Nigerian Research Journal of Chemical Sciences **(ISSN: 2682-6054)**
Vol. 7, Issue 2, 2019

EXTRACTION AND CHARACTERISATION OF KERATIN OBTAINED FROM GOAT HOOF AND CHICKEN FEATHER

*Adamu Mujitaba Muhammad, Omoniyi Kehinde Israel and Idris Sulaiman Ola
Department of Chemistry, Ahmadu Bello University, Zaria, Nigeria
*Corresponding Author: adamumujitaba90@gmail.com

ABSTRACT

This study presents the extraction and characterization of keratin nanoparticle from goat hoof and chicken feather. Chicken feathers (CF) and goat hooves (GH) were collected respectively from Sabon Gari market and Kusfa both in Zaria, Kaduna State, Nigeria. They were first washed with detergent and distilled water. CF and GH were degreased in diethyl ether, washed in warm distilled water and ground to 0.5 mm using mechanical grinder. Sodium sulphide was used to extract keratin from the feather and hooves at pH 3.5 and 5.5. The chicken feather keratin extracted at pH 3.5 ($KCF_{3.5}$) and 5.5 ($KCF_{5.5}$) showed percentage yield of 65.84 and 61.11% respectively while keratin obtained from goat hoof at pH 3.5 ($KGH_{3.5}$) and 5.5 ($KGH_{5.5}$) were 70.00 and 62.32% respectively. Ground samples, extracted KRT and commercial keratin (CK) were characterised using Fourier transform infrared (FTIR) spectroscopy. Ground CF showed absorption peaks at 3261, 2922, 1625, 1520 and 1237 cm^{-1}which correspond to Amide A, CH_3 stretch, Amide I, Amide II and Amide III respectively. Also absorption peaks were observed in ground GH at 3276, 2926, 1625, 1446 and 1237 cm^{-1} which correspond to Amide A, CH_3 stretch, Amide I, Amide II and Amide III respectively. $KGH_{3.5}$, $KGH_{5.5}$, $KCF_{3.5}$ and $KCF_{5.5}$ showed vibration bands around 3280 to 3261, 2963 to 2922, 1643 to 1628, 1561 to 1512, 1390 to 1230 and 1051 to 1021 cm^{-1} which correspond to Amide A, CH_3 stretching, Amide I, Amide II, Amide III and symmetric S-O stretch respectively. CK showed transmission band at 3276, 2959, 1628, 1524 and 1230 cm^{-1} which corresponds to Amide A, Amide I, Amide II and Amide III respectively. Therefore this research was focused on the conversion of feathers and hooves waste to obtain bio-products that added value to the wastes thereby providing not only inexpensive and renewable raw material but also play a key role in the mitigation of environmental pollution.

Key words: Chicken feather, goat hoof, keratin, sodium sulphide.

INTRODUCTION

Keratins are fibrous proteins that are present in wool, hair, feathers, finger nails, animal claws hooves and horns [1]. Very large amount of feathers and hooves discharged from abattoirs and poultry industries annually is on the increase and only a few is utilized as packing materials, embellishment as well as forage. In our day-to-day life, chicken feathers constitute large amount of waste byproduct of poultry industry totaling more than 4million tons annually worldwide [2].

Animal sources by-products (hooves, horns, bones and feathers) are presently used for different purposes such as fertilizers, livestock feed, cosmetics and pet food, etc [3]. Every year an enormous quantity of keratins in form of hairs, feathers, horns and hooves are wasted [4]. Feathers and hooves pose significant threat to life and environment because their disposal is largely by incineration or by landfilling. Disposal of feathers and hooves in landfills leads to the release of landfill leachetes which can contaminate ground water causing diseases, issues of odours emerging due to decomposition of substances in the biomass, as well as greenhouse gases such as methane and carbon dioxide and also results in discarding valuable raw material which is made up of more than 90% proteins. Also, this keratin bound feathers and hooves contain 5% and 1% sulphur of hard and soft keratin respectively, and thus their incineration produces environmental pollutants. Therefore this research work was focused on utilizing feathers and hooves to obtain valuable biopolymer and also to recycle animal wastes.

MATERIALS AND METHOD

Collection, Pretreatment and Extraction of Keratin from Chicken Feather and Goat Hoof

Chicken feathers were collected at Sabon Gari market, Zaria located between $11^{0}6^{1}24$N and longitude $7^{0}43^{1}41$E while goat hooves were collected at Kusfa, Zaria located between latitude $11^{0}31^{1}2$N and longitude $7^{0}42^{1}4$E. The feathers and hooves were both washed separately with distilled water and dried in an oven at 40 ^{o}C for 72 hours. Then the feathers and hooves were soaked in detergent for two hours. After washing with distilled water they were soaked in diethyl ether and left overnight. The feathers and hooves were then further washed in hot water at 100 ^{o}C and sun dried at approximately 48 hours. The dried feathers and hooves were chopped into small pieces in a mechanical grinder and stored separately in sealed bags [5].

The feathers and hooves were dissolved by mixing 25 g of both the chopped feathers and hooves into sodium sulphide (0.5M in 1L) [5, 6] separately. Each of the solution was heated at 50 ^{o}C using a mechanical stirrer. Each of the mixture was filtered twice using whatman filter paper and centrifuged at 10,000 rpm using centrifuge for 15 minutes to remove supernatant from undissolved materials.

Purification of Protein

The pH of each of the solution was adjusted to 3.5 by adding NaOH to precipitate the protein using JENWAY Model 350 pH meter (England) [5]. The keratin proteins obtained were subjected to centrifugation at 10,000 rpm for 10 minutes. Each was then washed using distilled water and freeze dried to obtain particles for further analysis and characterization [7].

Characterisation

The microstructure of the both the chopped feathers and hooves and their different keratin extract were analyzed using Cary 630 FTIR instrument (aligen technologies, USA). The spectra were analyzed using the program FTIR spectrum software (this helped to check changes in chemical composition of polypeptide) [8].

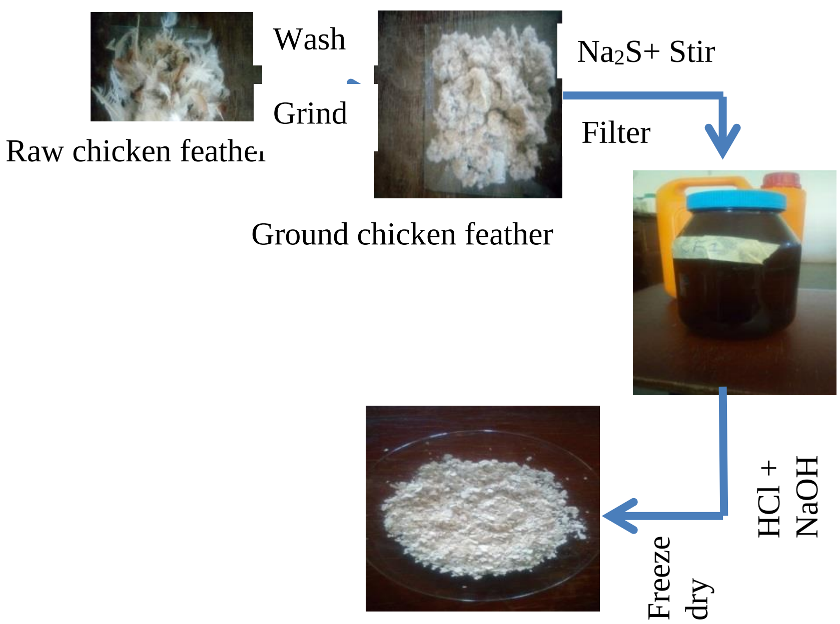

Figure 1: Schematic diagram of Chicken feather keratin

Figure 2: Schematic diagram of goat hoof keratin.

RESULTS AND DISCUSSION

Characterization

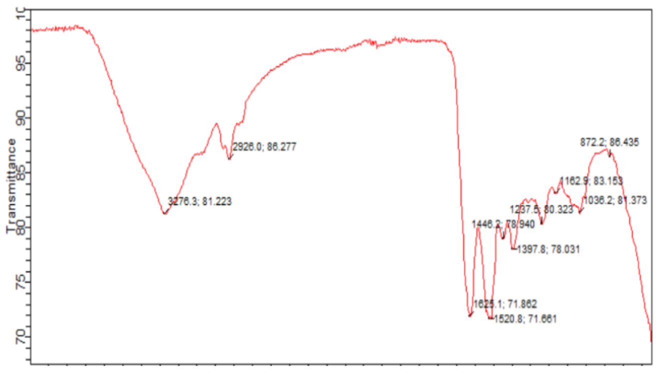

Figure 3: Fourier transform infrared (FTIR) analysis of ground goat hoof (GH).

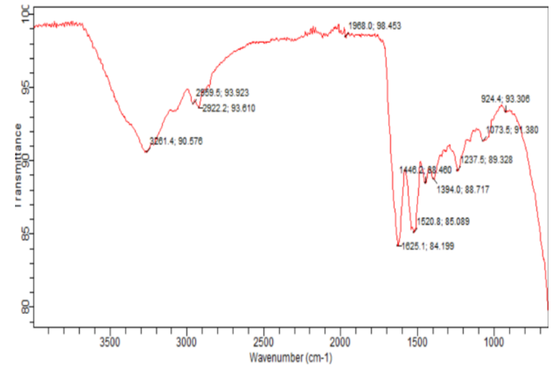

Figure 4: Fourier transform infrared (FTIR) analysis of ground chicken feather (CF).

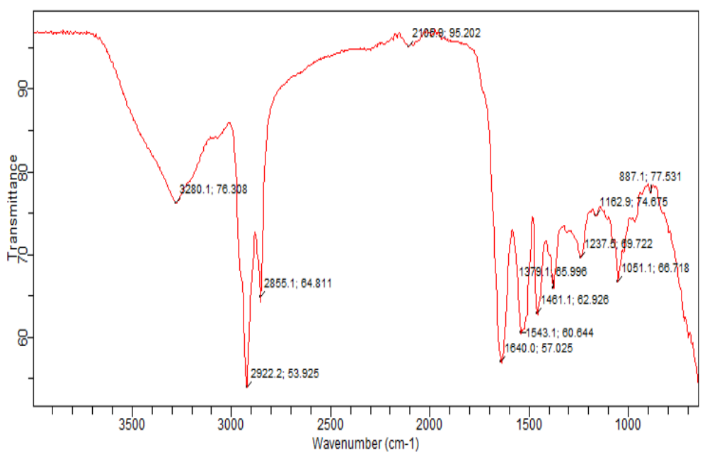

Figure 5: Fourier transform infrared (FTIR) analysis of $KGH_{3.5}$.

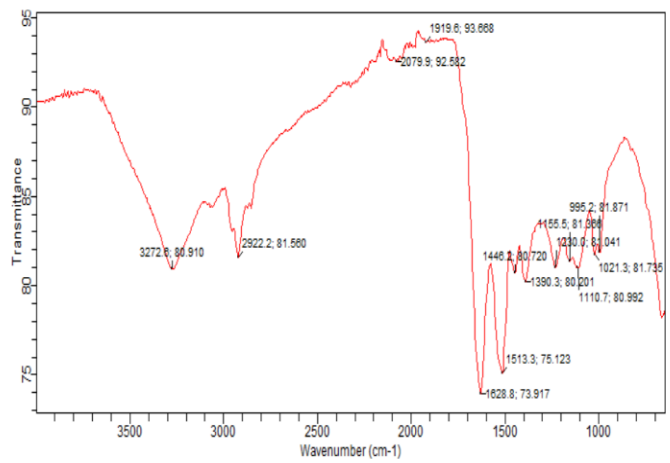

Figure 6: Fourier transform infrared (FTIR) analysis of $KGH_{5.5}$.

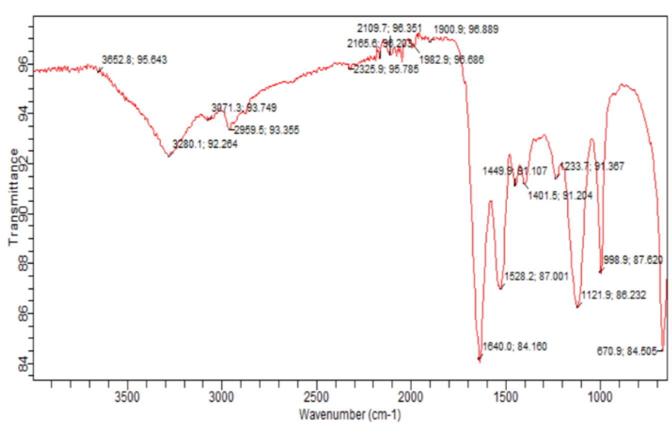

Figure 7: Fourier transforminfrared (FTIR) analysis of $KCF_{3.5}$.

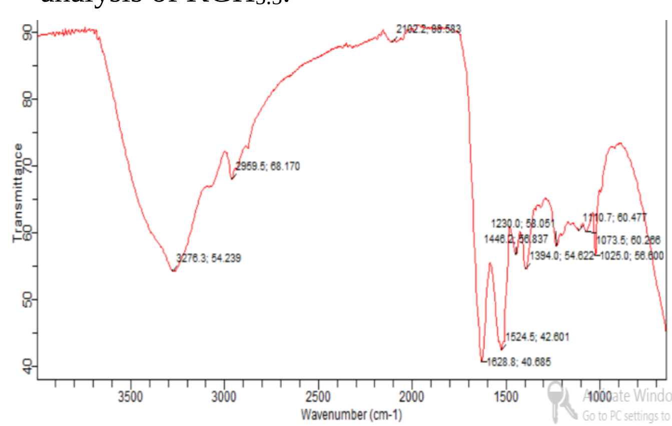

Figure 8: Fourier transform infrared (FTIR) analysis of $KCF_{5.5}$.

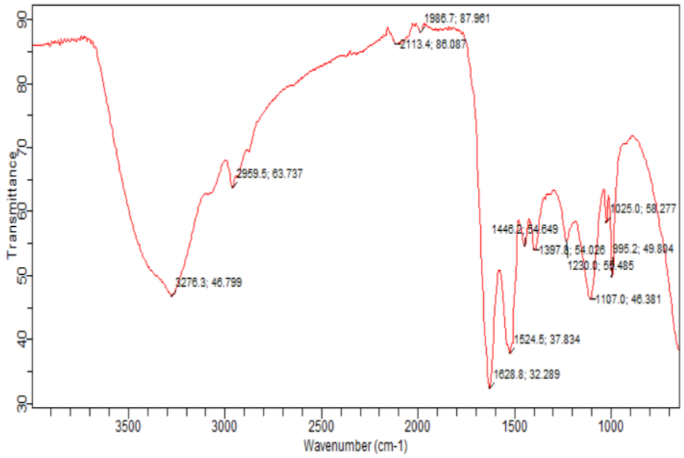

Figure 9: Fourier transforms infrared (FTIR) analysis of CK.

Percentage Yield of Keratin Extract

The percentage yield of $KCF_{3.5}$ and $KCF_{5.5}$ are 65.84% and 61.11% respectively. $KGH_{3.5}$ and $KGH_{5.5}$ yielded a percentage of 70% and 62.32% respectively. This shows that there is variation in the quantity of keratin obtained at iso-electric precipitates.

CHARACTERISATION

Figures 3 to 9 have absorption peaks at 3276, 3261, 3280, 3272, 3280, 3261 and 3276 cm^{-1} respectively which can be ascribed to N-H stretch (Amide A). Ground GH, ground CF, $KGH_{3.5}$, $KGH_{5.5}$, $KCF_{3.5}$, $KCF_{5.5}$ and CK show vibration bands at 2926, 2922, 2922, 2922, 2959, 2963 and 2959 cm^{-1} respectively which is ascribed to CH_3 stretch. The transmission bands at 1625, 1625, 1640, 1628, 1640, 1643 and 1628 cm^{-1} present in figures 3 to 9 respectively are attributed -C=O- (Amide I) [9,10]. The absorption bands at 1520, 1520, 1543, 1513, 1528,1561 and 1524 cm^{-1} in figures 3 to 9 respectively is attributed to C-H stretching and N-H bending (Amide II) [11]. C-N stretching and N-H bending which corresponds to Amide III were ascribed to vibration bands at 1237, 1237, 1237, 1230, 1233, 1390 and 1230 cm^{-1}present in figures 3 to 9 respectively [12].

CONCLUSION

Sodium Sulphide (Na_2S) showed an excellent ability for the extraction of keratin from GH and CF which is not only used for the recovery of high value fibrous protein but it is highly efficient for treatment of waste poultry and abattoir products. Goat hoof keratin produced higher percentage yield than the corresponding chicken feather keratin at different pH.

REFERENCES

[1] Idris, A., Vijayaraghavan, R., Rana, U.A., Fredericks, D., Patti, A. & MacFarlane, D. (2013). Dissolution of feather keratin in ionic liquids.*Green Chemistry*, 15(2), 525-534.

[2] Jiménez-Cervantes, A.E., Velasco-Santos, C., Martínez-Hernández.,A.L., Rivera-Armenta, J.L., Mendoza-Martínez, A.M. & Castaño, V.M. (2015). *Journal of Composite Materials*, 49, 275-283.

[3] Zhu, G.Y., Zhu, X., Wan, X.L., Fan, Q., Ma, Y.H., Qian, J., Liu, X.L., Shen, Y.J. & Jiang, J.H. (2010). Hydrolysis technology and kinetics of poultry waste to produce amino acids in subcritical water.*Journal of Analytical and Applied Pyrolysis*, 88(2), 187-191.

[4] Onifade, A., Al-Sane, N., Al-Musallam, A. & Al-Zarban, S. (1998). A review: potentials for biotechnological applications of keratin degrading microorganisms and their enzymes for nutritional improvement of feathers and other keratins as livestock feed resources. *Bioresources Technology*, 66, 1-11.

[5] Sharma, S. & Gupta, A. (2016). Sustainable Management of Keratin Waste Biomass: Applications and Future Perspectives. *Brazilian Archives of Biology and Technology*, 59.

[6] Sharma, S., Gupta, A., Chik, S.M.S.B.T., Kee, C.Y.G. & Poddar, P.K. (2017). Dissolution and characterization of biofunctional keratin particles extracted from chicken feathers, IOP Conference Series. *Materials Science and Engineering*, IOP Publishing, 012-013.

[7] Ramakrishnan, N., Sharma, S., Gupta, A. & Alashwal, B.Y. (2018). Keratin based bioplastic film from chicken feathers and its characterization. *Biological Macrmolecules*, 4-5. https://doi.org/10.1016/j.ijbiomac.2018.01.037.

[9] Mohanty, A.K., Misra, M. & Drzal, L.T. (2005). Natural Fibers, Biopolymers and Biocomposites. CRC press.

[10] Kakkar, P., Balaraman, M. & Shanmugam, G. (2016). Transient structures of keratins from hoof and horn influence their self-association and supramolecular assemblies. *International Journal of Biological Macromolecules,* 93, 172–178.

[11] Eslahi, N., Dadashian, F. & Nejad, N.H. (2013). An investigation on keratin extraction from wool and feather waste by enzymatic hydrolysis.*Preparative Biochemistry and Biotechnology*, 43 (7), 624–648.

[12] Xu, W., Ke, G., Wu, J. & Wang, X. (2006). Modification of wool fiber using steam explosion.*European Polymer Journal*, 42(9), 2168-2173.