COMPARATIVE STUDIES ON THE CHEMICAL PROPERTIES OF FEATHER BARBS IN BROILER AND KUTTANAD DUCKS

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Abstract

The present study was conducted to evaluate the chemical properties of keratin obtained from duck feather barbs. Feather barbs were collected from a total of 24 birds comprising of broiler Vigova Super-M ducks of six to eight weeks of age and spent Kuttanad ducks above 40 weeks of age. Different properties of feather barbs like protein content and amino acid content were studied according to the standard analytical methods. The percentage contribution of total feathers to the body weight was more in the broiler duck (5.03±0.24 %). Broiler duck feather contained 77.59 per cent and feather of Kuttanad duck contained 73.50 per cent protein. The relative high value of protein content in duck feather can be utilized as a good source of protein in the feed. Feather barbs of broiler and Kuttanad ducks showed similar proportion of amino acids. Serine was found to be the most abundant amino acid followed by glycine and proline. Percentage of hydrophobic amino acids was higher (56%) when compared to the hydrophilic amino acids (42%) in both the groups under study. Presence of amino acid cysteine, which has the ability to form disulfide bonds indicated the stable structure of keratin. The results indicated the importance of focusing on advanced technology to uplift the use of duck feather fibre as a natural protein source which is at present considered as a poultry industry waste and will help to build a ecofriendly environment.

Keywords: *Amino acid, Duck feather fiber, Protein content*

Duck rearing is an emerging animal husbandry sector that occupies a key position next to chicken farming in India. Livestock census 2012 reveals that duck population in India is 23.53 million which is about 10 per cent of the total poultry population. Rearing of ducks is mostly practiced in the eastern and southern states of India, especially in the coastal regions. In Kerala, consumption of duck meat constitutes around 40 per cent of the total poultry meat consumption (Athira *et al.*, 2017). Consequently, duck meat industry contributes about half of the poultry slaughter waste in the State. Feathers contribute about five to seven per cent of the body weight in birds. Avian feather is a branched structure composed of about 90

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per cent keratin, a natural protein constituting the most abundant keratinous source in nature. Being a water bird, the duck feather has water proof property and special characteristics compared to that of chicken. Down feathers of the duck have good thermal insulation property by entrapping air into its lofty structure. Moreover, keratin from duck feathers is reported to be most effective to preserve archaeological specimens of wood species compared to that of chicken or goose (Endo *et al*., 2008). Thus, duck feather, being a waste product of poultry industry, offers a cheap and renewable source of keratin fibres; proper utilization of this opens a wide array of future possibilities. Hence the present work was undertaken to assess the chemical properties of feather barbs in broiler and layer ducks which will pave way for future research in this field.

Materials and Methods

Sample Collection

Samples were collected from a total of 24 birds comprising of 12 broiler Vigova Super-M ducks of six to eight weeks of age and 12 spent Kuttanad (layer) ducks above 40 weeks of age from the Meat Technology unit, College of Veterinary and Animal Sciences, Mannuthy.

Protein Estimation

Samples of the feathers were taken and dried to constant mass at 90 to 95°C for 24 h. Total nitrogen of the dry matter was determined using three samples for the analysis (Holub *et al.,* 1988). Total nitrogen was measured by a micromethod (Conway, 1957).

Amino Acid Estimation

Preparation of Sample

The duck feather barb samples (each 250 mg) of broiler and layer groups were weighed accurately in an electronic balance and transferred into labelled glass test tubes. 3ml of 6M hydrochloric acid solution was added to the sample. All the sealed tubes were kept in a hot air oven at 110 °C for 24 h. After completion, transferred the digest into glass beaker and rinsed the tubes five times with distilled water. The samples were transferred to 3ml Eppendorf tubes and the acid in the digest was evaporated to core dry under vacuum using Rota-vac evaporator.

Preparation of Standard Stock Solutions

2.5µmol/ml from a solution of amino acids standards (Aspartic acid, Glutamic acid, Serine, Histidine, Glycine, L-Threonine, Arginine, Alanine, Tyrosine, Cysteine, Valine, Methionine, Phenylalanine, Isoleucine, Leucine, Lysine, Proline, L-Asparagine, L-Glutamine) was prepared for calibration curves.

Derivatization Procedure

150µmol/mL of amino acid standards, 150µL of buffer solution (Borate buffer; pH 9) and 300µL of FMOC reagent were mixed well and incubated for 20 minutes at room temperature. It was stopped by adding 50µL of ADAM / 50µL of HEPA solutions.

Chromatographic Instrumentation and Conditions

The HPLC analysis was carried out with Agilent 1260 series HPLC system (Agilent Technologies, Palo Alto, CA, USA) comprising a quaternary pump (Agilent Technologies 1260), a vacuum degasser, a variable wavelength detector and a 20 µl sample injector, column thermostat. The separation was performed on Zorbax Eclipse plus C18 column. Column specification: 3.5µm, 100X 4.6mm, Agilent. The reverse phase column was used as a stationary phase and isocratic elution of mobile phase: A: 20mmol/L Phospahate potassium Buffer (pH 6.9), B: 45/40/15 Acetonitile/ Methanol/water, Time program: B Conc. 11% - 13% (0.00-3.00 min), 31% (5.00 min) – 37% (7.5 min), 70% (10.00 min) – 100% (10.50-13.50 min), 11% (14.00 min), Flow rate: 0.8 mL/ min,(for asparagine and Glutamine standards same conditions with 0.6ml/min flow rate was used) Column temperature: room temperature, Injection volume 20µL, detection wavelength: 262nm. The column thermostat was maintained at room temperature. The chromatogram was quantified using Open LAB CDS ezchrom Workstation VL Software (Nuutinen, 2017).

Results and Discussion

The percentage contribution of total feathers to the body weight was more in broiler duck (5.03±0.24 %) compared to layers (4.87±0.41 %). The total weight of the feather was not significantly different among groups (*p* value 0.74). Holub *et al*. (1988) reported that feathers contributed 6.2 per cent to the total body mass in ducks.

The protein content obtained for broiler duck feather was 77.59 per cent and that of Kuttanad duck was 73.50 per cent. According to Tesfaye *et al.* (2017), the crude protein content of the chicken whole feather was 82.36 per cent. Eventhough the crude protein percentage is slightly lower than that of chicken feather, the relative high value of protein content in both broiler and Kuttanad duck feathers can be utilized as a good protein source in the feed. The percentage of amino acids in the feather barbs of broiler and Kuttanad ducks is given in table 1. Chromatograms showing the separation of amino acids of standard solution, broiler duck feather and Kuttanad duck feather are shown in figure 1, 2 and 3.

Understanding the nature of amino acid and its arrangement within the protein are essential to identify the charge of the protein and its hydrophobic or hydrophilic nature. Feather barbs of broiler and Kuttanad ducks showed similar proportion of amino acids. It is reported that the poultry feather had an amino acid sequence almost similar to that of other birds (Bonser and Purslow, 1995; Martinez-Hernandez *et al.,* 2005; Jagadeeshgouda *et al*., 2014). Serine was found to be the most abundant amino acid followed by glycine and proline. Methionine, histidine and lysine were present only in very small quantities in the barb protein. These findings tally with the earlier reports in duck feather (Arai *et al*., 1986).

Percentage of hydrophobic amino

Table 1. Amino acid content of broiler and Kuttanad duck feathers shown as proportional percentages (%) along with the nature of side chain

Amino acid	Feather of broiler duck (%) Mean±SE	Feather of Kuttanad duck (%) Mean±SE	t value	Nature of side chain
Aspartic acid	5.00±0.022	5.20±0.006	8.994**	Negatively charged, hydrophilic
Glutamic acid	7.00±0.044	7.35±0.021	7.287**	Negatively charged, hydrophilic
Serine	12.53±0.013	12.79±0.0132	13.965**	Neutral, hydrophilic
Histidine	0.02±0.001	0.65±0.0127	49.456**	Positively charged, hydrophilic
Glycine	10.78±0.043	11.05±0.040	4.720**	Special, neutral, hydrophobic
Threonine	4.19±0.015	4.44±0.037	6.233**	Neutral, hydrophilic
Arginine	5.80±0.016	5.01±0.026	26.139**	Positively charged, hydrophilic
Alanine	5.59±0.008	5.47±0.067	1.799	Neutral, hydrophobic
Tyrosine	1.39±0.010	1.06±0.051	6.343**	Neutral
Cysteine	7.74±0.030	7.91±0.024	4.365**	Neutral, hydrophobic
Valine	7.80±0.010	7.91±0.073	1.534	Neutral, hydrophobic
Methionine	0.08±0.001	0.04±0.006	6.838**	Neutral, hydrophobic
Phenyl alanine	2.19±0.008	2.90±0.132	5.359**	Neutral, hydrophobic
Isoleucine	3.53±0.054	3.89±0.098	3.323**	Neutral, hydrophobic
Leucine	6.58±0.014	6.93±0.440	0.795	Neutral, hydrophobic
Lysine	0.22±0.005	0.06±0.003	29.716**	Positively charged, hydrophilic
Proline	11.65±0.038	11.04 ±0.054	9.287**	Special, neutral, hydrophobic
Asparagine	3.05±0.027	2.27±0.056	12.380**	Special, neutral, hydrophilic
Glutamine	4.84±0.207	4.00±0.228	2.741*	Neutral, hydrophilic

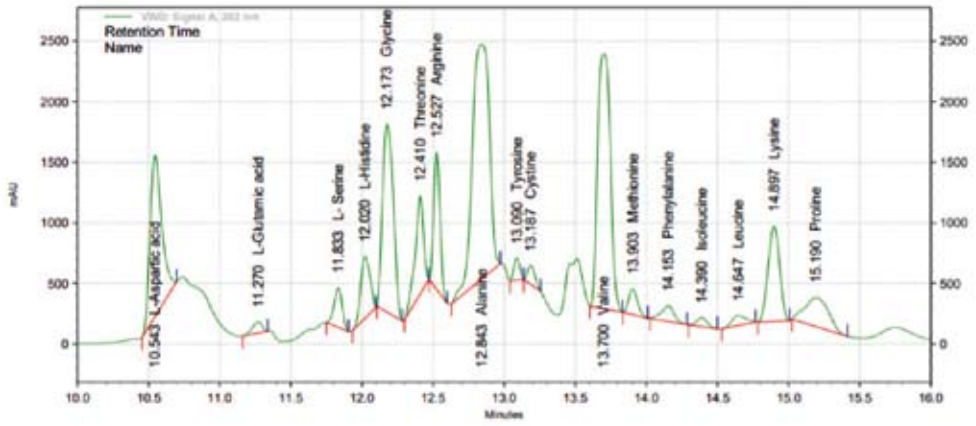

Fig. 1. Chromatogram showing the separation of amino acids of Standard Solution

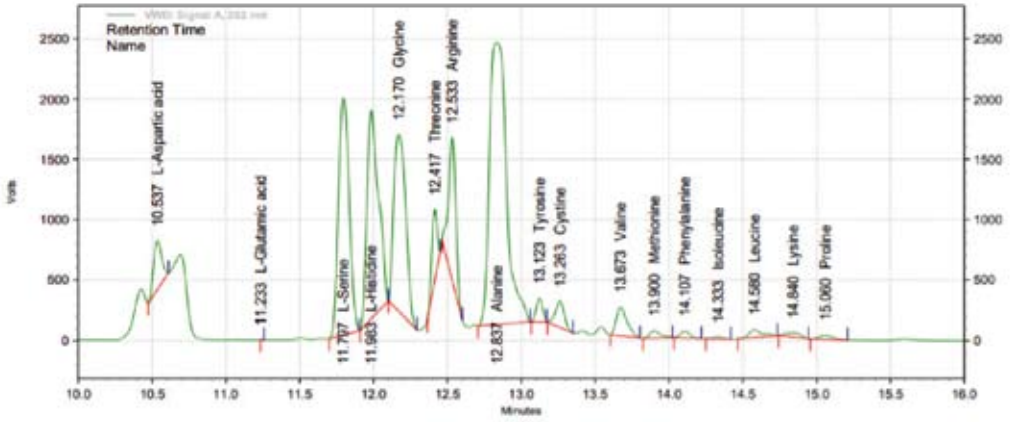

Fig. 2. Chromatogram showing the separation of amino acids of Broiler Duck feather

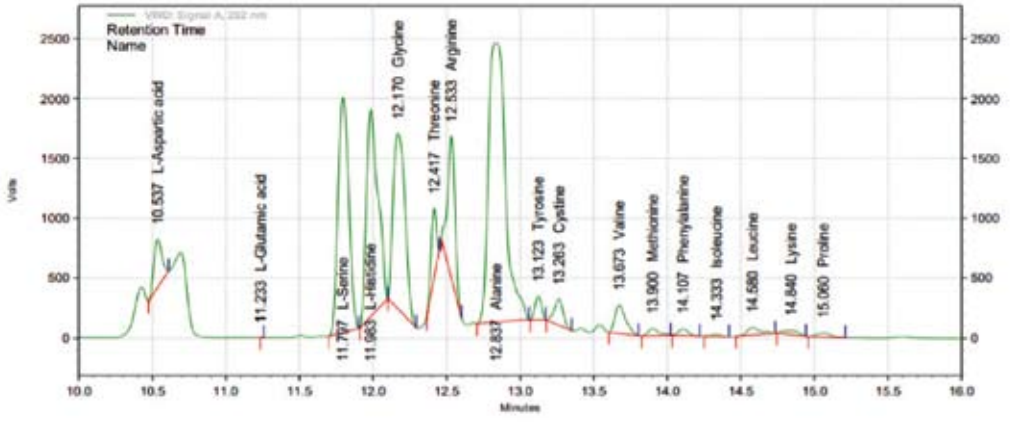

Fig. 3. Chromatogram showing the separation of amino acids of Kuttanad Duck feather

acids was higher (56%) when compared to hydrophilic amino acids (42%) in both the groups under study. Presence of amino acid cysteine, which has the ability to form disulfide bonds indicated the stable structure of keratin. Cysteine formed disulfide cross linking of adjacent polypeptides. Higher percentage of hydrophobic amino acids in the feather keratin and the hydrophobic interactions and forces are required for the folded structure of protein (Saravanan and Dhurai, 2012; Nuutinen, 2017).

Conclusion

The hydrophobic nature of feather keratin offers high resistance and durability to feather composites. Basic knowledge about the amount of amino acids present in duck feather fibre will help in the determination of reactive groups in the duck feather keratin which might interfere in the purification and manufacturing process. The natural keratin obtained from biomass does not contain any harmful chemical and can be used directly to produce variety of cosmetics, creams, shampoos, hair conditioners and biomedical products. Thus, the organic waste can be utilized as a natural source to extract the keratin and use it in commercial applications. Feather keratin is a potential source of inexpensive, ecofriendly and commercial biomaterial. It can be developed in various forms, for instance, gels, films, beads and nano/micro-particles. Undoubtedly, after modification, it finds numerous applications in green chemistry, food sciences, pharmaceutical and cosmetic industries.

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