International Journal of Advanced Biochemistry Research

ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2024; SP-8(6): 537-539
www.biochemjournal.com
Received: 02-04-2024
Accepted: 08-05-2024

Anima Mandal
Department of Textiles and Apparel Designing, College of Community Science, Assam Agricultural University, Jorhat, Assam, India

Dr. Nabaneeta Gogoi
Department of Textiles and Apparel Designing, College of Community Science, Assam Agricultural University, Jorhat, Assam, India

Smita Bhuyan
Department of Textiles and Apparel Designing, College of Community Science, Assam Agricultural University, Jorhat, Assam, India

Corresponding Author:
Anima Mandal
Department of Textiles and Apparel Designing, College of Community Science, Assam Agricultural University, Jorhat, Assam, India

Sustainable approaches to chicken feather extraction for environmental conservation

Anima Mandal, Nabaneeta Gogoi and Smita Bhuyan

DOI: https://doi.org/10.33545/26174693.2024.v8.i6Sg.1372

Abstract
Chicken is one of the most consumed meats worldwide, significantly impacting global food production. The sector produces a large quantity of chicken meat, generating substantial byproducts, including feathers. Chicken feathers are left over as waste after processing chickens for meat. As per statistical report more than 4 billion tons of chicken feathers are wasted annually worldwide. Though traditionally considered waste materials; feathers can be innovatively repurposed to reduce environmental pollution. The feathers of a chicken are mainly made up of keratin, a light and tough protein that can be used for various purposes. The present research was undertaken to extract chicken feather fiber, which holds promise in mitigating environmental pollution and promote sustainability in various sectors.

Keywords: Natural fiber, chicken feather fiber, extraction of fiber, environmental pollution

1. Introduction
Poultry feathers are byproducts remaining after processing chickens in the food industry. Approximately two or four billion pounds of poultry feathers are produced annually by the poultry industry (The times of India, 2006). This high consumption of chicken results in the generation of large amounts of chicken feathers each year worldwide. Unfortunately, the demand for feathers is rather low, and most of them are disposed of by burning, landfilling, or conversion into feather meal and fed to livestock or used as fertilizer.

Improper disposal of those organic wastes contributes to environmental damage and transmission of diseases (Tesfaye *et al*., 2017) [14]**.** Economic and environmental pressures, increasing interest in using renewable and sustainable raw materials, and the need to decrease reliance on nonrenewable petroleum resources have led the industry to find better ways to deal with waste feathers. A closer look at the structure and composition of feathers shows that chicken feathers (rachis and barb) can be used as a source of a pure structural protein called keratin, which can be exploited for conversion into a number of high-value byproducts. A feather is mainly composed of three distinct units, as shown in Figure 1. The central shaft of the feather is called the rachis, to which are attached the secondary structures, the barbs.

The tertiary structures of the feathers, the barbules, were attached to the barbs in the same way as the barbs are attached to the rachis (Reddy and Yang 2007) [12]. Feathers are distinctly ordered, hierarchical branched structures, ranking many of the maximum complicated keratin systems located in vertebrates.

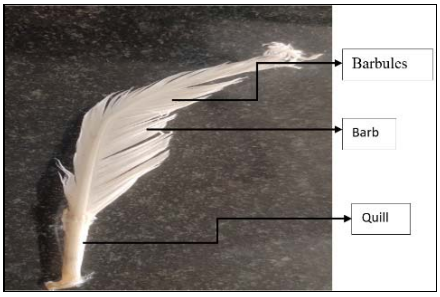

Fig 1: Distinct unit of feather

As a natural fiber derived from poultry feathers, chicken feathers possess high toughness, good thermal insulation properties, non-abrasive behavior and hydrophobic nature. Their low cost, low density, and large aspect ratio can make them good reinforcing materials. The chicken feathers pollute the soil into which it is dumped or pollutes the air when it is burnt. In both cases, the presence of Sulphur dioxide in feathers is the cause of pollution. Chicken waste also causes water pollution. Chicken feather fiber can be incorporated into erosion control products such as biodegradable erosion mats and blankets. These materials can be used in construction sites, slopes, and riverbanks to prevent soil erosion as well as sediment runoff. By stabilizing soil surfaces and promoting vegetation growth, feather fiber-based erosion control solutions help protect water quality, preserve natural habitats, and mitigate the adverse effects of erosion on ecosystems.

One promising approach is the development of chicken feather fiber, which has the potential to replace traditional synthetic fibers in products such as textiles, insulation materials, and biodegradable packaging. Integrating chicken feather fibers into manufacturing processes would lessen dependence on nonbiodegradable materials and thus decrease the environmental impact of different sectors. The primary goal of the study project is to examine the different qualities of fiber extracted from leftover chicken feathers so that it can be utilized for various end uses.

2. Experimental Method

2.1 Materials and Methods

The chicken feathers were collected from a nearby poultry farm in Jorhat, Assam. In the present research work, the required raw materials were obtained from boiler chicken after processing for meal. Chicken Feathers (CF) directly collected from a chicken processing plant or slaughterer were always dirty and contain various foreign materials, such as skin, blood, feces, and flesh.

2.2 Washing and cleaning

Waste feathers were washed several times with water first in order to remove the dirt and other unwanted particles present on the feather surface. The untreated feathers contain many kinds of bacteria, such as aerobic, anaerobic and enteric. If they grow on the feather, they will attack the feather keratin and make it very weak. Therefore, before using chicken a feather as a fiber, it is necessary to sterilize it to inhibit bacteria.

2.3 Pretreatment of Chicken Feather

The untreated chicken feathers were washed in warm water with 5% detergent solution. It helps in removing blood stains. The wet clean feathers were spread and dried under the sun for three days. The results showed that it cleans completely and kills most bacteria and reduces its stickiness. Sterilized feathers were decontaminated using 5 % sodium hypochlorite boiled in 100ml of water for an hour. This process helps to bleaching, cleaning, sanitization, and odor removal of feathers. The treated fibers were washed thoroughly with water, rinsed, and then dried in an oven (Hot air Oven) at 65 °C for 2 days. Dried feathers are then packed and stored at room temperature for further processing.

Feathers were soaked in warm water, and manually removed. Feathers were washed and sterilized at 121 °C and 12.5 MPa for 20 minutes to kill bacteria and avoid worms. Sterilized feathers were dried overnight and decontaminated using sodium hypochlorite or hydrogen peroxide solutions. Decontaminated feathers were rinsed twice and then oven dried (Kakonke *et al*.)

2.4 Extraction of fibres from feathers

Quills and barbs were separated from the dried chicken feathers. After drying, quills are separated by stripping from barbs, since they differ physically.

The quill has been separated from the feathers by means of two methods including blending and cutting.

The blended feather was found to be fluffy in nature. Then the barbs were removed and manually cut with the help of a surgical blade from the quill of the feather. The separation of fibers from the quill was done near the rachis to minimize loss of fiber length and natural properties due to the format of the fiber along the extension. To maintain the uniformity of the fiber length of the tip, the base of the feathers was cut and removed. Cutting takes a lot of time, but efficiency is greater than the grinding method.

2.5 Percentage yield of fibers

The percentage yield of fibers was determined using the equation:

Percentage yield (%) = M2 / M1 x 100

Where M1 is the mass of decontaminated and pre-treated chicken feather fibres before grinding and M2 is the mass of fibres after grinding feathers with a blender.

3 Result and Discussion

3.1 Effect on feather

Untreated feathers collected from the market were white, greasy and sticky with an unpleasant smell. It was observed that during the sterilization phase, a gradual change in color from white to yellowish. This variation was caused by the fatty acid composition generated from preen oil present in individual feathers, fecal matter, intestines and meats. Cleaning and decontamination were done to eliminate residual bacteria and remove odor, excess lipids and solvents. This step is considered as a treatment phase since it ensures that all contaminants are removed with the use of bleaching chemicals.

3.2 Effect of grinding technique on fibres

The purpose of grinding feathers was to separate the quill from the feathers, which are processable commodities. This was initially done using an electric blender and a surgical blade, and it took about 3 months to process 8 kg of feathers into fibres.

3.3 Optimization of Extraction Process

Optimization of fiber extraction is carried out by two methods:

Blender: The extraction of fibers from the chicken feathers is carried out by decortications process. The percentage yield of Chicken feather fiber was (74.4 %) for the electric blender is higher than the yield obtained when a tweezer is used. Fibres produced using this method are more flexible than those produced with a tweezer.

Cutting: The percentage of fiber yield for the cuttings is 67.7%. After separating the fibers the fibers are manually

separated from their rachis. The percentage yield of fibers is assumed to be 50% for the tweezer (Reddy and Yang, 2007) [12]. It makes this method to be time-consuming, especially for big batches. The Chicken feather fiber from all two equipment were of good quality based on their softness and fineness. After extraction, the different structural and functional properties of feather fiber were investigated. The average yield of chicken feather fiber was similar for cutter and blender at 67.7% and 74.4% respectively, which was higher than the percentage yield of fiber produced by tweezers.

4. Conclusion

With advancements in technology and research, there is an increasing awareness of the need to minimize the environmental impact associated with feather extraction. Innovative methods are being explored to ensure that the process is not only economically viable but also ecologically sustainable. The extraction of chicken feathers has transformative potential, offering solutions to waste management challenges while opening up new avenues for sustainable product development. Using the unnoticeable, cheap and ample feathers as fibers will reduce the fee, help the environment and also help the fiber industry be sustainable. By converting chicken feathers into textiles, insulation materials, and environmental remediation agents that have value, it is possible to minimize waste generation, protect resources and mitigate environmental impact.

5. Acknowledgement

The authors thankfully acknowledge the Department of Textile and Apparel Designing, Assam Agricultural University, Jorhat, India.

6. Reference

1. Acda M. Waste Chicken Feather as Reinforcementin Cement-Bonded Composites. Philippine Journal of Science. 2010;139(2).
2. Bansal G, Singh V, Gope P, Gupta T. Application and properties of chicken feather fiber (CFF) a livestock waste in composite material development. Journal of graphic era university. 2017;5(1):16-24. ISSN: 0975-1416 (print), 2456-4281
3. Bharathi S, Raj I. Studies on the Physical Properties of Chicken Feathers. International Journal of Current Microbiology and Applied Sciences ISSN: 2319-7706 2021, 10. https://doi.org/10.20546/ijcmas.2021.1007.033
4. Chinta S, Landage S, Yadav K. Application of Chicken Feathers in Technical Textiles. International Journal of Innovative Research in Science, Engineering and Technology. 2013;2(4).
5. Dhurai B. Exploration on Amino Acid Content and Morphological Structure in Chicken Feather Fiber. Journal of Textile and Apparel, Technology and Management 2012, 7(3).
6. Hearle JW, Morton WE. Physical properties of textile Fibers (4th Ed.). Elsevier, United Kingdom, 2008, p. 796.
7. Jagadeeshgouda K, Reddy P, Ishwaraprasad K. Experimental study of behaviour of poultry feather fiber - a reinforcing material for composites. International Journal of Research in Engineering and Technology. 2014. eISSN: 2319-1163 | pISSN: 2321-7308.
8. Kakonke G, Tesfaye T, Sithole B, Ntunka M. A novel method for rapid extraction of biofibers from waste chicken feathers; c2019.
9. Kar P, Misra M. Use of Keratin Fiber for Separation of Heavy Metals from Water. Journal of Chemical Technology and Biotechnology. 2004;79:1313-1319.
10. Martinez-Hernandez, Ana L, Velasco-Santos Carlos, De Icaza Miguel, Castano Victor M. Microstructural characterization of keratin fibers from chicken feathers; International Journal of Environment and Pollution. 2005;23(2):162-178.
11. Mi X, Li W, Xu H, Mu B, Chang Y, Yang Y. Transferring feather wastes to ductile keratin filaments towards a sustainable poultry industry, Waste Management. 2020;115:65-73, ISSN 0956-053X, https://doi.org/10.1016/j.wasman.2020.07.022.
12. Reddy N, Yang Y. Structure and Properties of Chicken Feather Barbs as Natural Protein Fibers. Journal of Polymers and the Environment. 2007;15:81-87. https://doi.org/10.1007/s10924-007-0054-7
13. Stephen V. Mechanical behavior of poultry feather. International journal of current engineering and scientific research (ijcesr). Issn: 2393-8374. 2019, 6(2).
14. Tesfaye T, Sithole B, Ramjugernath D, Chunilall V. Valorisation of Chicken feathers; Characterization of Chemical Properties. Waste Management. 2017;68:626-635. https://doi.org/10.1016/j.wasman.2017.06.050.
15. https://timesofindia.indiatimes.com/home/science/in-future-fashion-is-going-to-get-chick/articleshow/1984729.cms
16. Umar A, Abdullahi I, Aliyu A. Development and performance evaluation of chicken feather - plastic composite particle board, 2021. www.seetconf.futminna.edu.ng