensitivity, making it suitable for the analysis of complex matrices such as biological samples. LC-MS is particularly effective in identifying and quantifying multiple NSAIDs simultaneously.

UV-Visible Spectroscopy is a simple and cost-effective method for the quantification of NSAIDs in pharmaceutical formulations. NSAIDs often exhibit characteristic absorption bands in the UV-Visible range, allowing for their detection and quantification. However, this method does not have the specificity needed for complex biological samples.

Fluorescence Spectroscopy is a more sensitive technique that can be applied to the analysis of NSAIDs, especially when they exhibit fluorescence properties. Fluorescence spectroscopy enhances selectivity and sensitivity, making it a valuable tool for quantification in both pharmaceutical and biological samples.

Nuclear Magnetic Resonance (NMR) Spectroscopy is a powerful analytical tool for the structural elucidation of compounds, including NSAIDs. While not commonly used for routine quantification due to lower sensitivity compared to other methods, NMR can be valuable in confirming the identity of NSAIDs and elucidating their chemical structure.

Electrochemical methods, such as voltammetry and amperometry, have gained attention for their simplicity and sensitivity in the quantification of NSAIDs. These methods are based on the measurement of the current produced during the electrochemical reaction of the analyte. Electrochemical techniques are particularly useful for studying redox-active NSAIDs.

Biosensors are analytical devices that combine a biological component with a physicochemical transducer for the selective detection of analytes. Immunosensors, enzymatic biosensors, and DNA biosensors have been developed for the quantification of NSAIDs. These biosensors offer high sensitivity, selectivity, and the potential for real-time monitoring in biological samples.

Sample preparation is an important step in the analysis of NSAIDs in complex matrices like biological samples. Solid-Phase Extraction (SPE), Liquid-Liquid Extraction (LLE), and QuEChERS (Quick, Easy, Cheap, Effective, Rugged, and Safe) are common sample preparation techniques used to remove interfering substances and concentrate the analytes.

The reliability of analytical methods depends on rigorous validation to ensure their accuracy, precision, selectivity, and robustness. Parameters such as linearity, accuracy, precision, specificity, and Limit of Detection (LOD) and Limit of Quantification (LOQ) are evaluated during method validation. Additionally, adherence to Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP) is essential to ensure the quality and reliability of the analytical results.

The quantification of NSAIDs in pharmaceutical and biological samples is a critical aspect of ensuring their safety

and efficacy. Various analytical methods, including chromatographic techniques, spectroscopy, electrochemical methods, and biosensors, offer diverse approaches to meet the challenges associated with the complex matrices of these samples. Each method has its advantages and limitations, and the choice depends on the specific requirements of the analysis.

As technology advances, the development of innovative analytical methods continues to enhance the accuracy, sensitivity, and efficiency of NSAID quantification. Researchers and analysts must stay abreast of these advancements to adopt the most suitable techniques for their specific applications, ultimately contributing to the improvement of NSAID formulations and therapeutic outcomes.