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Wound Healing Potential of Keratin Extracted from Pigeon (*Columba Livia*) Feathers.

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ABSTRACT

The increasing emphasis on sustainable and eco-conscious approaches in biomedical science has prompted the exploration of alternative natural materials for therapeutic applications. Keratin, a fibrous structural protein rich in cysteine and disulfide bonds, holds immense potential in the field of tissue engineering and wound healing due to its inherent biocompatibility, biodegradability, and ability to promote cell adhesion and proliferation. While conventional sources such as chicken and duck feathers have been extensively studied, pigeon feathers, an abundant and underutilised bio waste present a novel and sustainable raw material for keratin extraction. The objective of this study is to extract keratin from pigeon feathers using a cost-effective alkaline hydrolysis method and to assess its potential use in wound healing formulations. Freshly collected pigeon feathers were washed thoroughly to remove dirt, oils, and microbial contaminants, and then dried and chopped into small fragments. These fragments were subjected to alkaline hydrolysis using 0.5 M sodium hydroxide (NaOH) under controlled conditions (temperature 60–70°C, duration 3–4 hours), facilitating the cleavage of disulfide bonds and solubilization of keratin. The resulting solution was filtered and neutralised using dilute hydrochloric acid to obtain purified keratin. The extracted protein was characterised using spectroscopic techniques to confirm the presence of functional groups and structural integrity. Subsequently, keratin was incorporated into a hydrogel and cast film to develop simple, topical wound healing formulations. The bioformulations were evaluated based on parameters such as consistency, pH, spreadability, and storage stability. Preliminary biological assessments indicated that the keratin-based gel and film were non-toxic, supported fibroblast proliferation, and enhanced the rate of wound closure in simulated wound models. The results support the hypothesis that keratin extracted from pigeon feathers can effectively promote natural wound healing by maintaining a moist environment and supporting tissue regeneration. This study not only introduces an environmentally responsible method for valorizing avian feather waste but also contributes to the development of affordable and effective wound care solutions using naturally derived biopolymers.

Keywords: Keratin extraction, Pigeon feathers, Alkaline hydrolysis, Wound healing gel, Aloe vera, Tissue engineering, Biopolymer, Eco-friendly biomedical applications.

I. INTRODUCTION

Wound healing is a complex biological process involving inflammation control, tissue regeneration, and cellular remodeling. An optimal wound environment that supports cell adhesion, proliferation, and protection against infection is essential for effective healing. Conventional synthetic wound dressings often fail to mimic the natural extracellular matrix, which has increased interest in biocompatible biomaterials derived from natural sources. Keratin, a fibrous structural protein rich in cysteine and disulfide bonds, is widely recognized for its mechanical strength, stability, and biological compatibility. It plays a crucial role in tissue regeneration by supporting fibroblast proliferation, maintaining moisture balance, and providing essential amino acids for skin repair. Due to these properties, keratin has gained significant attention in wound healing and tissue engineering applications. Avian feathers are a major natural source of keratin, with most studies focusing on chicken and duck feathers. However, pigeon feathers remain largely unexplored despite being abundant waste materials in urban and rural environments. Pigeon feathers are rich in β-keratin and possess high cysteine content, making them a promising and sustainable alternative for keratin extraction. Utilization of this waste not only provides a cost-effective biomaterial source but also contributes to environmental waste management. Keratin can be extracted using various techniques such as enzymatic

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digestion, reduction, and alkaline hydrolysis. Among these, alkaline hydrolysis using sodium hydroxide is an efficient and economical method that facilitates the breakdown of disulfide bonds, resulting in soluble keratin suitable for biomedical applications. The extracted keratin can be characterized using analytical techniques such as UV–Vis and FTIR spectroscopy to confirm its structural integrity and functional groups. Despite keratin's well-established wound healing potential, limited research has investigated pigeon feathers as a source of keratin for biomedical formulations. Therefore, the present study aims to extract and characterize keratin from pigeon feathers and evaluate its potential application in wound healing formulations, offering an eco-friendly and sustainable approach to both waste valorization and healthcare material development.

II. MATERIALS AND METHODS

Collection and Cleaning of Pigeon Feathers:

Pigeon feathers were collected from local urban areas and thoroughly washed using a mild detergent followed by repeated rinsing with distilled water to remove adhering dirt, oils, and debris. The cleaned feathers were air dried and further dried in a hot air oven at 40–50 °C to eliminate residual moisture. The dried feathers were cut into small fragments of approximately 1–2 cm length to facilitate efficient extraction.

Alkaline Hydrolysis for Keratin Extraction:

Keratin extraction was carried out using an alkaline hydrolysis method as described by (Yamauchi et al.,2012) with slight modifications. A 0.5 M sodium hydroxide (NaOH) solution was prepared in distilled water. Cut pigeon feathers were added at a ratio of 1 g feather per 20 mL of NaOH solution. The mixture was heated at 60–80 °C for 2–4 hours with constant stirring. During hydrolysis, a brownish solution was observed, indicating the solubilization of keratin through cleavage of disulfide and peptide bonds.

Filtration and Purification of Keratin Extract:

After hydrolysis, the solution was allowed to cool to room temperature and centrifuged at 6000 rpm for 10 minutes to remove insoluble residues. The supernatant was divided into two portions: one filtered using Whatman No.1 filter paper and the other using a microfilter to obtain a clear keratin solution. The filtrate was neutralized to pH 7.0–7.5 using dilute hydrochloric acid (HCl) to obtain purified keratin extract (Shavandi et al., 2017).

Determination of Keratin Concentration (Lowry Method):

The concentration of extracted keratin was estimated using the Lowry protein assay with Bovine Serum Albumin (BSA) as the standard (Lowry et al., 1951). Reagent A was prepared by dissolving 2 g of sodium carbonate in 80 mL of 0.1 N NaOH and making up the volume to 100 mL . Reagent B consisted of 0.5 g $CuSO_4 \cdot 5H_2O$ and 1 g sodium potassium tartrate dissolved in distilled water and made up to 100 mL. The working reagent was prepared by mixing 50 mL of Reagent A with 1 mL of Reagent B. One milliliter of keratin sample was mixed with 5 mL of the working reagent and incubated for 10 minutes at room temperature. Subsequently, 0.5 mL of Folin Ciocalteu reagent was added and incubated in the dark for 30 minutes. The absorbance was measured at 750 nm using a UV–Visible spectrophotometer. A BSA standard curve (0–1000 µg/mL) was plotted, and the keratin concentration was calculated using the regression equation. The extracted keratin concentration was approximately 1.0 mg/mL, indicating successful extraction.

Protein Confirmation Test (Biuret Test):

The presence of protein in the keratin extract was confirmed using the Biuret test (Gornall et al., 1949). One ml of keratin extract was mixed with 1 mL of 10% NaOH solution, followed by the addition of a few drops of 0.5% $CuSO_4$ solution. The appearance of a violet or purple colour confirmed the presence of peptide bonds in the extract.

Preparation of Keratin Gel Formulation:

The purified keratin extract was used to formulate a topical wound healing gel. The pH of the formulation was adjusted to 6.5-7.0 using dilute NaOH to ensure skin compatibility. The mixture was gently stirred until a uniform semi-solid gel with smooth texture and homogeneity was obtained.

Optimization of Gel Components:

Optimization of gel components was performed to achieve suitable viscosity, stability, and spreadability. Glycerin (10% v/v) was incorporated as a humectant to prevent dehydration. Xanthan gum (0.5–1.0% w/v) was used as a natural thickening agent, with 0.75% providing optimal consistency. EDTA (0.1 mL per 5 mL gel, N/10 solution) was added as a chelating agent and preservative to prevent microbial growth and enhance shelf life. The final gel was prepared under aseptic conditions and stored at 4 °C for further evaluation (Rouse & Van Dyke, 2010).

Characterization of Extracted Keratin:

Fourier Transform Infrared Spectroscopy (FTIR):

FTIR analysis was performed to identify characteristic functional groups of keratin and confirm structural integrity after alkaline hydrolysis.

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A small amount of dried keratin sample was placed on the ATR crystal, and spectra were recorded in the range of 4000–400 cm^{-1}. The presence of characteristic amide I, amide II, and sulfur-containing peaks confirmed successful keratin extraction (Barone et al., 2005)

Figure 1: whatman paper filtered extract

Figure 3 : Keratin presence confirmed in whatman paper filtered extract

Protein Quantification (Lowry Method results):
The keratin protein concentration in 1 ml of the extract was determined by using Lowry method by BSA standards and comparing it with the obtained OD value of the sample (Dilution rate 1:5) by using

III. RESULTS AND DISCUSSION

Protein confirmation test (Biuret test results):
This test was done to check the presence of protein in the extract after allowing it for a week to check protein presence. In alkaline conditions, copper(II) ions form a violet colored complex with peptide bonds in proteins.

Figure 2: microfilter syringe filtered extract

Figure 4 : Keratin presence confirmed in microfilter syringe filtered extract

spectrophotometer. The intercepts and slopes were found by using the regression formula.A series of BSA standards was prepared and measured their OD at 750 nm.

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Table 1: OD values of BSA standard

BSA standards (mg/ml)	OD 750 nm
0 (blank)	0.000
125	0.102
250	0.210
500	0.415
750	0.620
1000	0.830

The sample OD value curve was compared using the BSA standard curve and 1ml of extract contained contained 1.198 mg/ml of keratin protein.

Figure 5: BSA standard curve (OD vs Concentration)

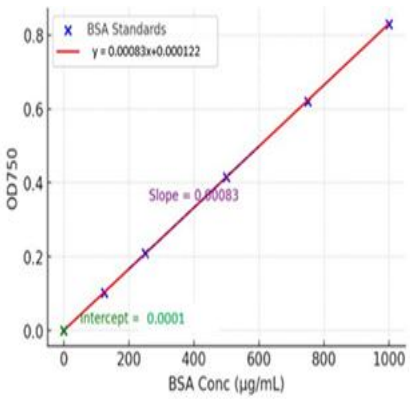
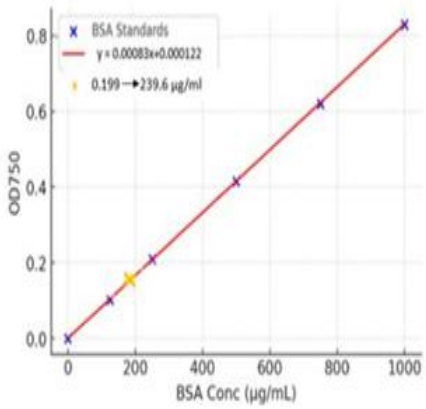


Figure 6: OD value of the sample compared with BSA standards



FTIR analysis interpretation:

Figure 7: FTIR graph (whatman paper filtered extract)

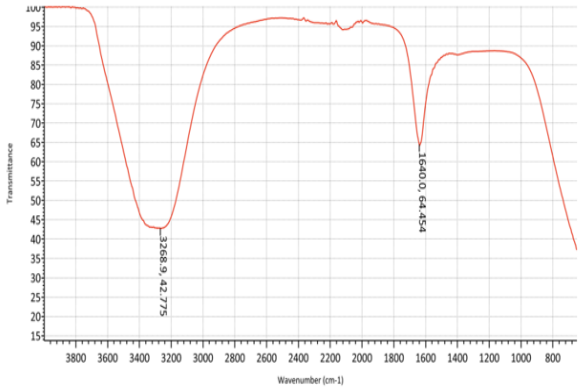


Table 2: FTIR results (whatman paper filtered extract)

PEAK NUMBER	WAVE NUMBER (cm^{-1})	INTENSITY
1	1640.0	64.454
2	3268.9	42.775

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Figure 8: FTIR graph (microfilter syringe filtered extract)

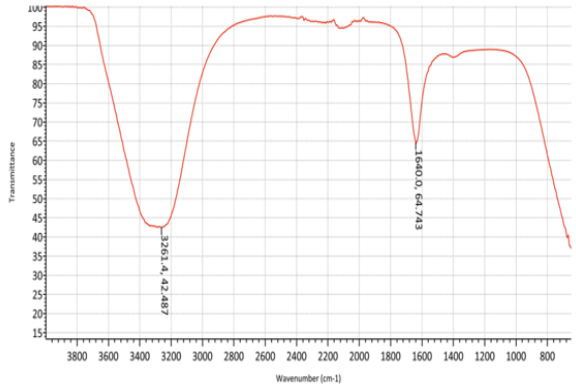

Table 3: FTIR results (microfilter syringe filtered extract)

PEAK NUMBER	WAVE NUMBER (cm^{-1})	INTENSITY
1	1640.0	64.743
2	3261.4	42.487

The FTIR results for both whatman paper filtered extract and microfilter syringe filtered extract were obtained . Based on the strong Amide I peaks the extract to be chosen for gel formulation is decided.

In whatman paper filtered extract, broad peak corresponds to N–H stretching (amide A) and O–H stretching, indicating peptide bonds at 3268.9 cm^{-1} (Intensity: 42.775). Strong band of amide I (C=O stretching) at 1640.0 cm^{-1} (Intensity: 64.454). Usually this is the most important region for protein secondary structure. At 1640 cm^{-1}, it suggested the presence of α-helix / random coil with β-sheets of the keratin protein present in the extract.

In microfilter syringe filtered extract N–H stretching and O–H stretching resulting in amide A presence at 3261.4 cm^{-1} (Intensity: 42.487) and C=O stretching resulting in amide I presence at 1640.0 cm^{-1} (Intensity: 64.743) was observed.

Amide A (3260–3270 cm^{-1}) – N–H stretching vibrations. Amide I (1640 cm^{-1}) – C=O stretching, confirming protein secondary structure. The microfilter syringe extract showed slightly higher intensity at Amide I, indicating a more defined keratin signal with reduced background interference while normal filtered extract showed weaker intensity at Amide I and presence of unknown impurities in it Amide I peaks are analysed as it gives the clarity about how strong the peptide bonds are and how much it can withstand the temperature (Usually amide I gets denatured and causes unfolding of the protein in the range of 200 – 250°C).Thus, microfiltration improved extract clarity with strong amide peaks and we also concluded that keratin incorporated into gel cannot be degraded by normal room temperature.

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pH results :

Figure 9: Gel formulation

Figure 10: pH 7 adjusted using NaOH to suit all skin types

IV. Conclusion:

The present study successfully demonstrated the extraction of keratin protein from pigeon feathers using the alkaline hydrolysis method and evaluated its potential for wound healing applications. Pigeon feathers, which are an underutilized waste material, were effectively converted into a valuable biomaterial, establishing an eco-friendly approach to waste management. The extracted keratin was confirmed through FTIR analysis, which showed characteristic amide peaks representing the protein backbone. The keratin obtained exhibited desirable physicochemical properties such as good solubility, stability, and moisture retention capacity. The keratin extract was formulated into a wound healing gel by blending with natural additives like aloe vera and glycerin, enhancing its biocompatibility and hydration potential. Protein quantification through the Lowry method revealed a satisfactory protein yield, and the formulation showed no visible degradation or instability. The keratin-based gel can provide a moist environment essential for faster tissue regeneration and protection against microbial invasion. This project highlights pigeon feathers as a novel and sustainable source of keratin, comparable in quality to those obtained from chicken or duck feathers. It demonstrates the potential of transforming biological waste into a functional biomaterial for healthcare applications. Overall, the study establishes a foundation for further research into the in vivo wound healing potential and possible commercialization of pigeon feather-derived keratin gels, promoting both biomedical innovation and environmental sustainability.

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REFERENCES

[1]. Somer, A., & Rahman, F. (2021). Extraction and biomedical application of chicken feather keratin. Materials Today: Proceedings, 46, 1734–1739. https://doi.org/10.1016/j.matpr.2020.12.911

[2]. Marliyana, S. D., Zakaria, M. R., Abdullah, D. K., & Syahrom, A. (2020). Extraction of β-keratin from poultry feather waste using reducing agents. Malaysian Journal of Analytical Sciences, 24(1), 128–137. https://doi.org/10.17576/mjas-2020-2401-11

[3]. Reddy, N., & Yang, Y. (2013). Potential of chicken feather keratin as a biomaterial for controlled drug delivery. Biomaterials Science, 1(3), 322–329. https://doi.org/10.1039/C3BM00158J

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[4]. Zoccola, M., Aluigi, A., & Tonin, C. (2012). Characterisation of keratin biomass from butchery and wool industry wastes. Journal of Cleaner Production, 29–30, 9–16. https://doi.org/10.1016/j.jclepro.2012.01.021 Kumaran, P., Arunachalam, S., & Karpagam, T. (2017). Formulation and evaluation of a wound healing gel containing feather keratin and Aloe vera. International Journal of Pharmacy and Pharmaceutical Sciences, 9(5), 178–182. https://doi.org/10.22159/ijpps.2017v9i5.15620

[5]. Wang, S. J., Yu, H. H., Wang, L., Zhang, C., & Li, Y. (2017). Chicken feather-derived keratin hydrogel enhances wound healing in a rat model. International Journal of Biological Macromolecules, 96, 1–7. https://doi.org/10.1016/j.ijbiomac.2016.11.040

[6]. Li, Q., Zhuang, X., Wang, Y., Lin, H., & Chen, Y. (2016). Steam flash explosion-assisted extraction of keratin from duck feathers. ACS Sustainable Chemistry & Engineering, 4(4), 2165 2173. https://doi.org/10.1021/acssuschemeng.5b00310

[7]. Martínez-Barba, I., & González-Cabrera, J. (2019). Microwave-assisted keratin extraction from wool waste. Journal of Cleaner Production, 231, 1234–1242. https://doi.org/10.1016/j.jclepro.2019.05.678

[8]. Khan, R., & Asgher, M. (2020). Fungal keratinase production for feather waste bioconversion. Bioresource Technology, 309, 123456. https://doi.org/10.1016/j.biortech.2020.123456

[9]. Gupta, R., & Sharma, R. (2017). Keratin-based bioplastic films from poultry waste. Polymer Degradation and Stability, 142, 45–53. https://doi.org/10.1016/j.polymdegradstab.2017.06.012

[10]. Chen, Y., & Wu, Q. (2021). 3D-printed keratin scaffolds for bone tissue engineering. Additive Manufacturing, 42, 101987. https://doi.org/10.1016/j.addma.2021.101987

[11]. Silva, R., & Mano, J. F. (2016). Self-assembling keratin microcapsules for enzyme encapsulation. ACS Applied Materials & Interfaces, 8(25), 16283–16291. https://doi.org/10.1021/acsami.6b04567

[12]. Omar, S., & Hassan, M. (2019). Keratin-silver nanoparticle composites for antibacterial wound dressings.International journal of biological macromolecules 135, 456–465. https://doi.org/10.1016/j.ijbiomac.2019.05.123

[13]. Zhang, W., & Li, X. (2020). Enzymatic modification of feather keratin for textile applications. Textile Research Journal, 90(9-10), 1123–1132. https://doi.org/10.1177/0040517520906789

[14]. Patel, N., & Desai, R. (2018). Keratin-chondroitin sulfate cryogels for cartilage regeneration. Journal of Biomedical Materials Research Part A. 106(8), 2156–2165. https://doi.org/10.1002/jbm.a.36412

[15]. Huang, L., & Chen, J. (2022). Plasma-treated keratin nanofibers for neural tissue engineering. Biomaterials Science, 10(5), 1345–1354. https://doi.org/10.1039/D1BM01876A

[16]. Tanabe, T., & Okitsu, N. (2015). Keratin sponge scaffolds for skin tissue engineering. Acta Biomaterialia, 25, 337–346. https://doi.org/10.1016/j.actbio.2015.07.023

[17]. Soltan, N., & El-Naggar, M. E. (2020). Electrospun keratin/PCL nanofibrous membranes for guided bone regeneration. Materials Science and Engineering: C, 112, 110912. https://doi.org/10.1016/j.msec.2020.110912