www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; SP-10(7): 174-176

www.thepharmajournal.com
Received: 25-05-2021
Accepted: 27-06-2021

SV Bharathi
Technical Manager, Venkateshwara Hatcheries Pvt. Ltd. Company, Bangalore, Karnataka, India

Indu V Raj
Associate Professor, College of Veterinary and Animal Sciences, Pookode, Wayanad, Kerala, India

Corresponding Author:
Indu V Raj
Associate Professor, College of Veterinary and Animal Sciences, Pookode, Wayanad, Kerala, India

Comparative studies on the mechanical and thermal properties of broiler and layer chicken feathers

SV Bharathi and Indu V Raj

Abstract
Studies were undertaken on the feather of broiler chicken of six to eight weeks of age and culled White Leghorn birds above 64 weeks of age, slaughtered at Meat Technology Unit, Mannuthy. The feather samples were collected from a total of 24 birds comprising of six males and females from the broiler and layer groups. The tensile strength was tested on an Instron 5848 Micro-tester with a 2530–439 load cell, 12.7 mm gauge length and 1.27 mm min^{-1} cross-head speed. The mean tensile strength of the barb of broiler male, broiler female, layer male and layer female was 30.92±1.81, 28.27±2.32, 43.78±1.33 and 42.05±1.25 MPa respectively. The tensile strength was more for layer chicken than broiler ($p < 0.01$) and there was no significant difference between sexes. Thermo-gravimetric analysis was done at a rate of heating of 10 °C/min, 2.5mg sample weight, nitrogen mode of heating and a temperature range of 0-1000 °C. Both broiler and layer feather fibre exhibited similar thermal stability. They showed the first decrease in mass of 5 per cent from about 25 °C to 80 °C due to the loss of free water and a second decline of weight at about 230 °C from where the chicken fibre gradually started to decompose. The second stage of weight loss process occurred from 230 °C to 330 °C resulting in about 40 per cent loss of feather fibre mass. It could be suggested that the drying temperature for chicken feather fibre should be above 80 °C, while the processing temperature for chicken feather fibre should be controlled below 230 °C.

Keywords: broiler chicken, layer chicken feather, mechanical and thermal properties

Introduction
India is the fifth largest poultry producer in the world. However, the increased use of chicken meat has led to the generation of millions of tonnes of feather waste. Hence it is necessary to find better ways for effective and profitable utilization of chicken feather, which would definitely increase its worth. The structure and properties of chicken feathers are very distinct when compared to any other natural or synthetic fibre and can be utilized for making composites and textiles. Hence a detailed understanding is required on the mechanical and thermal properties of chicken feather so that it can be used in the field of tissue engineering, water purification, textile finishing and in plastics.
The present study was conducted to assess the mechanical and thermal properties of feather in broiler and layer chicken. It will be contributory to the existing knowledge and will also form a basis for future research on techniques for processing chicken feather so that it can be used to its full potential.

Materials and Methods
Studies were undertaken on the feather of broiler chicken of six to eight weeks of age and culled White Leghorn birds above 64 weeks of age, slaughtered at Meat Technology Unit, Mannuthy. The feather samples were collected from a total of 24 birds comprising of six males and females from the broiler and layer groups. Immediately following exsanguination, primary and secondary remiges were collected from the 12 wing feathers of each bird to study the physical properties. To clear out the foreign materials clung to the feathers, they were first washed with five per cent non-ionic liquid soap solution followed by rinsing and exposed to natural light until completely dried. The feathers were sterilized with 95% ethanol at 21 °C for 30 min (Fan, 2008). They were then rinsed with water and dried. The sterilized feathers were then processed to get fibres. The feathers were dried and conditioned at a relative of humidity (RH) 65 ± 2% and a temperature of 20 ± 2 °C. The barbs were separated from the rachis manually by cutting with scissors. The samples of chicken feathers were then tested to characterize their mechanical and thermal properties.

Mechanical Properties- Single Fibre Tensile Test

Samples were prepared by carefully removing single barbs from the rachides of chicken feathers. Because of the inherent nature of the fibers, a single fibre was attached to a piece of cardboard with epoxy resin to avoid direct contact with the grip of the testing machine. The single fibre was mounted on the cardboard sample holder, which had dimensions of 25 * 20 mm^2 with a 12.7-mm diameter hole in the center. A small amount of bonding resin was applied to the sample and the fibres were subsequently bonded to the sample holder. The resin was then cured overnight.

Tensile properties of single fibre were tested on an Instron 5848 Micro-tester (Norwood, MA) with a 2530– 439 load cell (capacity: 5 N, sensitivity: < 0.5% reading). The gauge length is 12.7 mm and the cross-head speed is 1.27 mm min^{-1} (10% of initial specimen length/min). The barbs were conditioned for 24 h before testing under standard conditions of 21 ± 1 °C and 65 ± 5% RH according to ASTM standard D1776. After the sample was mounted on the grips of the Instron, both sides of the cardboard were cut off and the force-extension curve was measured. If a sample slipped in the grips, broke at the edge or in the grips, the sample was discarded. At least five force-extension curves from each feather were obtained. The samples were tested in a completely random order (Zhan and Wool, 2011) [10].

Thermal Properties- *Thermal Stability*

Thermo-gravimetric analysis was done to observe the change in weight of a material in relation to change in temperature. The rate of heating, sample weight, mode of heating and temperature range used for this study were 10 °C/min, 2.5mg, nitrogen and 0-1000 °C respectively (Neha *et al.*, 2015) [5].

Statistical Analysis

The data were analyzed statistically using one way analysis of variance (ANOVA) technique (Cochran and Cox, 1992) [1] to test the difference if any between the following parameters of the male and female broiler chicken and male and female White Leghorn chicken and independent t test was performed to test the difference between the broiler and layer groups.

Results and Discussion

Mechanical Properties- Tensile Strength

A scanning electron microscope was used to measure the cross-sectional area of the barb, which was more accurate. The tensile strength was tested on an Instron 5848 Micro-tester (Norwood, MA) with a 2530–439 load cell, 12.7 mm gauge length and 1.27 mm min^{-1} cross-head speed. The mean tensile strength of the barb of broiler male, broiler female, layer male and layer female was 30.92±1.81, 28.27±2.32, 43.78±1.33 and 42.05±1.25 MPa respectively. The tensile strength was more for layer chicken than broiler ($p < 0.01$) and there was no significant difference between sexes. Taylor *et al*. (2004) [9] suggested that the tensile strength varied indirectly with moisture content while strain varied directly with moisture content. Reddy and Yang (2007) [6] found that chicken feather fibres had tensile strength of 180 MPa for untreated intact barbs from contour feathers. Hong and Wool (2005) [2] reported that the tensile strength of chicken feather fibres varied due to the heterogeneity of the fibres and ranged from 41-130 MPa. Huda and Yang (2009) [3] observed that barbs had average tensile strength of 113 MPa. According to Sudalaiyandi (2012) [7], the tensile strength of chicken feather fibre treated by hydrogen peroxide and sodium hypochlorite was 38 to 190 MPa. The disparity in values of tensile strength of barb fibres may be due to the difference in processing conditions and length and diameter of the feather fibre studied.

Thermal Properties- Thermal Stability

Both broiler and layer feather fibre exhibited similar thermal stability. They showed the first decrease in mass of 5 per cent from about 25 °C to 80 °C due to the loss of free water and a second decline of weight at about 230 °C from where the chicken fibre gradually started to decompose. According to Martinez-Hernandez *et al*. (2005) [4] thermal analysis showed that keratin fibre lost free water at 69 °C, while the decomposition process occurred mainly from 222 °C to 392 °C, resulting in loss of 78 per cent of fibre mass.

The se cond stage of weight loss process occurred from 230 °C to 330 °C resulting in about 40 per cent loss of feather fibre mass (Fig. 1 and 2). Zhang *et al.* (2015) [11] noticed that for feather keratin the first weight loss step seen at 100 °C was due to the loss of bound water while the second loss between 250−400 °C was mainly due to the degradation of the feather keratin.

Similar to the reports of Neha *et al*. (2015) [5], it could be suggested that the drying temperature for chicken feather fibre should be above 80 °C, while the processing temperature for chicken feather fibre should be controlled below 230 °C.

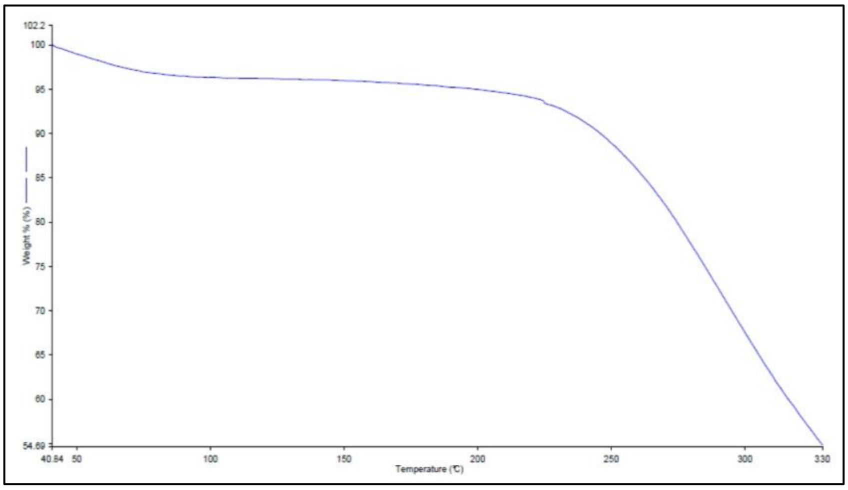

Fig 1: Thermal gravimetric analysis (TGA) curves of broiler chicken feather fibre (barbs)

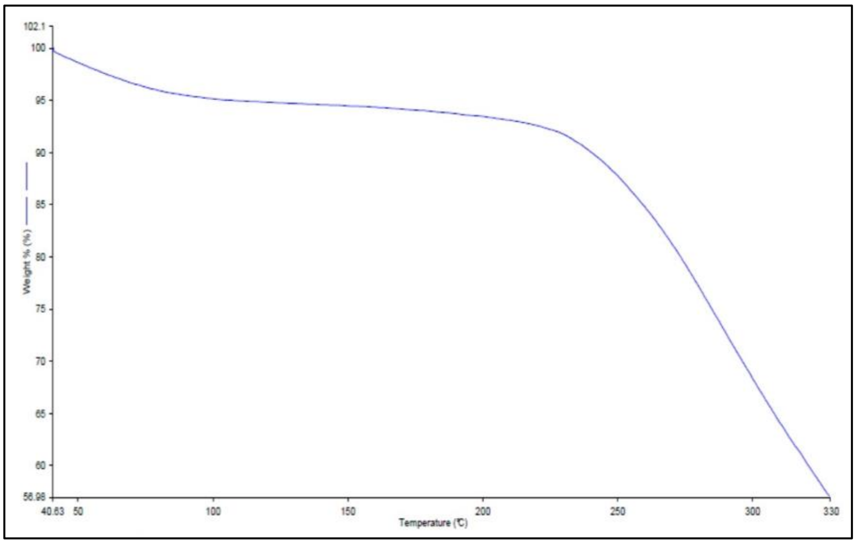

Fig 2: Thermal gravimetric analysis (TGA) curves of layer chicken feather fibre (barbs)

References

1. Cochran WG, Cox GM. Experimental Designs. John Wiley and Sons, New York 1992.
2. Hong CK, Wool RP. Development of a bio-based composite material from soybean oil and keratin fibres. J. Appl. Polym. Sci 2005;95:1524-1538.
3. Huda S, Yang Y. Feather fibre reinforced light-weight composites with good acoustic properties. J. Polym. Environ 2009;17:131.
4. Martinez-Hernandez AL, Velasco-Santos C, De Icaza M, Castano VM. Microstructural characterisation of keratin fibres from chicken feathers. Int. J. Environ. Pollut 2005;23:162-178.
5. Neha S, Alka G, Omre PK. Characterization of chicken feather fibre as novel protein fibre for commercial applications. Int. J Trop. Agric 2015;33:3373-3377.
6. Reddy N, Yang Y. Structure and properties of chicken feather barbs as natural protein fibres. J Polym. Environ 2007;15:81-87.
7. Sudalaiyandi G. Characterizing the cleaning process of chicken feathers. Master’s thesis, University of Waikato, Hamilton, New Zealand 2012, 93.
8. Swatland HJ, Barbut S. Fluorimetry via a quartz-glass rod for predicting the skin content and processing characteristics of poultry meat slurry. Int. J Food Sci. Technol 1991;26:373-380.
9. Taylor AM, Bonser RHC, Farrent JW. The Influence of Hydration on the Tensile and Compressive Properties of Avian Keratinous Tissues. J Matr. Sci. 2004;39:939-942.
10. Zhan M, Wool RP. Mechanical properties of chicken feather fibres. Polym. Composites 2011;32:937-944.
11. Zhang Y, Zhao W, Yang R. Steam Flash Explosion Assisted Dissolution of Keratin from Feathers. ACS Sustain. Chem. Engng 2015;3:2036-2042.
12. Zhao J, Nagashima K, Bogart RS, Kosovichev AG, Duvall Jr TL. Systematic center-to-limb variation in measured helioseismic travel times and its effect on inferences of solar interior meridional flows. Astrophys. J. Lett 2012;749:5.
13. Zhongfu L, Xingwen C, Lixin S. Study of a Rapid Detection Method for Protein Content in Milk and Development of Detection Equipment. Int. J. Multimedia Ubiquitous Engng 2015;10:67-78.