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Utilization of Human Hair in Animal Feed

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ABSTRACT

Protein-rich (approximately 84%–86%) keratins—epidermal derivatives—have not yet found a wide area of effective application as proteins. This is because of the disulphide bridges of cystine molecules, which make the proteins very rigid and strongly resistant to solubilization and normal enzymatic degradation. The present study was chiefly aimed at breaking up this resistance so as to explore the possibility of utilizing keratins, particularly hair-keratin, as a part of the protein component of animal feeds. The results were encouraging in the sense that human hair could be degraded either by physical or chemico-physical or chemico-enzymatic means and the protein so obtained was found to be good enough to serve as a partial, but effective, supplement supporting the growth of rats. The PER values ranged from 1·49 to 2·20 and the NPR values indicated that all the test diets were at par in maintaining the growth of either sex.

INTRODUCTION

Among the keratinous products, wool has a high commercial value in the preparation of garments, blankets, carpets, etc. Feathers, horns, fish scales, and even spines of some animals like the porcupine are used for various purposes. Human hair, apart from use in wigs, has a value in forensic investigations. For a long time, hair was the source for the manufacture of the amino acids, cystine and cysteine. Wool and hair have

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been used as experimental materials in deciphering the complex nature of globular protein.

While hair has such important commercial and scientific uses, hair trimmed for cosmetic reasons is discarded as waste.

A survey carried out in a local rural area indicated that, on average, a wayside saloon throws away 300 g of trimmed hair per day, equivalent to about 95–96 kg of hair annually. At the rate the population is increasing in developing countries, one can expect an increase in the already massive hair-waste. Considering the protein value of hair, an attempt was made to realize the useful portion from the tough, insoluble but protein-rich human hair-waste.

METHODS

Trimmed hair collected from the hair-cutting saloon was cleaned, washed with water then 1% teepol solution, followed by successive rinsing with water to eliminate all the traces of teepol, dried at room temperature and processed separately as follows:

(i) Autoclaved at 50 psi for 30 min in a flask stoppered with non-absorbent cotton and then freeze-dried.

(ii) Pretreated with the anionic surfactant, sodium dodecyl sulphate (SDS, 0·06%), in the presence of 1·5% H_2O_2 for 8 days at 35 °C (1 g hair to 100 ml SDS + H_2O_2) followed by successive rinsing with water and autoclaving as above.

(iii) Pretreated with SDS (0·06%), in the presence of 1·5% H_2O_2 for 8 days at 35 °C followed by successive rinsing with water and subsequently enzymatically disintegrated with trypsin (1 g hair, 0·05 g trypsin (2000 E/g, Merck) in 100 ml 0·1 M phosphate buffer, pH 7·8) at 35 °C for 24 h and then dialysed at 4 °C. The disintegrated hair solution was then freeze-dried.

Products thus obtained were referred to as Diet 1, Diet 2 and Diet 3, respectively, which were compared against a control nitrogen-free diet and a standard skim-milk diet.

The hair preparations replaced 50% of the skim milk protein in the diets of weanling rats. Each test diet was also fortified with Lys, Met, Phe and Ile at 0·95, 1·81, 1·05 and 2·23 g per 100 g protein, respectively (Simmonds, 1954). Both standard (skim milk) and test diets (50% skim

milk + 50% processed hair) were prepared at a 10% protein level. Composition of other constituents was as follows: groundnut oil, 10 g (containing 1 mg, or 100 IU, of vitamin E); 4% mineral mixture (U.S.P. XVII—4); glucose, 5 g; complete vitamin mixture, 5 g; autoclaved, dried potato starch to make 100 g diet. Two drops of adexolin containing vitamin A (120 000 IU g^{-1}) and vitamin D (IP 2000 IU g^{-1}) were administered orally twice a week. The protein quality of the diets was evaluated in terms of Protein Efficiency Ratio (PER) (Osborne *et al.*, 1919) and Net Protein Retention (NPR) (Bender & Doell, 1957) using 22-days-old weanling albino rats weighing 30–40 g. The rats were divided into four groups. All groups for each experiment had the same average initial weight. Each group consisted of three males and three females. PER was calculated as weight gained per gram of protein consumed and NPR was calculated as follows:

$$\text{NPR} = \frac{\text{Wt. gain of TPG} + \text{wt. loss of NPG}}{\text{Wt. of protein consumed}}$$

where: TPG = test protein group (hair diets) and NPG = non-protein group.

RESULTS AND DISCUSSION

Analysis of variance (ANOVA) for PER (Peter *et al.*, 1977) (Table 1) reveals that, while the difference between the two sexes was non-significant, the differences among the treatments were found to be significant at the 1% level. The interaction between diets and sex was

TABLE 1
Analysis of Variance for PER

SV	*DF*	*SS*	*MS*	*F ratio*
Diets (D)	3	5·515	1·838	30·13**
Sex (S)	1	0·205	0·205	3·36
DX S	3	0·636	0·212	3·47*
Error	16	0·972	0·061	

* Denotes significance at the 5% level.
** Denotes significance at the 1% level.

TABLE 2
Mean Values of Protein Efficiency Ratio (PER) and Net Protein Retention (NPR) Values

Diets	*PER*	*NPR*
Wheat HD 4502	1·240	2·62 (Sikka *et al.*, 1978*a*)
Wheat Kalyan Sona	0·926	2·27 (Sikka *et al.*, 1978*a*)
Rye	1·465	2·86 (Sikka *et al.*, 1978*a*)
Triticale	1·412	2·63 (Sikka *et al.*, 1978*a*)
Spirulina platensis	2·070	— (Rao *et al.*, 1981)
Spirulina maxima	2·300	— (Anon. 1975)
Seed type soybean, Hill	1·965	4·15 (Sikka *et al.*, 1978*b*)
Vegetable type soybean, Coker Stuart	2·338	4·45 (Sikka *et al.*, 1978*b*)
Skim milk	2·740	4·42 (present study)
Diet 1	1·730	3·02 (present study)
Diet 2	1·490	3·01 (present study)
Diet 3	2·200	2·85 (present study)

significant at the 5% level. The average mean values (Table 2) indicate that the standard diet was the best for supporting the growth of rats, followed by Diet 3. No variation was found between the growth of rats reared on Diet 1 (processed physically) and Diet 2 (processed chemico-physically).

ANOVA carried out for the values of NPR (Peter *et al.*, 1977) (Table 3) showed no significant variation between the two sexes reared on different

TABLE 3
Analysis of Variance for NPR

SV	*DF*	*SS*	*MS*	*F ratio*
Diets (D)	3	9·75	3·25	12·50**
Sex (S)	1	0·21	0·21	0·81
DX S	3	0·96	0·32	1·23
Error	16	4·15	0·26	

** Denotes significance at the 1% level.
CD for comparing any two diets = 0·62.

Critical differences
CD—1: for comparing any two diets = 0·30.
CD—2: for comparing sex differences = 0·21.
CD—3: for comparing any levels of D and S = 0·43.

diets. The interaction between the diets and the sexes was also non-significant. However, variation among the diets was found to be significant at the 1% level. The mean values (Table 2) indicate that the standard diet was significantly superior to the three test diets in supporting the maintenance of rats but the test diets were found to be at par. Comparing the biological values between test and other diets (Table 2), it may be concluded that PER and NPR values of fortified test diets are between those of cereal crops and soybean or food additives.

It was reported that autoclaved cattle and hog hair, and feather supplemented with essential amino acids, could replace 5% and 3%, respectively, of protein in chick feeds, while ground raw hair, regardless of amino acid supplementation, failed to support chick growth (Moran *et al.*, 1967*a*,*b*; Moran & Summers, 1968). The fact that the protein of fortified, processed human hair is good enough to support the growth of rats, at least as a partial supplement, establishes that even the protein involved in corneal tissues is not too difficult to process and utilize as feed.

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