REVIEW ARTICLE

Titanium Dioxide (TiO_2): A Versatile Excipient in Pharmaceuticals

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ABSTRACT

Titanium dioxide (TiO_2) is a commonly used excipient in pharmaceutical formulations, offering several benefits to pharmaceutical products. As a highly insoluble and thermally stable oxide, TiO_2 is utilized as an opacifying agent and suspending agent to improve the appearance, stability, and bioavailability of pharmaceutical products. Its high refractive index and high surface area make it an excellent adsorbent and filler material, while its non-toxic and odorless nature ensures its safe use in pharmaceutical applications.

Here, the authors deliberate the properties and major applications of TiO_2 as a versatile excipient in pharmaceuticals. The mesmerizing physic-chemical features of TiO_2 depend on the size and shape of particles. At present, TiO_2 has added countless considerations as an auspicious photocatalyst due to its extraordinary features such as excellent photocatalytic, electronic, and optical features, high stability, and economical and non-toxic nature.

Moreover, the benefits of using TiO_2 as an excipient are discussed, including its ability to improve product appearance, stability, and bioavailability. The review also reports the challenges associated with TiO_2, including environmental concerns and biocompatibility issues. However, the benefits of TiO_2 far outweigh its drawbacks, making it an extensively accepted excipient in pharmaceuticals. Inclusively, this article aims to provide a comprehensive overview of TiO_2 as an excipient in pharmaceuticals, highlighting its unique properties, several applications, and benefits.

Keywords: Excipient, Nano-TiO_2, Pharmaceuticals, Stability.

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INTRODUCTION

Excipients are essential components in pharmaceutical formulations, playing a crucial role in enhancing the efficacy, quality, and safety of pharmaceutical products. Among the various excipients available, titanium dioxide (TiO_2) stands out for its unique properties and versatility. TiO_2 is a white, odorless, and non-toxic powder that is commonly used as a filler, coating agent, and pigment in pharmaceutical products.[1,2] TiO_2 has a specific gravity of 3.9 to 4.2, a hardness of 5.5 to 6.5, and a melting point of 1854°C. It is water-insoluble and, but it's soluble in hot H_2SO_4 and HF. Presently, the crystalline phase of TiO_2 has been categorized into rutile, brookite, anatase, and TiO_2 (B).[3] TiO_2 is insulated and has a high dielectric constant, 50 to 60 and 80 to 110 for the anatase and rutile phase, respectively[4].

General Properties of TiO_2

TiO_2 is a highly inert and chemically stable substance, making it an ideal excipient for pharmaceutical applications. TiO_2 has an excellent pigment for coloring pharmaceutical products. Its high refractive index and light scattering properties make it suitable for capsules, tablets, and ointments. Additionally, TiO_2 has been shown to have antifungal and antibacterial properties, which can contribute to its preservative effects in pharmaceutical formulations.

General Applications of TiO_2

The versatility of TiO_2 as an excipient lies in its numerous applications in pharmaceutical formulations. Some of the key uses of TiO_2 include:

Filler

TiO_2 is used as filler in tablets and capsules to improve their appearance and flowability. It also helps to mask unpleasant odors and flavors.

Coating agent

TiO_2 is used as a coating agent in oral and topical pharmaceutical products to enhance their appearance, stability, and bioavailability.

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Pigment

TiO_2 is used as a pigment in pharmaceutical products to provide color, improve their appearance, and mask unpleasant odors or flavors[5].

Preservative

TiO_2 has been shown to have antifungal and antibacterial properties, making it a useful preservative agent in pharmaceutical formulations.

Antioxidant

TiO_2 has been shown to possess antioxidant properties, which can help to protect pharmaceutical products from degradation and oxidation[6, 7].

Photodegradation

The photodegradation of nisoldipine was considerably enhanced by the addition of TiO_2. TiO_2 is used as an excellent photocatalytic agent[8].

Pharmaceutical Applications of TiO_2

TiO_2 is used in various pharmaceutical applications, including

Tablets

TiO_2 is used as an opacifying agent to improve the appearance of tablets and capsules. It helps to mask any discoloration or unwanted coloration of the active ingredients.

Capsules

TiO_2 is used as a filler material to improve the flowability and compressibility of powders used in capsule filling.

Lotions and creams

TiO_2 is used as an opacifying agent to improve the appearance of topical dermatological products.

Suspensions

TiO_2 is used as a suspending agent to improve the stability and sedimentation resistance of suspensions.

Coatings

TiO_2 is used as a coating material to improve the stability and bioavailability of pharmaceutical products[9,10]

Benefits of TiO_2

The use of TiO_2 as an excipient offers several benefits to pharmaceutical products, including:

Improved appearance

TiO_2 helps to improve the appearance of pharmaceutical products by masking any unwanted coloration or discoloration.

Improved stability

TiO_2 helps to improve the stability of pharmaceutical products by preventing the growth of microorganisms and protecting the active ingredients from degradation.

Improved bioavailability

TiO_2 can help to improve the bioavailability of pharmaceutical products by reducing particle size and increasing surface area.

Cost-effective

TiO_2 is a cost-effective excipient compared to other materials with similar properties.[11,12]

Advantages of TiO_2

The use of TiO_2 as an excipient offers several advantages, including

Improved product appearance

TiO_2 can enhance the appearance of pharmaceutical products, making them more attractive to consumers.

Improved stability

TiO2 can help to improve the stability of pharmaceutical products by reducing the risk of degradation and oxidation.

Improved bioavailability

TiO_2 can help to improve the bioavailability of pharmaceutical products by enhancing their absorption and dissolution rates.

Cost-effective

TiO_2 is usually more economical than other excipients, making it a cost-effective option for pharmaceutical manufacturers.

Wide range of applications

TiO_2 can be used in a wide range of pharmaceutical products containing oral tablets, capsules, ointments, creams, and injectables.

Challenges Associated with TiO_2[13,14]

Despite its numerous benefits, there are several challenges associated with the use of TiO_2 as an excipient. Some of these challenges include.

Environmental concerns

The use of TiO_2 has raised concerns about its environmental impact, particularly its potential to harm aquatic life.

Biocompatibility

There is some debate about the biocompatibility of TiO_2, particularly its potential to cause adverse reactions in certain individuals.

Regulatory issues

The use of TiO_2 as an excipient requires regulatory approval, which can be a complex and time-consuming process.

Conclusions and Future Prospective

In conclusion, TiO_2 is a versatile excipient that offers numerous benefits to pharmaceutical products. Its unique properties and applications make it an ideal choice for pharmaceutical manufacturers looking to improve the quality, safety, and efficacy of their products. As the demand for innovative excipients remains to rise, the use of TiO_2 is possible to become even more widespread in the pharmaceutical industry. Nano-TiO_2 is a crucial feature of an extensive diversity of sectors of advanced materials, devices, and systems in view of their versatility and extraordinary characteristics, mostly optical, electrical, and catalytic properties. Nano-TiO_2 was also investigated for photodynamic therapy in cancer patients.

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