



Extraction and utilization of keratin protein from chicken feathers: A promising approach for cosmetic and pharmaceutical application.

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Abstract:

The goal of the current study was to remove keratin protein from chicken feathers. In addition to being a necessary essential for maintaining bodily structures, protein is a key component of cosmetics. Every year, vast amounts of chicken are consumed, which results in an immense amount of feather waste that is seen to be an environmental issue. Feathers are a good source of protein because of their high keratin concentration.

A significant part of hair, horns, claws, hooves, feathers, wool, hoof, and the outside layer of skin is keratin, a fibrous structural protein. Known as "dead tissue," these keratinous components are made up of keratin-filled cells. In the cortex, keratin functions as an interior structural protein as well as an exterior protective protein. Both water and organic solvents will not dissolve it. Improvements in the extraction, purification, and characterization processes allow for the extraction of keratin from both human and animal sources.

The primary procedures entail dissolving chicken feathers with various reducing agents first, followed by the protein's separation from chemicals. Sodium sulfide, potassium cyanide, and sulfuric acid are the reducing agents that are used. The protein precipitation process involves adding ammonium sulfate solution to the solution after the feathers have been dissolved using reducing agents. To recover the precipitated protein in solution form, it is repeatedly rinsed with water and then treated with sodium hydroxide solution. The fastest dissolution rate of chicken feathers among the three reducing agents tested was achieved with sodium sulfide, as the feathers dissolve quickly.

Strong mucoadhesive qualities in drug delivery systems are demonstrated by keratin, which has been converted into oxidized and reduced forms in terms of keratose and keratein. Particularly for skin care, hair care, and abrasive goods like conditioners, shampoos, and detergents. It can be utilized to make a range of pharmaceutical and cosmetic items because it has no negative effects. The biuret test and FTIR analysis are used to determine the proportion of keratin protein.

Key words:

Chicken feather, Keratin, Drug delivery, Reducing agents, Cosmetic, Analysis

Introduction:

About 90% of the feathers from chickens are made of keratin, which is a crucial component of cosmetic, shampoo, and hair care treatments. Because chicken dung feathers are produced in large quantities and are not biodegradable, they pose a serious environmental threat. The feathers have been burned and buried in accordance with traditional techniques, which could contaminate the ground and air. Insoluble in organic solvents, extracted keratin is non-abrasive, biodegradable, inexpensive, and possesses good mechanical qualities. The objective of this study is to extract keratin from chicken feathers, which is regarded as an environmental contaminant with a variety of industrial applications.

With around 750 g of protein per kilogram of pure protein, feathers are a bioresource with a high protein concentration. Conditioners, sulfite hair straighteners, anti-wrinkle therapy creams, and other personal care products are made from keratin protein fraction. There are three types of keratin: alpha, beta, and gamma. Hair cuticle, which serves as a protective layer, contains beta keratin, while hair follicles have gamma keratin. Alpha keratin is found in hair fibers. The creation of extracted keratin scaffolds for biomedical applications is a result of its capacity to self-assemble into three-dimensional porous structures. An important functional component found in many biological tissue, keratin is a protein rich in cysteines. Cysteine can be found in 14–15% of human hair, 8% of horse hair, 3% of horse hoof, etc. Keratin is composed of histidine, lysine, and arginine, with molecular ratios of around 1:4:12. The components of keratin—sulfur, tyrosine, tryptophane, phenylalanine, and glycine—are found in extremely modest amounts, ranging from 2 to 3% and 15% nitrogen.

Material and methods:

Feather collection and pretreatment:

Collecting white chicken feathers from Mosul's chicken processing plants, they were soaked in concentrated ethyl ether for a whole day to eliminate oil and grease, then washed with soapy, boiling water, and sun-dried for a full 48 hours. After that, dried feathers were combined and stored with caution in a sterile container.

Extraction of keratin:

Keratin was isolated with some changes in accordance with place of sodium sulfide, 0.5M sodium hydroxide was used as follows: 50g of blended feathers were added to 2L of 0.5M sodium hydroxide and agitated constantly for more than 6 hours at 40 degrees Celsius. After filtering out the feather fragments that were intractable, the keratin solution was centrifuged for ten minutes at 10,000 rpm. Following that, the supernatant was filtered using 0.45-micron filter paper. After that, the filtrate was subjected to dialysis, which was carried out for 48 hours at room temperature using a 76x49 cellulose dialysis sleeve. 10 ml of hydrochloric acid 2N was gradually added to the solution dropwise after dialysis in order to precipitate keratin at pH 4.2. Following a 10-minute centrifugation at 3000 rpm, the mixture was repeatedly rinsed to remove the precipitate.

Pharmaceutical application:

Nanoparticles:

The most effective way to boost a drug's specific efficacy is to incorporate it into nanoparticles. Recent research has shown that keratin-based nanoparticles are highly efficient anticancer medication carriers with some degree of tumor targeting capability. The design and development of mucoadhesive drug delivery systems can benefit from recent research on effective methods to manage and regulate the mucoadhesion and drug release of keratin-based nano drug delivery systems as well as the keratin volatility under

various pH settings. Biocompatible gold nanoparticles coated in keratin have antibacterial action against *S. aureus*, the germs that cause bovine mastitis. It has antioxidant properties as well. Creation of doxorubicin (DOX)-loaded keratin-g-polyethylene glycol nanoparticles showed that loading efficiency rises as keratin concentration on the keratin-g-PEG nanoparticles grows because of the drug's hydrogen bonding with keratin. The anti-cancer properties of keratin-coated silver nanoparticles have been demonstrated, together with their increased stability in an aqueous environment.

Keratin film:

Pharmaceuticals make extensive use of these biomaterials. Biomaterials are typically incorporated into implants or devices, and they need to work well with the body that is being transplanted. Certain keratin films made with solvent casting technology are utilized to produce films with extremely high-quality standards. Keratin films are produced using many hair samples due to their high sensitivity and repeatability. Keratin film is appropriate for effectively screening a wide range of natural and chemical compounds. Glycerol serves as a plasticizer and modifies keratin derived from chicken feathers.

Keratin hydrogels:

It has recently been found that keratin hydrogels can absorb fluid, exhibit homeostatic qualities, and may even be a useful hemostat. By encouraging thrombus formation and creating a seal or mesh-like structure on the wound site, the keratin gels applied to the injury site served as a scaffold to promote the production of granulose tissue. The ability of biomaterials based on keratin proteins to be translated into humans is clarifying the mechanisms through the control of nerve regeneration and hemostasis. Because these hydrogels allow for the prolonged release of therapeutic chemicals, they are a useful polymeric system for applications in tissue engineering and regenerative medicine. According to certain accounts, hydrogels are used to deliver antibiotics continuously, which is beneficial for bone regeneration and the prevention of acute infections and traumatic injuries.

Micro needles:

Transdermal drug delivery is more appropriate and convenient as it prevents stomach discomfort and first pass effect, which enhances patient compliance. Drugs and other components, including serum, albumin, bovine albumin, and calcein, have been effectively delivered using keratin microneedles, indicating their safety and promise for drug administration.

Other Pharmaceutical products:

Keratin is utilized as a biomaterial in tissue engineering, scaffolding, keratin sponge production, and keratin fiber production. It can be processed into a variety of forms, such as microparticles, to further drug release action technology. It was recently found to aid in wound healing and peripheral nerve restoration.

Cosmetic Application:

Proteins are the basic building blocks for today's skin and hair care products. Proteins are extracted from a range of sources and have characteristics that are vital for maintenance and defense. Its protective colloid effect lessens the chapping and irritation brought on by

detergents and other harsh chemicals, making it especially helpful for healing hair that has been permanently damaged by waving and bleaching. Another excellent skin moisturizer is hydrolyzed keratin. These cosmetics have better hydration and elasticity qualities. Maximum concentration of usage, or up to 5%, has been documented for dressings, hair tonics, and other expanding pharmacological aids.

Formulations for hair

Keratin was able to improve both mechanical and thermal properties of normal hair. Its applicability as a cosmetic product was supported by its compatibility with aquatic environments. Nevertheless, research on its genotoxicity and cytotoxicity revealed that it reduced skin irritation and cell viability. It was discovered that the peptide linkage, which is primarily composed of cysteine amino acids, is noncytotoxic and does not cause DNA damage or crosslinking in human foreskin or limit cell development. Protein based on keratin offers biological assessment and fortifying qualities on relaxed hair. Keratin-containing shampoo helps repair damaged hair, strengthen it, and prevent additional breakage. It is possible to straighten kinky, curly, or even wavy hair with the recently developed straightening lotion.

Keratin Complex Smoothing Therapy:

Keratin is bound to the hair using the latest cutting-edge technology used in Smoothing Therapy treatments. By keeping humidity from entering the hair, this procedure helps keep frizz at bay. Furthermore, this distinctive keratin technology is incorporated into the hair coloring procedure via Keratin Complex Color Therapy, which helps to strengthen and smooth the hair as it changes color.

In others cosmetics:

Certain keratin derivatives can be found in goods that are intended to be used near the eyes or mucous membranes. Hydrolyzed keratin, for instance, is utilized in concentrations of up to 0.2% in mascara, 0.028% in detergents and bath soaps, and a maximum of 0.059% in hair sprays, according to reports. Some of these compounds may also be ingested because they are reportedly used in hair sprays.

In skin care product:

The long-term investigation has shown that applying wool keratin samples to healthy skin has positive effects. Wool-derived hydrolyzed keratin protein can be used on its own or in conjunction with the internal lipid structure of the wool to improve the profile of moisture sorption and desorption as well as elasticity and hydration. Given the high content of cholesterol, free fatty acids, cholesterol sulphate, and ceramides found in internal wool lipids, this novel combination of derivatives from wool fiber may prove useful in the development of new medicinal or cosmetic treatments for skin care. It effectively moisturizes the skin by penetrating the top six layers of the epidermis and increasing the skin's moisture content. This leaves the skin looking smooth and healthy.

Keratin based nail cosmetic products:

Human nail plates are hard to come by for research on medication absorption and for treating a range of nail conditions. Keratin may be extracted under reductive circumstances, and solvent evaporation can be used to make its films. Due to their mechanical stability and

water resistance, the generated films were appropriate for permeation investigation. A very powerful daily keratin protein therapy that uses the protein's ability to heal damaged nails. A major element of a natural nail is keratin protein. To reinforce the nail plate, soluble keratin proteins form a link with the native nail.

Analysis:

Biuret Test:

1% potassium hydroxide solution and 1% copper sulfate solution are made. Potassium hydroxide solution is combined 1:1 with 5 mL of the collected solution. To the mixed solution, three drops of copper sulphate solution are added variations in the solution that are noted and documented. To determine the solution's absorbance, UV-vis analysis is done.

Analysis of the Sample:

Following purification, the solution is collected, examined in FTIR, and a wavelength graph is produced. This graph is then compared to a reference graph. Ammonium sulfate was used to fully precipitate the solution; the solids were then separated, measured, and their weight was noted. The entire procedure was performed using 0.5 M potassium cyanide solution in place of the sodium sulfide solution and 0.5 M potassium glycol colate solution. 0.1 N sodium hydroxide is used to make solutions of potassium cyanide and sulfuric acid

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