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Application of Chicken Feather in Textiles

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ABSTRACT

Chicken feathers are a valuable source of biomaterials that can be used in a variety of industries. In recent years, chicken feathers have found their way into everything. It is important to note that the exact chemical composition of the chicken feather can vary depending on factors such as the age and health of the bird, diet, genetics, and environmental conditions. Chicken feather fractions have potential applications as textile fibres for yarns, fabrics, and composites. This paper summarizes the chemical composition and biodegradability of chicken feather fibres and discusses their potential applications.

KEYWORDS

Chicken feather fibre, Sustainable, Applications in textiles, Biodegradable fibres.

INTRODUCTION

Every year, the poultry business produces six billion tonnes of chicken feathers, the majority of which end up in landfills. However, chicken feathers have recently found their way into everything from art projects to running shoes to automotive manufacture. Chicken feathers also serve as insulation, keeping chickens warm in cold weather and shielding them from the sun's harsh rays.

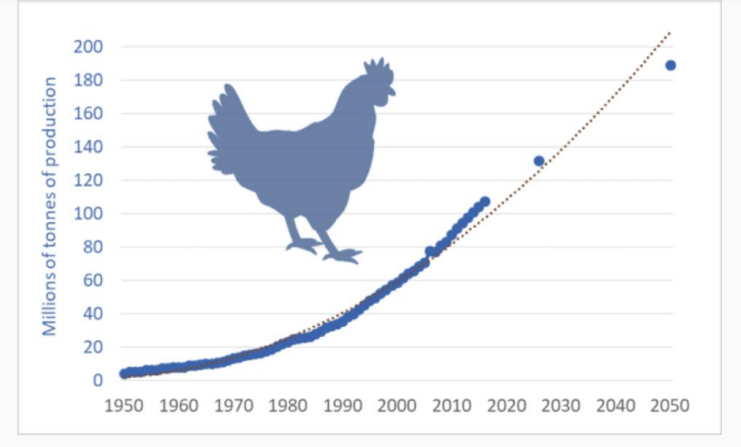

Fig 1: Production of chicken meat worldwide, both real and predicted, from 1950 to 2050.

CHICKEN FEATHER ANATOMY

Chicken feathers have a strong honeycomb construction with small air spaces, which made them exceptionally lightweight and robust. The stringy network that makes up the fluffy sections of the feather are the barbs, and barbules, which may have a wool-like sensation on the skin. The shaft is a stiff, stem-like structure at the centre of each feather. The mature shaft's bottom is hollow, which is known as a quill. The chicken feather is made up of three parts:

- the rachis, which is the main axis and is sometimes referred to as the shaft.
- secondary structures, or the barbs connected to the rachis.
- the barbules, which are connected to the barbs.

The feathers' barbs were rigid, compact, and closely knitted on one end, while they are downy which is soft, loose, and fluffy on the other.

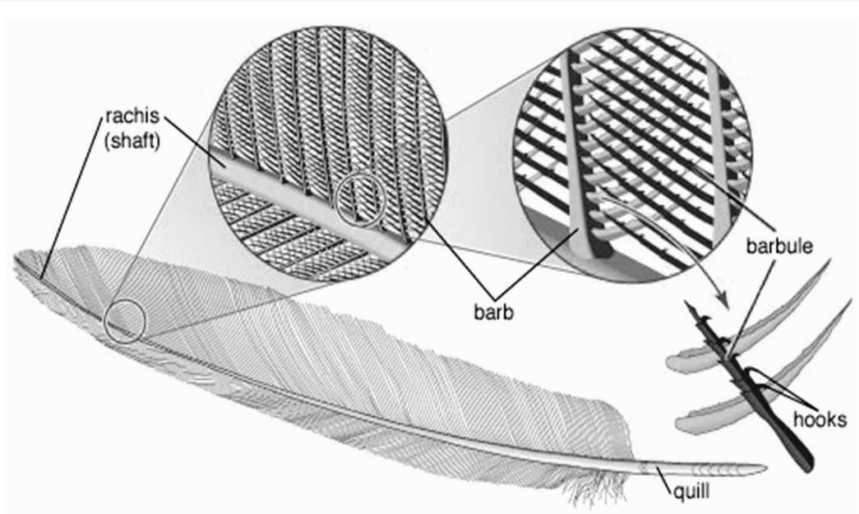

Fig 2: Feather Structure

The four main types of feathers that adorn a chicken's body are,

Down feathers: Bird down, a layer of feathers covering young and older birds, traps air and insulates against heat loss. It serves as an additional feathering layer, while flying feathers act as an air foil, cushion, moisture barrier, and colour source, hiding beneath outer feathers.

Contour feathers: Contour feathers, the outermost feathers on a bird, cover the wings, tail, and body, forming the bird's colour and shape. They distinguish breeds and have well-developed shafts with branching barbs. Frizzled feathers curl and grows out.

Semi-plumes: Semi-plume feathers, hidden between contour feathers, provide insulation and keep the bird's smooth look, while shaft-like contour feathers, like down feathers, lack hooks.

Filoplumes: Filoplumes have rigid, hair-like nerve endings at the base of each contour feather, which help hold the feathers in place without specific feather muscles.

CHICKEN FIBRE CHEMISTRY

Chicken feathers are primarily composed of protein, specifically a protein called keratin. Keratin is the same protein found in human hair and nails, as well as in the feathers, fur, and scales of various animals. The chemical composition of chicken feathers consists mainly of the following elements and compounds:

1.Keratin: Keratin is a fibrous structural protein composed of amino acids, including cysteine, serine, glycine, and others. It forms a strong and flexible structure that provides strength and rigidity to feathers.

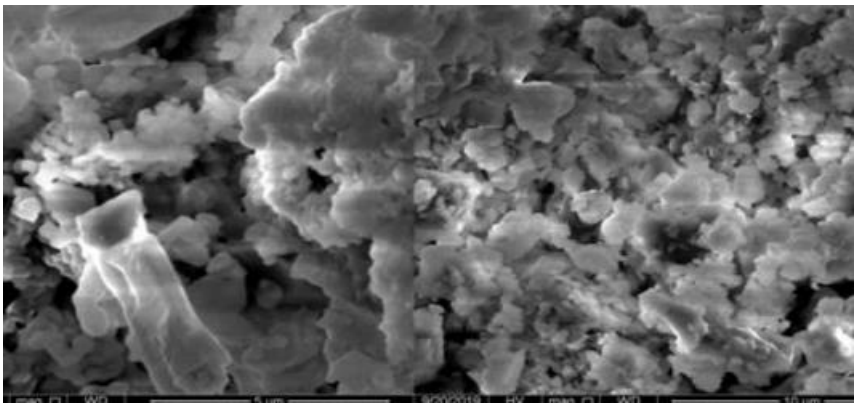

Fig3: SEM Image of Keratin Protein

2.Amino Acids: Chicken feathers are rich in various amino acids, which are the building blocks of proteins. Cysteine is particularly abundant in feathers and plays a crucial role in the formation of disulfide bonds, contributing to the strength of the feather structure.

3.Water: Feathers contain a small amount of water, which helps maintain their flexibility.

4.Lipids: Feathers may also contain trace amounts of lipids (fats), which can provide some waterproofing properties.

5.Trace Minerals: Feathers may contain small amounts of minerals like calcium, phosphorus, and sulphur, which are essential for the formation and structure of keratin.

6.Pigments: In some cases, feathers may contain pigments that give them colour. These pigments can vary greatly among different bird species.

It is noted that the exact chemical composition of chicken feathers can vary depending on factors such as the age and health of the bird, diet, genetics, and environmental conditions.

CHICKEN FEATHER PROPERTIES

Chicken feather fibres have unique physical, mechanical, and chemical properties that make them interesting for various applications, including in the textile and agricultural industries.

A. Physical Properties:

1.Length: Chicken feathers vary in length, but they typically range from 2 to 12 inches (5 to 30 cm), depending on the location on the bird.

2.Diameter: The diameter of a chicken feather fibre is relatively small, typically around 0.02 to 0.04 millimetres (20 to 40 micrometres).

3.Color: The colour of chicken feathers can vary widely, depending on the breed of the chicken. Common colours include white, brown, black, and various shades in between.

4.Density: Chicken feather fibres are relatively lightweight, with a density ranging from 1.0 to 1.3 grams per cubic centimetre (g/cm^3).

5.Thermal Properties: Chicken feathers have good insulation properties, making them effective at retaining heat. They are often used as insulation material in various applications.

B. Mechanical Properties:

1.Tensile Strength: Chicken feather fibres have reasonably good tensile strength, meaning they can withstand a certain amount of pulling force before breaking. However, their strength can be affected by factors like moisture and temperature.

2.Flexibility: Chicken feather fibres are quite flexible and can bend without breaking. This property makes them suitable for applications where flexibility is required, such as in textiles and composites.

3.Elasticity: Chicken feathers are somewhat elastic, meaning they can return to their original shape after being deformed to some extent.

4.Abrasion Resistance: Chicken feather fibres are relatively resistant to abrasion, which makes them suitable for use in durable textiles and protective gear.

C. Chemical Properties:

1.Protein Composition: Chicken feathers are primarily composed of a protein called keratin. Keratin is a tough and durable protein that is also found in human hair and nails.

2.Hydrophobic Nature: Chicken feathers have a hydrophobic (water-repellent) surface due to the presence of lipids and waxes on the feather's surface. This property can be advantageous in certain applications where water resistance is required.

3.Biodegradability: Chicken feathers are biodegradable, meaning they can naturally decompose over time. This makes them environmentally friendly compared to synthetic materials that do not biodegrade easily.

4.Chemical Reactions: Chicken feathers can undergo chemical treatments to modify their properties. For example, they can be treated with chemicals to increase their adhesion to other materials or to make them more flame-resistant.

Chicken feather fibres are found to possess high toughness, good thermal insulation and acoustic properties, nonabrasive behaviour, more hydrophilic and less hydrophobic in nature. Chicken feathers are a great option for the study because they are plentiful, their supply is certain, and their quality is constant. The feather is often more tolerant of the cold if its feathering is fluffier. It is hypothesised that the Herbst's corpuscles, which are located near the base of the feather, may sense variations in sound vibration and air movement.

Chicken feather rachis and barbs might be employed for applications requiring exceptional compressibility and resilience with its elastic modulus ranging from 0.045 GPa to 10 GPa, warmth retention with thermal conductivity values varying from 0.024 to 0.034 W/(m K), and fluid absorption due to the existence of hollow honeycomb structures and an extremely low density of 0.89 g/cm^3.

APPLICATIONS

They could be used in future garments to create textiles like cotton, linen, or wool, reducing the need for synthetic materials like polyester. The feathers are washed, dried, ground, and dissolved. Agricultural proteins like keratin from chicken feathers offer fabric potential. Chemical cross-linking and nanotechnology can enhance their tensile strength and biodegradability, enabling mass production of eco-friendly products. They have a robust honeycomb construction with small air pockets, making them incredibly lightweight and durable. Their barbs and barbules provide a comparable sensation to wool on the skin.

I.GARMENTS MADE OF CHICKEN FEATHER FIBRE

i)Down Jackets: Chicken feather fibres, particularly the soft and fluffy under feathers known as "down," are often used as insulation in winter jackets and coats. Down provides excellent warmth-to-weight ratio, making jackets lightweight and highly insulating. Down feathers are prized for their softness, making them suitable for use in the lining of coats, jackets, and even in hoods to provide a luxurious feel.

ii)Vests: Down vests are another popular garment that uses chicken feather fibres for insulation. They are ideal for layering and provide warmth without bulk.

iii)Sleeping Bags: Chicken feather fibres are commonly used in the insulation of sleeping bags, ensuring a warm and comfortable sleep experience, especially in cold weather conditions.

iv)Outdoor Apparel: Chicken feather fibres are used in various outdoor clothing items, including gloves, mittens, and boots, to provide insulation and keep users warm during outdoor activities. Chicken feather fibres can be found in inner linings and padding of various winter garments to provide extra warmth and comfort.

Fig4: Shawl made of Chicken Fibre.

Fig5: Jackets made of Chicken Fibre.

II. PILLOWS:

i)Feather Pillows: Chicken feather fibres, specifically down and feather blends, are commonly used as filling material in pillows. Feather pillows are known for their softness, support, and ability to conform to the shape of the user's head and neck.

Fig 6. Pillow.

ii)**Pillow Inserts:** Feather and down pillow inserts are used to fill decorative pillow covers, providing a plush and luxurious look to the pillows.

iii)Body Pillows: Long body pillows filled with chicken feather fibers offer excellent support and comfort for individuals who prefer a larger, snuggly pillow.

iv)Adjustable Pillows: Some pillows are designed with compartments or chambers filled with chicken feather fibres, allowing users to adjust the loft and firmness of the pillow to their preference.

To address concerns about allergies, some manufacturers offer hypoallergenic versions of feather and down pillows, where the feathers are carefully cleaned and sanitized to minimize allergens. It is also important to note that the quality of chicken feather fibre-based products can vary based on factors such as the type of feathers used, the processing methods, and the ratio of feathers to down. Additionally, proper care and maintenance, such as regular fluffing and occasional drying, can help extend the lifespan of garments and pillows filled with chicken feather fibres.

III. DIAPERS

While chicken feather fibres are not a conventional or widely used material in diaper production, they have unique properties that, in theory, could make them suitable for certain diaper applications. Here are some potential ways chicken feather fibres could be used in diapers:

i)Absorbent Core:

Chicken feather fibers can be processed and treated to improve their absorbent properties. They could be incorporated into the absorbent core of a diaper along with other materials like superabsorbent polymers (SAP) and cellulose fibres to enhance the diaper's overall absorbency.

ii)Biodegradable Back sheets:

Chicken feather fibres could be used in the construction of the diaper's outer back sheet. This could make the back sheet more environmentally friendly and biodegradable compared to traditional plastic backings.

iii)Breathability:

Feather fibres have natural breathability, which could be beneficial for diaper designs aimed at maintaining airflow and reducing moisture build-up, thus potentially reducing diaper rash.

iv)Sustainable Diapers:

Incorporating chicken feather fibres into diaper production could contribute to sustainability efforts by utilizing a byproduct of the poultry industry and reducing waste.

Research and development would be necessary to explore the feasibility of using chicken feather fibres in diapers and to address regulation requirement challenges.

IV. CHICKEN FEATHER NON-WOVEN SHEETS

Chicken feather nonwoven sheets, which can be made from processed and treated chicken feather fibres, have various potential applications due to their unique properties. These sheets can be used in a range of industries for diverse purposes.

i)Agriculture and Horticulture:

Soil Erosion Control: Chicken feather nonwoven sheets can be used as erosion control blankets in landscaping and agriculture to stabilize soil and prevent erosion on slopes and construction sites.

ii)Construction and Civil Engineering:

Chicken feather nonwoven sheets, given their natural insulation properties, can be used as an insulating material in construction for applications such as wall insulation or soundproofing.

iii)Automotive Interiors:

These sheets can be used for sound and thermal insulation within vehicles to reduce noise and improve temperature control.

iv)Air and Liquid Filtration:

Chicken feather nonwoven sheets can be used as filter media in various applications, including air filtration in HVAC systems and liquid filtration in industrial processes.

v)Packaging:

These sheets can be used as cushioning material in packaging to protect fragile items during shipping and transportation.

vi)Biodegradable Mulch:

Chicken feather nonwoven sheets can serve as biodegradable mulch for agricultural fields, helping to retain moisture, suppress weeds, and improve soil health.

vii)Fashion Accessories:

Designers explore the use of chicken feather nonwoven sheets to create unique fashion accessories like hats, fascinators, and jewelry.

viii)Art and Craft:

Chicken feather nonwoven sheets can be used in art and craft projects for their unique texture and appearance.

V. Chicken Feathers in Technical Textiles

Chicken feather fibres can be processed and incorporated into insulation materials used in construction, automotive, and aerospace applications. Their natural insulation properties make them effective at maintaining temperature control.

i)Filtration Media:

Chicken feather fibres can be used as filter media in applications such as air and liquid filtration. Their fine fibres and porous structure can capture particles and contaminants.

ii)Geotextiles:

Chicken feather nonwoven sheets can be used as geotextiles in civil engineering and construction projects. They can provide erosion control, soil stabilization, and drainage solutions.

iii)Sound Absorption:

Chicken feather fibres can be used in sound-absorbing materials for acoustic control in buildings, automobiles, and industrial environments.

iv)Biodegradable Textiles:

Technical textiles made from chicken feather fibres can be designed to be fully biodegradable, making them suitable for applications where sustainability and minimal environmental impact are important.

v)Reinforcement in Composites:

Chicken feather fibres can be incorporated into composite materials to enhance their strength and reduce weight. These composites can find use in industries like automotive, aerospace, and sports equipment manufacturing.

Fig7: Chicken feather Reinforced Composites

vi)Flame Retardant Materials:

Chicken feather fibres can be treated to improve their flame-resistant properties. This can be valuable in applications where fire safety is a concern.

vii)Oil Spill Cleanup:

Nonwoven materials made from chicken feather fibres can be used in oil spill cleanup efforts due to their ability to absorb and contain hydrophobic substances like oil.

viii)Protective Apparel:

Technical textiles made from chicken feather fibres can be used in the development of protective clothing and gear for industries like firefighting, chemical handling, and hazardous waste management.

ix)Aerospace Applications:

Chicken feather fibres can be used in aerospace applications, such as lightweight materials for aircraft interiors, insulation for spacecraft, or even as reinforcement in advanced composites.

CONCLUSION

Chicken feather fractions have potential applications as textile fibres for yarns, fabrics, and composites. The poultry sector generates significant profits globally, but generates significant waste, including chicken feathers. Despite further work, chicken feathers may soon transition from coops to cups, potentially reducing the need for new plastic production on a large scale. Ongoing research and innovation in this field are exploring new ways to leverage the unique properties of chicken feather fibres in various technical textile industries.

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