CHARACTERIZATION OF DEHYDRATED KERATIN PROTEIN EXTRACTED FROM CHICKEN FEATHER USING NaOH

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Conflict of Interest

In this research, the authors assert that there is no conflict of interest. The authors are responsible for article and content of the paper.

Abstract

Keratin is one of the most significant biomaterials through commercially available due to its relatively good biocompatibility, excellent mechanical properties, high physicochemical, and good formatting-film ability. Chicken feather is the essential waste in the poultry industries which can get and control the quality of the keratin easier than the other keratin sources that the pure keratin presents a 90% of the featherweight.

Chicken feathers are abundant of keratin protein which can be considered as a suitable protein source and used as a component in the cosmetic and pharmaceutical industry. The aim of this study is using the chicken feather source to extract keratin portion. Further, the chemical structure of the compound was examined by Fourier transform infrared spectroscopy (FTIR) while surface morphology analysis was described by Scanning electron microscopy (SEM)

and X- Ray Diffraction resulted the crystalline form of the chicken feather dehydrated keratin. In this work, the drying of keratin in vacuum conditions was analyzed and presented a fulfilled result.

Key words: Chicken Feather; Keratin; Vacuum Dryer; Keratin Mass.

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1 Introduction

Nowadays, the increase in poultry products consumption led to an increase in waste about by 8.5 billion tons of feather, that is produced from 24 billion from the consumption of chicken yearly [1]. Feathers of chicken are a natural source of protein (keratin) that it is utilized in many applications such as cosmetic, biomedical and others [2], [3], [4].

Keratin from feathers of chicken has included some feature compared to other keratin like the feather keratin of fibrous can extend almost to 6 % and get breaking, but hair keratin can extend to double of length [5], [6]. It is famous that feathers are essentially made of a structural keratin protein (>90%), rich in cysteine, and hydrophobic residues that enhances crosslinking by disulphide bonds and includes a variety of predominantly cystine, amino acids, lysine, serine, and proline [7], [8], [9].

The reduction of keratin is a multi-step, long-lasting method in that sulphitolysis is a key reaction. The disulfide bond are disrupted by sulphite to ($\mathrm{Keratin-Cys-S-}$) cysteine thiol (reduced keratin) and ($\mathrm{Keratin-Cys-SSO_3^-}$) cysteine-S-sulphonate residue (Bunte salt) [10]:

$$\mathrm{Keratin-Cys-S-S-Cys-Keratin} + \mathrm{SO_3^{2-}} \rightarrow \mathrm{Keratin-Cys-S^-} + \mathrm{Keratin-Cys-SSO_3^-}$$

Keratins are classed into two types of Alpha (α) keratins and beta (β) keratins [11]. (α) keratin proteins are found in all vertebrates, while (β) keratin proteins are found exclusively in feathers of birds and reptiles [12].

In this study, feather keratin was extracted by NaOH and convert to powder and the drying under vacuum conditions was first developed for keratin protein biomedical, pharmaceutical and cosmetics applications.

2 Materials and Methods

Materials

The chicken feathers have taken from the chicken was obtained from Balok Poultry Farm Sdn. Bhd. Malaysia, Malaysia. Sodium hydroxide and hydrochloric acid.

The Extraction of keratin from chicken feather

The preparation of the feather keratin was into the Lab of chemical engineering at University Malaysia Pahang (UMP) according to previously studied techniques which put 50g feather with 1L sodium hydroxide into the conical flask. The mixture was kept at 50°C and continuously stirred for 5 hours. Then, The mixture was filtered by filter paper and biomass waste was removed by centrifugation at 10,000 rpm for 10 min [13], [14], [15].

Protein neutralization

The filtrate solution collected earlier was placed in a beaker and stirred. 2N hydrochloric acid was added drop wise to the solution for making neutral pH. The solution was again centrifuged at 10,000 rpm for 5 minutes and filtered using cellulose filter paper with Grade 1 from Whatman to ensure it is particle free then stored for the further analysis.

The total Mass of Keratin

The content of the keratin protein from the 50g feather was determined by dehydrating 5 ml of the solution at 104°C for 24h in the oven and the totals mass rate of keratin is calculated from the below equation:

$$Mass\ rate = \frac{m}{V} \times 100\% \quad (1)$$

Where m is the weight of the solute after evaporation and V is the weight of the initial mixture.

Dehydration of keratin

Under vacuum condition, a 50mL of keratin solution was poured in Pyrex glass dish and dried in the vacuum oven for 20 hours, at 60°C and 20inch Hg.

Characterization of keratin protein

The characterization of keratin will be FTIR, SEM and, XRD as shown below:

Fourier transform infrared spectroscopy (FTIR)

FTIR spectra of keratin were read from 400 to 500 cm-1 utilizing a Perkin-Elmer Model 1000 Series FTIR spectrophotometer. The all data obtained for hydrogel was through the utilizing of the software of FTIR [15].

Scanning electron microscopy (SEM)

The surface properties and morphology of the keratin protein powder sample secondary electron images were collected Emission Scanning Electron Microscope[16].

X-ray diffraction (XRD)

The keratin protein in crystal structures was examined by X-ray diffractometer. The models were collected with a radiation source of the Cu Kα. The crystallinity index (Crl) of the samples was described by the following equation [17]:

$$Crl(\%) = \left(\frac{A_{Crystal}}{A_{Total}}\right) * 100 \quad (2)$$

Where, ($A_{Crystal}$) is the sum of the areas below the crystalline diffraction peaks and (A_{Total}) describes the total area below the diffraction curve 2θ ranging from 5 to 50°.

3 Results and Discussion

The Total mass of keratin protein

The amass concentration of keratin as powder was 5g/mL from 1L keratin solution as shown from the calculation bellow:

$$Mass\ concenteration\ of\ keratin = \frac{50g}{1000\ mL} \times 100\% = 5g/mL \quad (3)$$

Fourier transform infrared spectroscopy (FTIR)

The FTIR measurement was utilized to identify the chemical structure of the keratin as shown in Figure 1. The result indicates that the band at 3274.15 cm^{-1} correspond to the peptide bonds (–CO–NH–). The wavenumbers at 1632, 1559 and 1392 cm^{-1} are the waves of the peptide bonds identified as amides I, II and III which provide important information on the keratin protein structure and alteration in backbone composition of the keratin protein. While It described (-OH) the groups of carboxylic acids at wavenumber 1126 $cm^{-1}$and the (N-H) band of transmission at 750 to 600cm^{-1}. Hence, FTIR proved the appearance of amino acids like and threonine, cysteine, and glutamine in the keratin sample [16].

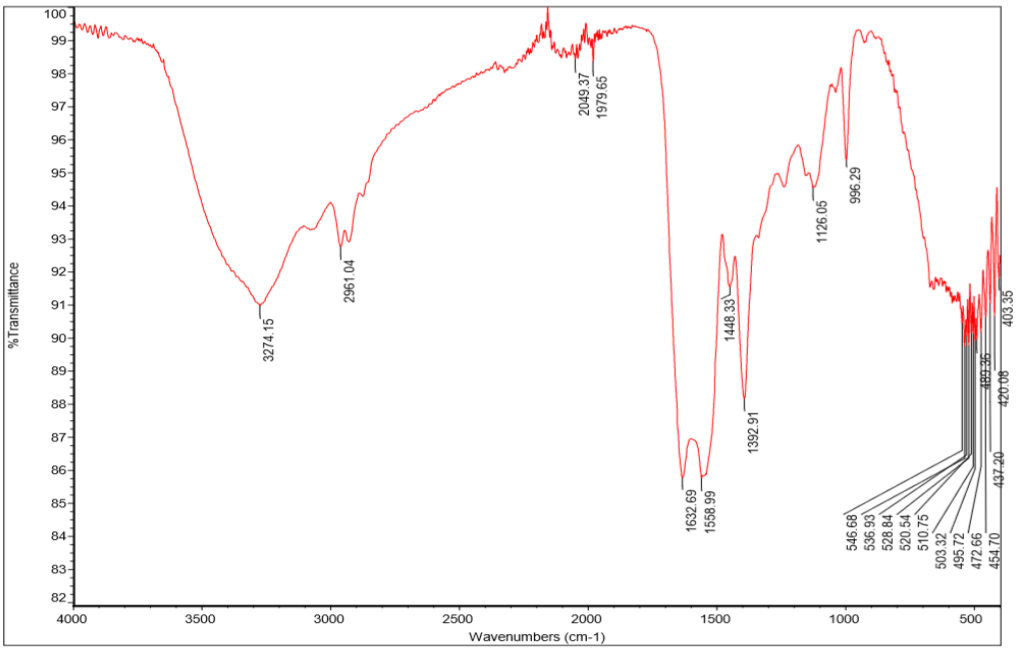

Figure 1 The FTIR spectra of keratin

Scanning electron microscopy (SEM)

The morphological characteristic of the keratin displays the highly porous structure in the surface with multitude features, like the specimen explained a horny layer, and very thick. Also, the SEM images confirmed that keratin seemed as small particles in aggregates form.

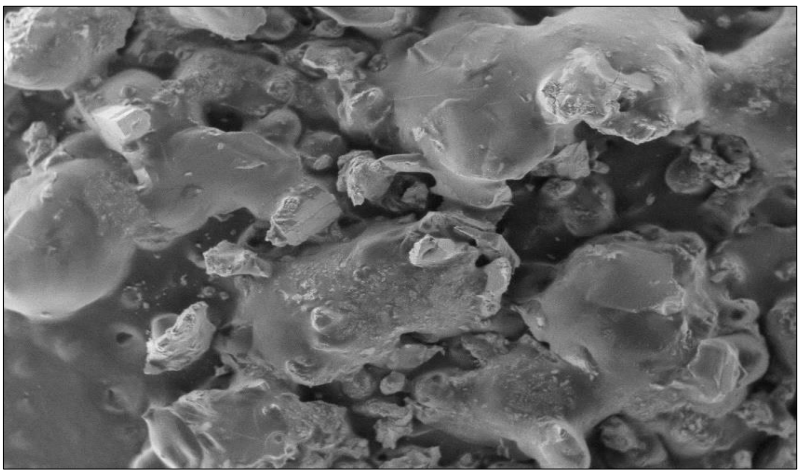

Figure 2 The SEM of keratin hydrogel

X-ray diffraction (XRD)

The KF exhibits eight narrow peaks approximately 2θ = 28˚, 32˚, 33˚, 46˚, 55˚, 57˚,66˚,74˚, and 76˚, that corresponds to the interplanetary spacings of 3.21616 Å, 2.79649 Å, 2.77643 Å, 1.98187 Å, 1.68986 Å, 1.61871Å, 1.40434 Å, 1.28976Å, and 1.25853 Å, and relative intensity (%) of

15.29%, 81.14%, 68.65%, 72.38%, 4.38%, 17.89%, 6.91%, 4.16% respectively. These effects are caused by the presence of crystalline regions within the sample.

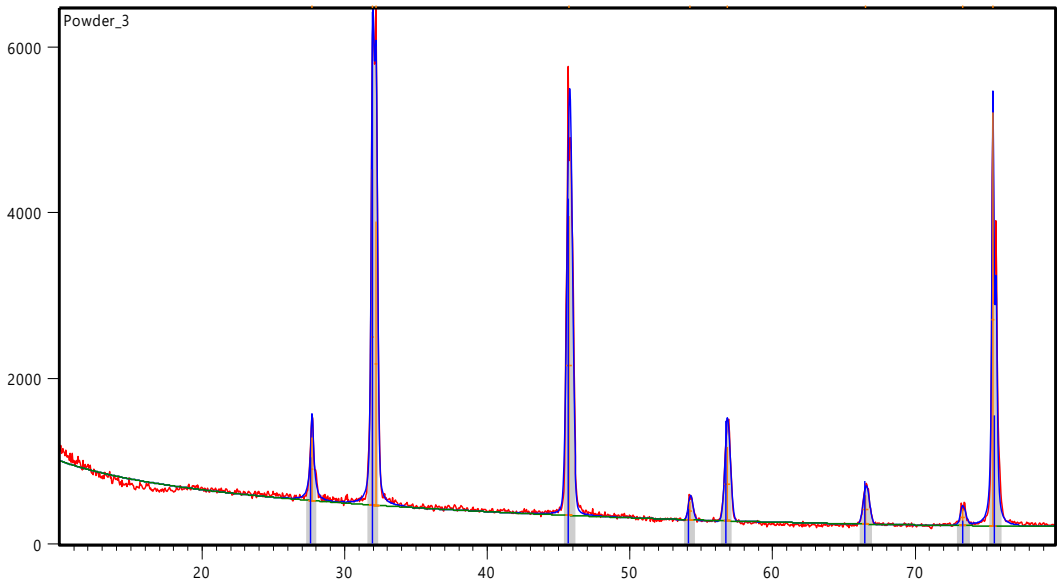

Figure 3 The XRD of keratin

4 Conclusions

In conclusion, in this study, the drying of keratin in vacuum oven conditions got successful as was analyzed and presented a satisfying result. The recombinant keratin, with properties of distinct amino acid sequence, high purity, stable characteristics, and molecular weight, have excellent potential to be utilized for future studies.

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