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Research Paper

Standardization and Quality Evaluation of Feather cum Skin Meal Prepared by Hydrothermal, Chemical and Biological Methods

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ABSTRACT

A study was under taken with the objective of standardizing the techniques for processing of feather-cum-skin meal and their effect on nutritive value. Broiler chicken feathers along with skin were washed and dried at 80±5°C in oven for 4-5 hours. Weighed samples were subjected to modified hydrothermal rendering (HT) alone and supplemented with chemical degradation (CT) and microbial degradation (MT). The meals were evaluated for nutritive quality in terms of proximate composition, mineral and amino acid profile. The quality of rendered fat was evaluated in terms of iodine value, peroxide value and free fatty acid value. The yield of fat and feather-cum-skin meal obtained after rendering was also estimated. The supplementation of CT and MT methods improved protein content of meal by 30 and 32 percent, respectively over HT method. The quality of the rendered fat was found satisfactory. It is concluded that CT or MT methods following HT method greatly improves the nutritive quality of feather cum skin meal besides providing good quality fat and can be used in industrial sector.

Keywords : *Byproducts, Hydrothermal rendering, Feather meal, Chemical degradation, Microbial degradation*

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INTRODUCTION

Poultry industry is a well established industry worldwide, providing 24 billion chickens annually for slaughter (Anon . Besides meat, the industry also produces by-products including blood, offal and feathers (Kulkarni and Suresh 2015). About 8.5 billion tons of feathers are being produced as by-products, posing challenge for disposal to the modern poultry industry. In India due to the booming poultry industry the annual production of feather is around 350 million tons (Sarita and Neeraj 2010). Due to the increased consumption of poultry meat in the state of Jammu and Kashmir, about 40 million broilers are slaughtered annually generating approximately 3 tons of feather as a by-product. The existing practice of poultry processing include de-skinning along with feathers followed by dumping in the water bodies and road sides, leading to water pollution, dog nuisance and bad odour. Feathers rich in proteins (>90%) and skin being rich in fat and protein (13%) are good nutrient sources for livestock (Mandal *et al*. 2011). Hydrothermal and chemical rendering have been used for the processing of feathers meal with some disadvantages viz., destruction of essential amino acids, poor digestibility and low nutritional value. Biological process utilizing microorganisms in the process of feather meal have been used successfully (Khardenavis *et al.* 2009 and Guo Wang *et al*. 2013). Hence, keeping in view the production of huge quantity of feathers cum skin, their nutritive value and its potential as nutrient source for animal feed, this study was undertaken to standardize the hydrothermal, chemical and microbiological processing techniques for production of feather-cum-skin meal and to compare their nutritive value.

MATERIALS AND METHODS

Broiler chicken feathers along with skin were collected from poultry retail shops in Srinagar and adjoining areas. The raw material was washed with tap water to remove contaminants, dried in oven at 80±5°C for 4-5 hours followed by weighing. The feather cum skin was processed by following Boushy and Vander (2000) hydrothermal rendering method with slight modification in temperature-time combination for digestion. The weighed dried material was rendered in a pressure cooker at 121°C and 15 lb psi for 30 minutes followed by agitation. The contents were transferred to a large sieve and squeezed under manual pressure for the collection of fat and water in the container followed by quiescent storage for fat layer to be separated out. The rendered fat was recovered to maximum possible extent. The process was repeated four to five times till fat was completely recovered. The tankage was dried at optimum time temperature combination (80±5°C for 3 days). The oven dried feather-cum-skin material was ground to powder in blender. The meal obtained was further subjected to two treatments viz., chemical degradation (Papdopoulos

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1985) and microbial degradation. In chemical degradation, the meal obtained by modified hydrothermal rendering was treated with 0.2 % NaOH and heated at 80±5°C for 10-15 min followed by neutralization with 35% HCL and distilled water followed by drying in an oven at optimum time temperature combination (80±5°C for 3 days). The dried material was ground to form a feather-cum-skin meal. In microbial degradation, *Bacillus licheniformis* was used for feather degradation due to the higher keratinolytic and proteolytic activity of proteases and keratinase produced by the bacterial strain. The lyophilized culture of *Bacillus licheniformis* was procured from Institute of Microbial Technology, Chandigarh (IMTECH) and used after its revival. The method described by Xiang *et al*. (1992) was followed for the preparation of basal media. Method described by Swetlana and Jain (2010) was followed for microbial degradation of feather with slight modifications. The proximate composition of feather-cum-skin meal prepared by HT, CT and MT processing methods were evaluated as per standard procedure of AOAC (1995). Mineral composition of meal was determined following AOAC (2003) method using Atomic absorption spectrophotometer (Make: ECI, New Delhi; Model: 4141). Qualitative amino acid profile of the feather-cum-skin meal was evaluated by following Ninhydrin, Xanthoproteic and Lead sulphide test. Rendered fat was analyzed for its quality in terms of Iodine value, Peroxide value and Free Fatty acids (AOAC 1995). The yield of meal and rendered fat was also estimated. Evaluation of feather cum skin meal and fat for each parameter was repeated three times. The data generated was subjected to analysis of variance using SPSS version 20.

RESULTS AND DISCUSSION

Proximate composition: The results pertaining to proximate composition of feather-cum-skin meal are delineated in Table 1. The average moisture content (%) of meal prepared by HT, CT and MT was found as 7.99±1.20, 8.43±1.32 and 8.05±1.40, respectively. Moisture content of meal prepared by CT was non-significantly ($p>0.05$) higher than the meal prepared by HT and MT. The results of HT and MT were in agreement with those of Bertsch and Coello (2005) and Cotanch *et al*. (2006). The results obtained in CT were more or less in agreement with the findings of Bhuiyan *et al*. (2015). The probable reason for the variation in moisture contents could be because of the difference in the processing techniques (Han and Parsons 1991).

The crude protein (%) of meal prepared by HT, CT and MT was found as 44.90±1.68, 74.96±0.96 and 76.55±1.73, respectively. Meal prepared by HT showed significantly lower crude protein ($p<0.05$) content than CT and MT. This could probably because of incomplete hydrolysis of keratin protein compared to CT and MT wherein, keratin gets hydrolyzed by alkali (NaOH) and fermentation by *Bacillus licheniformis*, releasing protein from chicken feather (Rachmat *et al*. 2014). The proteins in the chicken feathers are bound by physical and covalent interactions which get degraded by chemical and biological treatments (Lee and Tan 2002). As compared to HT, the release of protein improved by 30 and 32 percent in case of CT and MT, respectively. The results obtained in CT and MT process were more or less in agreement with the findings of Isika *et al*. (2006) and Bhuiyan *et al*. (2015).

The mean ether extract (%) of meal obtained by HT, CT and MT methods were found as 12.28±0.44, 12.18±0.72 and 8.82±0.18, respectively. MT was having significantly ($p<0.05$) lower values than HT and CT. The lower fat content in MT could be attributed to the lipolytic activity of *Bacillus licheniformis* (Prasad and Sethi 2013). Ether extract of meal processed by HT and CT was found corroborating with the results reported by Cotanch *et al.* (2006). The results obtained in MT were more or less in agreement with Nick (1992) and Anon (1994), who reported the ether extract values as 7.7 and 7 %, respectively. The results obtained in the current study for the HT and CT showed higher fat content which could probably be due to the incorporation of skin with feathers during processing. The average ash (%) of meal prepared by HT, CT and MT methods was found as 0.43±0.26, 0.47±0.27and 0.40±0.05, respectively. Non-significant difference was found between the treatments.

Mineral profile: The mean sodium (ppm) of HT, CT and MT were found significantly ($P<0.05$) different among each other (Table 1). The variation could be due to the difference in the processing methods (Kim and Patterson 2000). The average potassium (ppm) of meal prepared by the HT (2.58±0.29), CT (1.90±0.52) and MT (2.23±0.28) were found non-significantly different among each other. The study revealed that the potassium content of meal was in disagreement with the observations of Cotanch *et al*. (2006). The difference could be attributed to the different processing methods employed in the preparation of meal and also incorporation of skin along with feather might have contributed to the variation in potassium content.

The mean calcium (ppm) of meal prepared by HT (636.38±82.55), CT (1193.43±227.7) and MT (3671.0±38.46) were found significantly ($p<0.05$) different among each other. The average magnesium (ppm) of meal was found as 322.30±42.04, 396.96±50.34 and 473.16±5.59 in case of HT, CT and MT

methods, respectively. The magnesium content of HT was found significantly ($p<0.05$) lower than that of MT, however, both HT and MT showed non-significant ($p>0.05$) difference with CT. The results obtained in the current study were in agreement with the results obtained by Cotanch *et al*. (2006) who found that the magnesium content of meal was 300 ppm. No manganese was found in the meals prepared by all three methods.

Table 1: Proximate composition and mineral profile of feather-cum-skin meal prepared by HT, CT and MT methods (Mean± S.E)

Treatment	HT	CT	MT
Moisture (%)	7.99 ± 1.20	8.43 ± 1.32	8.05 ± 1.40
Crude protein (%)	44.90 ± 1.68^{a}	74.96 ± 0.96^{b}	76.55 ± 1.73^{b}
Ether extract (%)	12.28 ± 0.44^{b}	12.18 ± 0.72^{b}	8.82 ± 0.18^{a}
Ash (%)	0.43 ± 0.26	0.47 ± 0.27	0.40 ± 0.05
Sodium (ppm)	210.28 ± 1.37^{a}	1159.0 ± 34.36^{c}	346.05 ± 5.44^{b}
Potassium (ppm)	2.58 ± 0.29	1.90 ± 0.52	2.23 ± 0.28
Calcium (ppm)	636.38 ± 82.55^{a}	1193.43 ± 227.7^{b}	3671.0 ± 38.46^{c}
Magnesium (ppm)	322.30 ± 42.04^{a}	396.96 ± 50.34^{ab}	473.16 ± 5.59^{b}
Manganese (ppm)	0.00	0.00	0.00

Means across the rows with different superscript differ significantly ($p<0.05$)

Amino acid profile: The results of amino acid profile (qualitative) (Table 2) revealed that meal obtained by CT and MT were found negative for ninhydrin test in all the observations, which indicated the absence of the amino acids viz., glycine, tyrosine and tryptophan. However, HT was found positive in one observation for Ninhydrin test. The absence of these amino acids could be attributed to the treatment of feather meal with steam and acid causing depletion of amino acids glycine and tyrosine to a greater extent (Tiwary and Gupta 2012). The meal obtained by HT, CT and MT was found positive for Xanthoproteic (indicating presence of phenylalanine) and lead sulphide test (indicating presence of cysteine, cystine and methonine). The results obtained were in agreement with the results of Han and Parsons (1991) who reported the lower concentrations of tyrosine in feather meal. The depleted levels of amino acids could be due to steam, alkali and bacterial treatments given to feather and skin for the production of feather-cum-skin meal. The current study revealed the presence of phenylalanine, cysteine, cystine and methionine in the feather meal corroborating with the results of Isika *et al*. (2006). Further, the results of MT in the current study were in agreement with those of Riffel *et al*. (2003) and Bertsch and Coello (2005) who reported that biotechnological processing of feathers with the use of keratinolytic microorganisms preserves the essential amino acids viz., methionine, lysine and histidine. Addition of skin in the current study did not make any change in the amino acid profile.

Table 2: Amino acid profile of feather-cum-skin meal prepared by HT, CT and MT methods

Treatment	HT	CT	MT
Glycine	+- -	- - -	- - -
Tyrosine	+- -	- - -	- - -
Tryptophan	- -+	- - -	- - -
Phenylalanine	+++	+++	+++
Cysteine	+++	+++	+++
Cystine	+++	+++	+++
Methionine	+++	+++	+++

(+ + +) indicates samples positive for the amino acid in all 3 replications, (- - -) indicates absence of amino acid in the sample in all 3 replications.

Yield: The yield (%) of feather cum skin meal and rendered fat calculated on weight by weight (W/W) basis was reported as 25.39±0.39 and 10.96±1.00, respectively.

Quality of fat: The average peroxide value (meq.), free fatty acid (%) and iodine value (g) of fat was found as 0.44±0.05, 2.63±0.18 and 75.67±1.06, respectively. The peroxide value and free fatty acid content of rendered fat was in disagreement with Baião and Lara (2005). However, it was observed that the quality of fat in terms of PV, FFA and IV was satisfactory.

From the above results, it could be concluded that the feather cum-skin meal prepared by chemical and microbial degradation has high nutritional quality and great potential to be incorporated in livestock feeds as a rich source of protein. Moreover, fat extracted during processing of the meal could be utilized for the industrial purposes adding more revenue to the industry, besides reducing environmental pollution.

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