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Studies on the chemical properties of broiler chicken feathers

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Abstract
Studies were undertaken on the feather of broiler chicken of six to eight weeks of age, slaughtered at Meat Technology Unit, Mannuthy. The feather samples were collected from a total of 12 birds comprising of six males and females from the broiler groups. The proximate analysis of broiler chicken feathers showed the presence of high crude protein, significant fat content and negligible amount of crude fibre. The crude protein content in broiler feather was 77 per cent and the fat content was 2.26 per cent. Negligible amounts of crude fibre content (0.5 per cent) and ash content (0.8 per cent) was recorded. The average composition of carbon, hydrogen, nitrogen and sulphur were 46 per cent, 7.5 per cent, 15 per cent, and two per cent respectively while oxygen and inorganic matter formed 29.5 per cent in all the birds. It was concluded that since the proximate analysis of broiler chicken feathers showed the presence of high crude protein, significant fat content and negligible amount of crude fibre, future research work may be carried out for use of chicken feathers for the production of biodiesel and as a more convenient gaseous fuel for generation of heat and electricity in conventional equipments like boilers, engines, and turbines.

Keywords: broiler chicken, feather, chemical properties

Introduction
Poultry industry has taken a quantum leap in the last three decades and now India is the fifth largest poultry producer in the world. Increased use of chicken meat also generates millions of tonnes of waste which if not properly disposed, becomes one of the major environmental pollutants. Hence it is essential to find alternate ways to utilize the feather wastes from poultry industry to make the poultry industry more profitable. The present study was conducted to assess the chemical properties of feather in broiler chicken. It will be contributory to the existing knowledge and will also form a basis for future research on techniques for processing chicken feather to realize its full potential.

Materials and Methods
Studies were undertaken on the feather of broiler chicken of six to eight weeks of age, slaughtered at Meat Technology Unit, Mannuthy. The feather samples were collected from a total of 12 birds comprising of six males and females from the broiler 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 chemical properties.

Proximate Analysis
Samples were prepared by grinding feather in a pulverizer.

Crude Protein and Fat
Samples of the feathers were then taken and dried to constant mass at 90 to 95 °C for 24 h. Total nitrogen and fat content of the dry matter were determined using two samples for each analysis (Holub *et al.*, 1988) [6].

Total nitrogen was measured by a micromethod (Conway 1957) [3] and fat by 24 h petroleum-ether extraction in a Soxhlet apparatus (Montemurro and Stevenson 1960) [10].
The protein content was further calculated according to Kjeldahl method described by Godfrey and Reichelt (1982) [5].

Total Ash
The ash content was calculated in relation to the dry weight of the original sample after overnight ignition of the sample at 575 ± 25 °C.

Crude Fibre
Crude fibre was obtained as the residue of a precisely defined digestion procedure using acetic, nitric and trichloro-acetic acids (AACC, 2000 and Tesfaye *et al.*, 2017) [1, 14].

Elemental Composition
The amount of carbon, hydrogen, nitrogen, and sulphur in the chicken feathers were ascertained using a CHNS analyser. Before analysis, samples were dried at 105°C in a hot air oven over night in order to remove excess moisture. Average values of two parallel samples were measured and reported (Tesfaye *et al.*, 2017) [14].

Results and Discussion
Gross Structure of Feathers
The remiges or wing feathers were mainly composed of three distinct units *viz.*, rachis (primary structure), barbs (secondary structures) and barbules (tertiary structures). The main shaft comprised of rachis and calamus which was seen along the entire length of the feather. The calamus or quill (lower shaft) was found to be rounded, transparent, hollow and devoid of vane structure in all the birds under study. The interlocking feather vane comprised of barbs that branched from the rachis and barbules that branched from barbs in all the birds. Neighbouring barbules adhered to one another via hook-and-groove structures to form an organized feather vane. These results are parallel with the observations of Tesfaye *et al.* (2017) [14] and Reddy and Yang (2007) [13] in chicken.

Chemical Properties
Proximate Analysis
The proximate analysis of broiler chicken feathers showed the presence of high crude protein, significant fat content and negligible amount of crude fibre. The crude protein content in broiler feather was 77 per cent. Crude protein was composed of true protein or natural protein which was either degradable or not degradable and non-protein nitrogen source (Msahli *et al.*, 2006; Zhongfu *et al.*, 2015) [11, 15]. The higher protein content suggested that chicken feathers could be used as a source of high quality protein (Msahli *et al.*, 2006; Tesfaye *et al.* 2017) [11, 14].
In the present study the fat content in broiler chicken feather was 2.26 per cent. High fat content seen in feathers in this study indicated that they could be used for the production of biodiesel as reported earlier by Kondamudi *et al.* (2009) [8].
Negligible amounts of crude fibre content (0.5 per cent) was recorded in broiler chicken feathers since feather biomass, did not contain cellulose, hemicelluloses and lignin present in the cellulosic biomass as reported by Tesfaye *et al.* (2017) [14].
The ash content was about 0.8 per cent in broiler feathers. Ash was an impurity that reduced burning capacity and affected combustion and boiler efficiency (Kwiatkowski *et al.*, 2012) [4]. The low ash content seen in the present study indicated that chicken feathers could be suitable for use as fuel. Further chicken feathers could also be used for fixed-bed gasification as reported earlier by Dudynski *et al.* (2012) [4]. It might be converted into a more convenient gaseous fuel for generation of heat and electricity in conventional equipments like boilers, engines, and turbines or advanced equipments like fuel cells (Omosun, 2004) [12].

Elemental Composition
The average composition of carbon, hydrogen, nitrogen and sulphur were 46 per cent, 7.5 per cent, 15 per cent, and two per cent respectively while oxygen and inorganic matter formed 29.5 per cent in all the birds. Aguayo-Villarreal *et al.* (2011) [2] determined the elemental composition of the feather's barbs and evaluated their possible usage as sorbents. The carbon (47.65 per cent) was the most abundant element and hydrogen has 7.49 per cent. High content of nitrogen (9.98 per cent) and a considerable quantity of sulphur (1.44 per cent) were also found in the sample. However, the values of elemental composition differed from that of turkey feather fibres, reported by Kardas *et al.* (2015) [7] which might be due to the difference in species. Similar results were noticed for elemental composition of the chicken feather barbs by Tesfaye *et al.* (2017) [14] as observed in the present study.
It was concluded that since the proximate analysis of broiler chicken feathers showed the presence of high crude protein, significant fat content and negligible amount of crude fibre. chicken feathers could be beneficiated as a good source of protein and energy and were suitable for use as a raw material for the production of biodiesel. Future research work may be carried out for use of chicken feathers as a more convenient gaseous fuel for generation of heat and electricity in conventional equipments like boilers, engines, and turbines.

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