The creation of medications is a delicate art requiring precise chemical combinations to optimize drug efficacy. In many cases, however, the initial drug formulation is only half of the equation; protecting medications from environmental interferences that compromise the integrity of the drug is critical to ensuring the delivery of safe, effective pharmacological therapies. One of the key points of vulnerability for many medications is photoreactivity, whereby optical radiation caused by certain types of light changes the chemical structure of the drug, resulting in photodecomposition. As pointed out by the Royal Society of Chemistry, "The most obvious result … is a loss of potency of the product [and] in the final consequence this can result in a drug product that is therapeutically ineffective."[1]

Although some drugs are reactive to light on the visible spectrum, UV light is the primary culprit in most pharmaceutical photodecomposition and can significantly impair drug stability. This type of photoreactivity is uniquely difficult to guard against, as UV radiation is a product of not only sunlight, but common artificial light sources in factories, pharmacies, hospitals, and patients' homes. The need to protect light-sensitive pharmaceuticals during storage has spurred the development of specialized light-resistant polymers that use advanced UV absorbers to shield vulnerable medications from UV damage. Spectral analysis using spectrophotometric instrumentation allows pharmaceutical packaging manufacturers to accurately evaluate the efficacy of UV absorbent packaging, preserving pharmaceutical quality and protecting patient health.

UV Absorbers in Pharmaceutical Packaging

UV absorbers are compounds that physically "absorb the UV rays and dissipate them into thermal energy."[2] Many plastics include UV absorbers to prevent photodegradation of the polymer itself and preserve product appearance and function. When UV absorbing compounds are introduced plastic pharmaceutical packaging, they can protect photoreactive medications from UV light exposure by preventing UV rays from penetrating the packaging and reaching its vulnerable contents. The particular type of pharmaceutical packaging used will dictate which kind of UV absorber is the most appropriate choice, but all compounds must be stable, resin-friendly, and safe for contact with drugs meant for human consumption.

Historically, UV absorbers have most successfully introduced in high concentrations to thicker plastic products and have at times interfered with polymer appearance, limiting the range of potential applications. However, advancements in the field of plastic additives and novel uses of non-traditional compounds are now making it possible to effectively and economically incorporate UV absorbers in a wider array of plastic types, including thin, clear plastic films, while maintaining optical quality. The introduction of more stable and potent UV absorbers has allowed for increased integration within a growing number of plastic packaging systems, including bottles, bags, blister packs, and cartridges.[3] This expanded variety and quality of UV-resistant polymers gives pharmaceutical companies added flexibility for creating attractive and functional packaging to enhance both marketability and user experience while blocking harmful UV radiation.

Spectrophotometric Evaluation of UV Absorbers

Testing the degree of UV protection offered by polymers containing UV absorbers is critical to ensuring that light-resistant pharmaceutical packaging will perform as required to preserve the safety and therapeutic value of vulnerable medications. To assess the efficacy of UV absorbent packaging, the transmittance characteristics of the sample must be evaluated; in other words, you measure the amount and quality of light that passes through the polymer. Double-beam UV-Vis spectrophotometers are ideally suited for obtaining accurate transmittance values, as they are capable of scanning for both the entirety of the ultraviolet range (200-380 nm) in addition to the visible light range (380 to 800 nm). The extraordinary precision of UV-Vis spectrophotometry allows you to detect even the smallest amounts of light transmission to accurately quantify the protection afforded by UV absorbent packaging and determine its suitability for various types of photoreactive pharmaceuticals.

Spectrophotometric analysis can also be used to evaluate the stability UV absorbers within plastics over time; by exposing the polymers to artificial aging processes, you can simulate environmental exposure that may interfere with the efficacy of the product and assess changes in UV protection at various stages of aging. As such, spectrophotometers play a central role in the creation of new UV absorbent polymers throughout research and development while also allowing operators to monitor efficacy in the manufacturing phase.

Full article with photos available here:

https://www.hunterlab.com/blog/color-pharmaceuticals/spectrophotometric-evaluation-of-uv-absorbers-in-pharmaceutical-packaging/