

VALORISATION OF WASTE CHICKEN FEATHERS

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KEY FINDINGS

Chicken feathers are produced in large quantities as a by-product at poultry processing plants. Their disposal by incineration or landfilling is fraught with problems, e.g., environmental pollution and transmission of diseases due to microbial contamination. However, chicken feathers are composed of materials and components that can be valorised into valuable products and materials. This study shows that chicken feathers should be regarded as a valuable resource for extraction of fibres for conversion into fabrics and composite materials; for extraction of composites that can be converted into high-value products that are normally sourced from petroleum-based products.

INTRODUCTION

Compassion in World Farming stated, in 2013, that 58 billion chickens are slaughtered per year. Considering a 2 kg slaughter-weight of a chicken with 5-7% of feathers per chicken, a minimum of 5,8 billion kg of chicken feathers are produced per year as a by-product. USA and India produce approximately 1.044 billion kg and 140 million kg chicken feathers, as waste, per year, respectively. Two to three tons of chicken feathers can be produced by a slaughterhouse that processes 50 000 chickens per day. South Africa produces 258 million kg of chicken feathers as a by-product while producing meat. Insignificant amounts of these feathers are used as useful products, for low-value applications like animal feed and fertilizer; the other significant portion is considered as a waste product. The trend of poultry production indicates an increase in chicken production and, consequently an increase in chicken feathers. The valorisation of chicken feathers can result in their sustainable conversion into high-value materials and products on the proviso of existence or development of cost-effective technologies for converting this waste into the useful products. Below is a summary of some of the problems experienced in the industry and the technologies developed during the study to overcome some of these challenges.

MAIN RESULTS

Application of keratin based green biofilms from waste chicken feathers

Plastic packaging are ideal materials for many commercial and industrial activities especially in food packaging where they are used to help keep food fresh and free of contamination. This is due to their lightness, flexibility, stability, strength, impermeability characteristics. The consumption of synthetic polymers to produce plastics is

expected to grow four-fold (25% of oil production) in 2100 due to the growing human population and increasing demand for packaging materials. Accumulation of post-consumer waste due to non-biodegradability of plastics is a serious environmental problem of using plastics for packaging that cannot be solved by landfilling. Plastic waste can be incinerated for energy recovery, but this has negative environmental impact due to greenhouse gas emissions during burning of the plastics. In order to reduce the environmental impact of synthetic polymers partially biodegradable polymers have been prepared from a mixture of synthetic and natural polymers. Recently, increased attention has been focused on replacement of synthetic polymer-based films with eco-friendly bio-based biodegradable packaging films for applications in food packaging, drug delivery systems, and tissue engineering. Replacement of synthetic plastic packaging by biodegradable polymers from renewable biomass significantly reduces the volume of waste generated. Although bio-based plastics have some limitations in terms of their mechanical properties, their thermal resistance and water barrier function characteristics offer very desirable features. It has been reported that 100% biodegradable packaging materials can be produced from renewable sources such as starch, proteins, cellulose, and rubber and lipids. Keratins are desirable proteins due to their environmental stability, biodegradability, and biocompatibility characteristics. The abundant cysteine amino acids in keratin are oxidised to give inter- and intra-molecular disulphide bonds, and they form a three-dimensional crosslinked network that results in high mechanically strength, hydrophobicity and good thermal stability characteristics. Thus, these qualities could led to development of biodegradable materials from feathers, such as films, sponges, self-

assemble structures, hydrogels for compostable packaging products, tissue engineering, fibroblast cell growth, wound healing trauma and drug delivery systems. One renewable source of keratin is waste chicken feathers which has about 8.5% cysteine content. Keratin films are highly ductile and have low flexibility. Starch is a completely biodegradable semi-crystalline polymer and a supplementary material for most plants. Waste avocado seeds can be beneficiated as a viable, relatively cheap, and readily available renewable source of starch. Although there are some reports on production of keratin-starch films, to the best of our knowledge, there are no reports on production of avocado seed starch cross-linked keratin materials. This work highlights utilization of biodegradable polymers from renewable resources (starch from waste avocado seeds and keratin from waste chicken feathers) in the production of keratin/starch blended films.

Beneficiation of waste chicken feathers via conversion into biomedical applications

In various fields, there is a need for biopolymers that can be used as alternative sources to petroleum-based polymers that have biocompatibility problems and/or environmentally unfriendly production. Keratin is one biopolymer that can replace some of these materials. Protein-based biomaterials can facilitate cell-to-cell and cell-to-material interactions which makes them more biocompatible than their counterparts. Potential biomedical applications of regenerated keratin also include materials for drug delivery, tissue engineering and wound healing. The fact that keratin can blend with other polymers such as polyethylene oxide, polylactic acid and so forth, to supplement each other widens its fields of applications. It also plays a vital role in dissolving drugs in the body; hence, keratin protein supports dissolution of drugs to body cells. Therefore, pure and or blended regenerated keratin membranes can be used for drug delivery because of their properties match the human stratum corneum; pores in keratin film provide excellent drug delivery property for the film.

Manufacturing and properties of nonwoven superabsorbent core fabrics used in disposable diapers

Absorbent hygiene products are made up of different types of raw materials, renewables and non-renewables,

to create the absorbent core which acts as a fluid storage structure in the product. With the addition of superabsorbent polymers in the absorbent structure, disposable diapers moved from being just a convenient item to a thinner, safer and efficient absorbent product. The presence of specialised biological inert polymers and superabsorbent polymers, which are not easily digested by bacteria present in sewage treatment plants, led to an increase in environmental problems such as excessive resource consumption, water and air pollution, excessive use of energy as well as waste disposal. Hence, this study focused on the use of sustainably resourced materials (Chicken feathers) that could replace the fossil-based ones for the sustainable production of bio-based disposable diapers.

CONCLUSIONS

Biofilms were successfully produced from starch and keratin obtained from waste avocado seeds and waste chicken feathers respectively. These biofilms could be used: in the food packaging industry (as a cost-effective and environmental alternative source of raw material to the commonly used packaging materials; in wound dressings; in the fashion industry (as artificial lens and breast implants); in biomedical applications, e.g., artificial skin replacement; and in the pharmaceutical industry (as drug delivery and transdermal drug delivery systems). Non-existence of breakthrough keratin-based biomaterial in the clinical applications shows innovative opportunities for further investigation of keratin biomaterials, including chicken feather keratin-based biomaterials. Chicken feather fibres could be used to eliminate fluff pulp/SAPs (super absorbent paper) nonwoven sheets in the manufacture of disposable diapers to reduce environmental pollution.

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