SYNTHESIS OF TIO_2 NANOPARTICLES USING CASSAVA STARCH AS REAGENT AND THEIR CHARACTERIZATION

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ABSTRACT:

The simple process for synthesizing TiO_2 with cassava starch as the reagent. Cassava starch is a tasteless, odourless, white powder that has good gelling, binding, and thickening qualities. When dissolved in water, it possesses a high viscosity and clarity that make it ideal for a variety of food and industrial uses. XRD is used to characterize the prepared sample. The average crystallite size of TiO_2 nanoparticles was found to be 49 nm using the Debye Scherrer formula. Water is often used as a solvent and mild reaction conditions are used in green synthesis methods employing cassava starch, minimizing environmental effect and waste generation.

KEYWORDS: Synthesis and characterization, cassava starch, TiO_2 nanoparticles.

INTRODUCTION

Nanotechnology is one of the key technologies had been developed in all fields including textile industries for medical, hygienic, and technical textiles [1]. Nanomaterials belongs to the range of below 100 nm has unique chemical, physical, electrical, and mechanical properties and also diversely utilized in the field of medical, biotechnology, microbiology, pharmaceutics and chemistry, engineering, inexpensive catalyst, cytotoxicity study, etc. [2–4]. Owing to its large surface area, nanomaterial synthesis methods are classified into the physical and chemical methods. However, these methods are not suitable for medicinal and biological applications because of its harmful nature to the environment. Therefore, researchers are going for a green synthesis route to prepare nanomaterials because the green synthesis approach is simple, eco-friendly, and cost-effective [5, 6]. Nanoparticles (NPs) have received substantial attention for their possible applications in many sciences and engineering fields including environmental remediation [7]. When compared with bulk materials, NPs possess unique physical and chemical properties like high specific surface area, a high number of surface activation sites, a good affinity to other species, and therefore, high sorption capacity for inorganic and organic compounds [8-10].

. With the development of nanotechnology, TiO_2 nanoparticles (NPs), with attractive properties, have been widely fabricated and developed. In the past decades, the demand of titanium dioxide NPs observed remarkable growth because of its specific properties. In recent years researchers are focussed on the green synthesis route. The aim of this work is to use starch instead of chemicals. Starch is natural polymers that are abundant, renewable, inexpensive and widely available. They contain two types of bio polymers, amylase, and amylopectin. Starch granules well when heated in the presence of the water and smaller amylase molecules start leaching out of the granules. The polyhydroxylated macromolecules of amylase and amylopectin present interesting dynamic supramolecular associations facilitated by inter and intermolecular hydrogen bonding resulting in molecular-level capsules, which can act as templates for nanoparticles growth. Because of their specific surface area, high porosity and low density, porous material has been attracting attention and are widely used in electronics, photonics, catalyst, sensors, and life sciences.

MATERIALS AND METHODS:

Materials:

Titanium dioxide, with the chemical formula TiO_2, is one of the most valuable raw materials and has been used in several applications including photo catalysis, medicine, sensors, paints, environment, solar energy, and others. TiO_2 has excellent corrosion resistance, good thermal and chemical stability, and low cost [11]. Moreover, titanium is accepted as a pharmaceutical and food additive [12]. It is also used in destruction of viruses and bacteria, inactivation of cancerous cells, as well as clean-up of oil spills [13]. Titanium oxide, an important semiconductor with a direct band gap (3.2-3.5eV) and relatively high excitation binding energy [14].

Methods:

The process was carried out by washing 100gm of cassava tubers peeling and shredded by liquefying with 200ml of water. Then screening with muslin cloth and filter the shredded cassava. The filtrate was decanted for 24hours, and supernatant was dismissed. The starch content was settled at the bottom of the beaker.

Titanium oxide nanoparticles using cassava starch:

Take 100ml starch solution in a beaker. Add 1g of gelatine into 25ml of double distilled water and stirred for 30 minutes under constant stirring in a magnetic stirrer. Maintain the temperature of the solution between 400C - 600C. The starch solution and gelatine mixture were added together and stirred about 1 hour. Add 10ml of Titanium oxide to the mixture and stir the solution for 2 hours. Wash the solution five times with ethanol and double distilled water. The precipitate was dried in hot air oven for 10 hours at 600C. Anneal the sample at 7500C for about 3 hours. White colour powder is obtained.

RESULT AND DISCUSSION:

Characterization using XRD

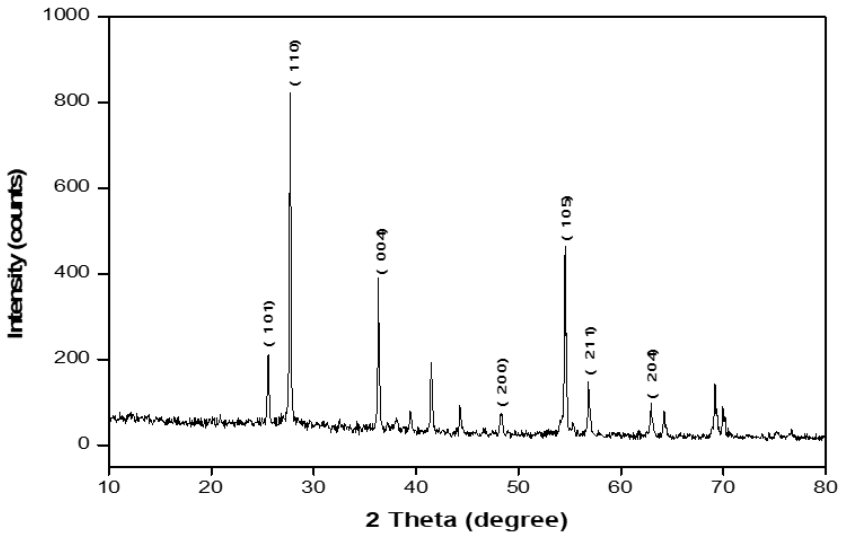
The structural characterization of the TiO2 nanoparticles synthesized using Cassava starch are carried out by the XRD method. The X-ray diffraction experiments are carried out with the XPERTPRO diffraction system using the CuKα radiation of wavelength 1.5406A°. The type of the scan used is continuous and range from 10° to 80°.

The average grain size is calculated using the Debye Scherrer formula,

$$D=K\lambda/\beta\cos\theta \ (m)$$

λ - X-ray wavelength

β- line broadening at half the maximum intensity (FWHM) θ- Bragg angle



XRD pattern of TiO_2 nanoparticles

The XRD results for the TiO_2 nanoparticles exhibit strong peaks around 2θ =27° along (1 1 0) plane, 2θ =36° along (0 0 4) plane, 2θ =48° along (2 0 0) plane, 2θ =54° along (1 0 5) plane, 2θ =55° along (2 1 1) plane, 2θ =62° along (2 0 4) plane and 2θ =75° along (2 1 5) plane is in well agreement with that of the literature [16]. The peak values are in good agreement with the JCPDS cards. The absence of impurity peaks denotes the high crystalline nature of the material. The average crystalline size of the particle is 48 nm which is calculated using Debye Scherrer formula.

CONCLUSION:

Nanomaterials have become an inevitable material in today's world. Titanium oxide is a versatile and widely used material with applications in various industries, environmental protection, healthcare, and everyday products. The main aim was to be to reduce chemicals at the time of synthesis TiO_2 nanoparticles and achieve a better efficiency to be use use in different applications. The TiO_2 nanoparticles have been synthesized using Cassava starch as reagent. Cassava starch is a white, odourless, tasteless powder with excellent thickening, binding, and gelling properties. It has a high viscosity and clarity when dissolved in water, making it suitable for various food and industrial applications. As prepared TiO_2 nanoparticles are highly crystalline in nature which is confirmed from the absence of impurity peaks. The Debye Scherrer formula was used to determine the average crystallite size of TiO_2 nanoparticles, which came out to be 49 nm.

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