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Starch Microsponges for Enhanced Retention by Biodegradable Sunscreen

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Abstract

To shield their skin from the harmful effects of UV radiation, many people regularly use topical sunscreen lotions [1]. Recent research have, however, highlighted the dangers of UV filter percutaneous absorption, which can result in unfavourable systemic side effects such hormone imbalances and allergies [2]. This study created a novel sunscreen formulation using starch microsponges as the primary carrier for the organic sunscreen benzophenone [3]. Nitrogen adsorption/desorption analysis and scanning electron microscopy were used to analyse the generated starch microsponges [4]. The findings demonstrated that starch microsponges had high BET surface areas, spherical porous morphologies, and pores smaller than 200 nm [5]. Scanning electron microscopy, differential scanning calorimetry, and benzophenone-3-loaded starch microsponges were used to load benzophenone-3 into the starch microsponges. Nitrogen adsorption-desorption experiments, scanning calorimetry, powder X-ray diffraction, and Fourier transform infrared spectroscopy [6]. The findings supported the effective entrapment of benzophenone-3 within the nanopores of starch microsponges [7].

Keywords: Starch; Benzophenone-3; Sunscreen; Microsponges; Porous; Oxybenzone

Introduction

A sunscreen cream made of starch microsponges was created, described, and put to the test in a clinical setting [8]. Rheological, texture, and sensory evaluations revealed that sunscreen products made with starch microsponges had high spread ability and a rich, non-sticky texture that was suitable for consumer use [9]. Benzophenone-loaded starch microsponges provided better photo protection, a higher SPF, and less cutaneous penetration than raw benzophenone-3 cream, according to in vitro and ex vivo experiments [10]. A clinical patch test verified the skin safety and biocompatibility of the sunscreen cream produced using starch microsponges [11]. Thus, a new, safe sunscreen product was created by combining the sunscreen ingredient benzophenone-3 with starch microsponges [12]. UV light exposure is linked to a number of adverse effects on human skin In order to shield humans from dangerous sun radiation, several compounds are utilised as UV-filters [13]. Radiation But the majority of chemical sunscreens cause allergic reactions and safety concerns as a result of their systemic distribution via the skin circulation. Although Oxybenzone, also known as benzophenone-3, is a sunscreen that has received USFDA approval, its high permeability makes it difficult to retain on the skin. Studies have shown that a significant amount of BNZ was found in human urine breast milk and blood plasma after the use of BNZ-containing products [14]. BNZ has been linked to contact eczema, and melanoma formulations are meant to stay on the skin's surface and form a UV protection barrier. Normally, a decent sunscreen lotion should release a little amount of melanin. It retains it topically across the skin's surface and is active throughout application [15]. Therefore, a method or carrier must be created to enhance sunscreen actives' retention on the skin while reducing their transdermal penetration. A potential strategy to lessen the biological toxicity of sunscreens is to prevent cutaneous penetration by encasing sunscreen actives in an appropriate carrier. Microsponges are porous microspheres that may hold a wide range of active ingredients, including anti-inflammatory, anti-acne, fragrance, and essential oil molecules. A huge number of interconnected nanopores with a lot of interior surface area make up the matrix of microsponges, which is a no collapsible structure. Microsponges come in sizes ranging from 5 to Microsponges are a perfect topical carrier since their pore capacity may expand to 300 m. Starch is a well-known inert substance that is frequently employed as a carrier, gradually releasing its encapsulated active without passing through the skin or mucous barrier. Many scientists have used starch as a biomaterial for medicine delivery, scaffolds for tissue engineering, and cosmetics. That is in our work, we created starch microsponges with outstanding properties, including a nanopores structure, a high surface area, a big pore volume, biocompatibility, and biodegradability. To create an effective UV-protective cream, the study aims to encapsulate BNZ in these starch microsponges. Specifically, to look at how it affects BNZ retention and absorption into the skin. It was assessed how BNZ encapsulation in starch microsponges affected the criteria for UV protection, SPF, texture, and sensory perception.

Discussion

Many other carriers, including cyclodextrin, polymeric microspheres, and lipid have been found to encapsulate and boost the effectiveness of UV actives. However, there have been no instances of UV filters being encapsulated in starch microsponges and used for enhanced topical retention or UV protection. We bought Span 80, soluble starch, ethanol, dichloromethane, and other chemicals from SD Fine. 60 grammes of soluble starch were provided. Acidity standard, acceptable white powder with mesh. Galaxy Surfactants sent a complimentary sample of benzophenone-3. Caprylic Acid Triglyceride and Carbopol 987 were gifts from Lubrizol and Abitec, respectively. Sasol Germany GmbH procured Cosmacol ELI and Imwitor 380, Wacker Chemie AG Belsil® DM 350, SEPPIC Montanov 202, Montanov 68, and Simulsol 165, Ashland Germaben II E, and Ultra International Floral Perfume. The emulsion gelation process was modified to create starch microsponges. 800 mg of soluble starch in 10 ml of an 8.0% w/w aqueous solution were heated in a beaker to 100

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°C while being agitated. The resultant transparent starch solution was cooled, mixed with 50 ml of dichloromethane, and homogenised using a Silverson homogenizer at 5000 rpm without creating an emulsion with 1 ml of Span80. The emulsion spent 24 hours in a refrigerator frozen at 18 °C. Next, a graded concentration of ethanol was used to swap the solvent in the emulsion every two hours. Finally, pure ethanol was utilised to totally replace the water from the aquagel to produce an impermeable layer. Alcogel filtered and dried the precipitated porous starch that was produced. Under By applying the photon correlation spectroscopy technique to the incoming beam at a 90° angle and using a Malvern Mastersizer 2000 particle size analyzer at 25 2 °C, the particle sizes were measured. In order to achieve obscuration within the sensitivity range of the device, SM were diluted and distributed in distilled water. By measuring the quantity of nitrogen gas adsorbed using the single-point BET analyser SAA-2000, the surface area and pore volume were determined. The materials were placed in the sample cell of a surface area analyzer and degassed for 24 hours at ambient temperature under vacuum before the adsorption process began in a Dewar flask filled with liquid nitrogen at -195 °C, which was placed beneath the sample cell. process. After the adsorption procedure was finished, the sample was submerged beneath a Dewar flask containing distilled water to begin the desorption procedure. The same procedure was used to estimate the pore volume using 90% nitrogen in helium as the adsorbate gas. After the adsorption/desorption procedure was finished, the surface area of each microsponge was assessed using a modified BET equation for quick single-point surface area estimation. Environmental Scanning Electron Microscope, FEI Quanta 200 ESEM equipped with imaging tool: Phenom running at an accelerating voltage of was used to evaluate the surface morphology of starch microsponges. Through the use of the imaging equipment, the programme was used to calculate the average pore and particle diameter. Span 80, ethanol, dichloromethane, and soluble starch they bought from SD great. A modified version of the emulsion gelation process was used to create soluble starch microsponges (SM). An aqueous solution of 8.0% w/w soluble starch (800 mg in 10 ml) was heated to 100 °C while being swirled in a beaker. In order to entirely remove the water from the aquagel and create an alcogel, the resultant clear starch solution was chilled and added to pure ethanol. To create free-flowing SM powder, the precipitated porous starch that had developed was filtered and dried in a vacuum. Starch microsponges were loaded with BNZ via solvent evaporation and immersion. By combining 500 mg of BNZ with 25 ml of ethanol, an alcoholic BNZ solution was created. The alcoholic BNZ solution was impregnated with 500 mg of starch microsponges, and the suspension was agitated at room temperature for 4 hours. At 50–60 °C, the slurry was dried in a rotary vacuum drier. SMBNZ was the name given to the dried composites. In order to determine the drug loading efficiency inside the SMBNZ pores, the SMBNZ was removed from the alcoholic BNZ solution by centrifuging the stirred suspension at 5000 rpm after 4 hours. Part of the BNZ was entrapped in the carrier pores while some of the BNZ crystals were adsorbed on the surface. The surface drug was represented by the supernatant, which was tested for drug content. The FT-IR spectrophotometer was used to obtain the FT-IR spectra. (Perkin Elmer) For BNZ, SM, and SMBNZ, the analysis was conducted. By compressing the sample and KBr mixture, KBr discs were created. 5 tonnes of pressure during 5 minutes in a hydraulic press. Samples used were scanned between 400 and 4000 cm-1 to produce FT-IR spectra. With the use of a Philips PAN analytical Xpert PRO MPD X-ray diffractometer, measurements of ray scattering were made. Physical mixture, SM, SMBNZ, and BNZ underwent analysis. Between 5 and 60° 2, the samples were subjected to monochromatized CuK radiation irradiation. The voltage and current used to gather the patterns were 45 kV and 40 mA, respectively. The pace of scanning (2/min) For BNZ, SM, and SMBNZ, a DSC analysis was done. The Differential Scanning Calorimeter (DSC) was used to make the DSC measurements. Perkin Elmer connected a thermal analyzer to Pyris-6 software. Samples were weighed precisely and packed in metal pans. 20 ml/min of nitrogen flow at a rate of scanning before heating From 30 °C to 200 °C, 10 °C/min. A pan of metal, empty, was used as a reference. The sample is moved away from the female cone's base by the male cone's 90° angle. Spread ability was equated to the area under the curve by measuring the force, expressed in grammes, needed to move the sample. Analysis of the samples was done in three copies. The sunscreen creams were created using a heated emulsion of oil and water. Using the components listed in Table 1. At 80 °C, the materials for the water phase and the oil phase were cooked separately. The water phase and oil phase were combined, and the mixture was homogenised in a homogenizer for three minutes at 9500 rpm. Using an overhead stirrer, the heated emulsion was further churned for 10 minutes. Triethanolamine was used to bring the emulsion's pH to a range of 6.0 to 6.5. For 24 hours, the cream was kept in a covered container. Physicochemical characterization comes first. The sunblock cream with simply raw benzophenone3 in it was referred to as BNZ cream, while the sunblock cream with starch sponges loaded with benzophenone3 was referred to as as SMBNZ cream is known. Stability tests were conducted under various circumstances. The formulations of BNZ cream and SMBNZ cream were tested for long-term stability. The creams were kept at 30 2 °C/65 5% RH and at the were kept in an accelerated condition of 40 2 °C/75 5% RH for six months. Analysed for their physicochemical characteristics, including pH and globule size Dimensions, viscosity, substance concentration, and physical stability. The globule size measurements of BNZ cream and SMBNZ cream were carried out using the same procedure for particle size analysis of SM in order to evaluate the physical integrity of developed sunscreens.

Conclusion

The creams were subjected to various mechanical, physical, and temperature stress cycles under controlled conditions. The globule size of the o/w BNZ cream and SMBNZ cream was measured on Malvern after they had been diluted with distilled water. Cream rheological behaviour was observed and researched. The All measurements were made at a temperature of, using a spindle, and a cone and plate viscometer Anton Par, Rheometer Germany GmbH, Model MCR to determine the viscosity and rheological behaviour of the sunscreen creams. The viscosity in Pas and the shear rate in the shear stress in Pa were calculated. Texture profile analysis was done using a texture. Analyzer A 1 cm diameter acrylic probe was squeezed twice into the sample with a delay at a predetermined rate of 2 mm s-1 to a depth of 15 mm. 15 s separates the two compressions. The TPA criteria are as the XTRA Dimension calculated the samples of sunscreen's cohesion, adhesiveness, compressibility, and hardness the sodium nitroprusside dye test was used to assess the effectiveness of in vitro sunscreen. In a nutshell, 10 ml of a sodium nitroprusside aqueous solution that was 0.05% w/w in concentration was poured into Petri plates. A cellophane membrane was used to cover the Petri plates, and a thin coating of 0.5 g of each of the sunscreen creams BNZ, SMBNZ, and sunscreen was evenly placed (6 mg/cm2) over the membrane. After that, the Petri plates spent 2 hours in a UV cabinet being exposed to UV radiation. As a control, a Petri dish containing sodium nitroprusside solution was wrapped entirely in simple cellophane membrane. A UV spectrophotometer operating at a wavelength of 395 nm was used to examine the sodium nitroprusside solution's altered absorbance following UV irradiation. A texture was used to determine the texture profile analysis. An analyser the sample was squeezed twice at a predetermined rate of 2 mm/s1 to a depth of 15 mm using an acrylic probe with a 1 cm diameter (P/0.5R). 15

s separates the two compressions. The TPA criteria are With the XTRA Dimension programme, the hardness, compressibility, adhesiveness, and cohesiveness of sunscreen samples was determined. On the texture profile analysis curve of the equipment measuring the load and displacement at predefined locations. The TTC Spread ability Rig HDP/SR attachment was used to assess spreadability using a texture analyzer (Model TA.XT Plus, Stable Micro Systems, and Surrey, UK). Without creating any air bubbles, the cream samples were neatly poured into the female cones. In relation to following the advice of the European Cosmetics Association's COLIPA, sunscreen compositions were applied to a 6 PMMA plate with a substrate of 50 mm 50 mm. By weight, the cream sample was put to the PMMA plate at a rate of 1.3 mg/cm2. By using monochromatic absorbance data measured on various sub sites within the product-treated plate, a mean value for transmission of UV radiation through the sample was determined from 290 to 400 nm at each 1 nm step. The product-treated plate was then placed in the light path of the measurement device. At least three plates were covered with each sunscreen sample that was evaluated. To make sure that a total area of at least 2 cm2 was measured, each plate was measured many times at various locations. Using the 35 healthy volunteers who provided their previous informed written permission underwent a patch test to assess the main skin irritation potential of the newly produced sunscreen creams BNZ and SMBNZ. The research was conducted at CLAIMS Pvt. Ltd., and the protocol was authorised in accordance with the November 2007 revision of IS 4011:1997 for clinical trials on cosmetic items. Results were compared to the starting state and the positive control in the trial, which was overseen by a dermatologist. The equivalent of 0.04 g of patch chamber wells was filled with test goods. Discs of filter paper poured in a second well of patch test chambers and both were applied conclusively. They were then dipped in 3% Sodium Lauryl Sulphate solution.

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Conflict of Interest

None

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