UTILIZATION OF POULTRY FEATHERS IN FOOD AND FEED:
1 - CHEMICAL COMPOSITION AND AMINO ACID PROFILE OF FEATHERS AND HYDROLIZED FEATHER MEAL (HFM).

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Abstract

Feathers and hydrolyzed feather meals (HFM) of chickens, geese and ducks were evaluated. HFM were prepared by alkaline hydrolysis with KOH (Treatment 1) or Na OH (Tratment 2) , while acid hydrolysis was carried out using HCL (Treatment 3) or H_3PO_4 (Treatment 4). Heating with catalyst (alkali or acid) took place at atmospheric presseur. After hydrolysis, neutralization was done , followed by vacuum drying.

Untreated feathers were rich in protein which composed 93.54 - 95.95% of the dry matter (82.21 - 83.77% of the wet sample) . Chicken feathers had the highest level of protein. Feathers protein were markedly rich in cystine, serine , proline valine, leucine and methionine + cystine, but as compared with FAO reference protein and caluclation of amino acid scores (A.S) Proteins of feathers were deficient in lysine and tryptophan.

Alkaline hydrolsis , particulary with NaOH (Treatment 2) was less damaging for EAA (essential amino acids) than the acid hydrolysis , which seems to destory the tryptophan completely. HFM of treatment 2 , showed highest protein and energy and less ash. In case of chicken feathers , this treatment gave best HFM due to highest protein content (71.52%) and energy value 321.90 Cal . /100g) the yield was about 115% of original feathers weights. Chicken HFM of treatment 2, showed also best EAA composition as indicated by A. S. values. Concentrations of EAA for HFM were the highest.

INTRODUCTION

It is now geneally recognized that high quality protein production in developing countries was found to fall behind population growth despite all current efforts to reverse this trend. For this reason, developing countries are encouraging chicken production because of their high efficiency to convert the diet into meat and eggs, and due to the faster production period of chickens than that of cattle. As a result of this practice, chicken feathers might be easily collected in relatively great amounts paralel to the expanding chicken producetion; the latter activity might be also faced by the problem of chickens feed shortage in many developing countries. Horns, hooves, feather and some other slaughter house wastes as hair are rich in protein called keratin which do not respond to digestion enzymes unless it is firstly processed by hydrolysis because of large number of cystine bridges in the protein molecule (Liberman and Pertrovski 1973) . Chicken feathers had 82% protein (Lillie et al . 1956 while on dry weight basis geese feathers at 4-7 week of age showed about 90% protein. Keratin raw materials were processed using several procedures such as alkaline and acid hydrolysis Sayevoy *et al* 1974 and Dulard *et al.* 1975 as well as autoclaving (without catalyst) as reported by Burgoș *et al* . 1974, Steiner *et al* 1983 and Papadopụlos *et al.* 1985. According to these authors , hydrolyzed feather meal (HFM) could be successfully used in ruminants and chickens rations as a source of protein and essential amino acids. Ghoneim *et al* 1982 used hydrolyzed keratin of buffalo hooves as a meat substitute in beef sausages.

This work was conducted to study the influnence of differnt methods of keratin hydrolysis on the composition and amino acid profile of chicken , goose and duck feathers. The obtained HFM products are intended to be used in food and feed.

MATERIALS AND METHODS

Feathers

Chicken (Habbard) feathers were obtained from automatized slaughter house at khanka district (Kalyobia Governorate). while duck and geese feathers were obtained from a poultry private shop at Cairo . For cleaning, feathers were soaked about 4 hours in water, thoroughly washed with rumning water, air dried then cut into small pieces.

Feathers were soaked in 4% NaOH solution for 2-4 days at room temperature , then heated (in same soaking solution) at 100 ^{o}C for 6-8 hours for NaOh alkaline hydrolysis. Neutralization was carried out by 15% HCL solution to pH 7.0 , followed by vacuum drying (500 mm) at 100 ^{o}C to obtain Na OH- HFM . KOH-HFM was prepared using 4% KOH solution and neutralization was carried out with orthophosphoric acid (70%) according to Darwiesh 1981 . Acid hydrolysis using 6N HC1 followed by nuetralization with NaOH Solution 30% , or using 9N orthophosphoric cvid, followed by neutralization with 13% KOH, was carried out according to Yatsishin *et al*. (1970) to obtain HCl - or HPO_4 - HFM.

Analytical methods

Moisture, protein (N x 6.25, Kjeldahl method), fat (hexane solvent , Soxhlet apparatus) and total phosphorus contents were determined according to the methods recommended by the A.O.A.C. 1980 . Calcium was determined using the method of Vogel 1951 . Carbohydrates were calculated by difference . Energe value was estimed by multiplying protein and carbohydrates by 4.0 and fat by 9.0. Amino acid composition after HCl hydrolysis was determined by paper chromatography method as described by Block 1958 while tryptophan was dertermind colorimetrically after alkaline hydrolysis using the method of Blauth *et al.* 1963 . Amino acids scores (A.S.) were calculated using FAO reference protein (FAO/WHO 1973) by dividing concentration of individual amino acid in protein of sample by corresponding content same amino acid of the pattern.

RESULTS AND DISCUSSION

1. Proximate and amino acids composition of feathers
a - proximate composition

Data presented in Table 1 showed that on dry weight basis (DW) chicken feathers had the highest protein percentage. followed by goose and duck feathers, however differences in protein were actually slight. Moreover, protein composed about 94-96 % of the dry matter , in contrast to fat (about 2%) Water birds had higher fat (50% and 36.18%) increas for duck and goose feathers resp. respectively in feathers than in the case of chickens . High fat was also reported by Khlebnikov

Table 1. Chemical composition of chicken, goose, and duck feathers on wet and dry weight basis (g/100g)

Components		Chicken feather	Goose feather	Duck feather
Miosture	WW	12.69	10.36	12.11
	DW	—	—	—
Protein	WW	83.77	84.87	82.21
	DW	95.95	94.68	93.54
Fat	WW	1.33	2.04	1.82
	DW	1.52	2.28	2.07
Ash	WW	1.03	1.33	2.40
	DW	1.18	1.48	2.73
Carbohydrates	WW	1.18	1.40	1.46
	DW	1.35	1.56	1.66
Energy value (Cal /100 g)	WW	351.77	363.44	351.06
	DW	402.88	405.48	399.43

WW : Wet weight basis

DW : Dry weight basis

1973 for feathers of swimming birsd. Ash and carbohydrates were highest for duck feathers. Assuming that protein of feathers is digestible , the evergy value showed no difference when calulated for the three studied feathers.

Because feathers are considerably rich in protein, it is of the atmost importance to find out suitable methods of using feathers as source of protein for both animal feeding and human consumption.

b- Amino acid composition

Although unhydrolyzed keratin is markedly not available by animals due to numerous cystine bridges (Liberman and Petrovski 1973), amino acids scores (A.S.), were calculted for comparison Tabel 2. Variable levels of individual amino acids were found in feathers of different poultries. Feathers protein of the three kinds of poultry were rich in leucine, valine proline, alanine+glutamic , glycine + aspartic, serine and cystine. As indicated by A. S. value. the protein of all studied feathers were deficient in lysine and tryptophan, which was in accordance with the results of Liberman and Petrovski 1973 and Nistan *et al.* 1981

2 . Hydrolyzed feather meals (HFM)

a . Proximate composition

Data of Table 3. show the chemical composition of HFM prepared by alkaline hydrolysis (with KOH or NaOH followed by neutralization with HCl or H_3PO_4 resp.) and acid hydrolysis (with HCl or H_3PO_4 followed by neutralization with NaOH or KOH resp.) On DW (and on most cases for WW) it was found that HFM of treatment 2 (NaOH- HCl) was the best due to the high protein and low ash percentage , while the yield (due to less ash) was somewhat lower. Highest energy value (but lowest fat) was also calculated for NaOH-HCl HFM. These differences were found in case of HFM of three kinds of poultry.

In general, alkaline hydrolysis gave HFM of higher protein and energy value (DW) when compared with acid hydrolysis , It might be indicated that the loss in protein (by breakdown during heating followed by volatilization, possibly as ammonia, Darwiesh 1981) was probably lower for alkaline hydrolysis and particularly for treatment 2 when compared with acid hydrolysis.

When differences due to kind of poultry were considered it could be observed (Tables 1 and 3) that feathers and HFM (DW) of chickens were highest in protein and

Table 2. Amino acid composition (g / 16g N) and amino acid score of chicken , goose and duck feathers (W W)

Amino acid	FAO erference protein(g/ 16g N)	Chicken feather			Goose feather			Duck feather		
		g / 16 gN	* A.S	g/100 g sample	g / 16 gN	* A.S	g/100 g sample	g / 16 gN	* A.S	g/100 g sample
Leucine	7.0	8.88	1.27	7.37	8.82	1.26	7.49	8.83	1.26	7.26
Isoleucine	4.0	5.49	1.37	4.60	5.45	1.36	4.63	5.45	1.36	4.48
Phenylalnine		4.67		3.91	4.28		3.63	4.70		3.86
Valine	5.0	6.72	1.34	5.63	5.98	1.20	5.08	6.02	1.21	4.79
Methionine		0.59		0.49	0.56		0.48	0.55		0.45
Methionine+	3.5	7.09	2.03	5.94	6.81	1.95	5.78	6.65	1.90	5.47
Cystine tyroisne		3.29		2.76	3.62		3.07	3.65		3.00
phenvlalnine+	6.0	7.96	1.33	6.67	7.90	1.32	6.70	8.35	1.39	6.86
Tyrosine Proline		8.45		7.08	8.48		7.20	8.92		7.33
Alanine+ glutam-		15.56		13.03	15.37		14.04	15.55		12.78
ic		4.35		3.64	4.52		3.84	4.62		3.80
Threonine	4.0	17.78	1.0	14.89	18.26	1.13	15.5	17.31	1.16	14.23
Glysine + aspar-		10.25		8.59	10.63		9.02	10.68		8.78
tic		6.20		5.19	6.44		5.47	6.48		5.33
Serine		1.35		1.13	1.18		1.00	1.07		0.88
Arginine		1.85		1.55	1.75		1.49	1.83		1.50
Histidine										
Lysine	5.5	6.50	0.34	5.45	6.25	0.32	3.3	6.10	0.33	1.50
Cystine										
Tryptophan	1.0	0.71	0.71	0.59	0.67	0.67	0.57	0.54	0.54	0.44

$$* \text{ (A.S) Amino acid score} = \frac{\text{g / 16 g test protein}}{\text{g / 16 g reference protein}}$$

Table 3. Chemical composition of hydrolysed meal from chicken , goose and duck feathers after alkaline and acid hydrolysis on wet and dry weight (g / 100 g)

Components		Hydrolysed meal from chicken feather				Hydrolysed meal From goose feather				Hydrolysed meal From duck feather			
		(1) KOH 4%	(2) NaOH 4%	(3) HCl 6N	(4) H_3PO_4 9N	(1) KOH 4%	(2) NaOH 4%	(3) HCl 6N	(4) H_3PO_4 9N	(1) KOH 4%	(2) NaOH 4%	(3) HCl 6N	(4) H_3PO_4 9N
Moisture	WW	14.69	8.93	10.78	15.93	12.77	7.65	10.78	13.00	14.59	8.64	10.42	15.85
	DW	—	—	—	—	—	—	—	—	—	—	—	—
Protein	WW	46.88	65.13	26.75	16.13	33.89	52.75	26.75	15.50	21.94	48.79	21.35	13.63
	DW	54.95	71.52	29.98	19.16	38.85	57.12	29.98	17.82	25.69	35.40	23.83	16.20
Fat	WW	0.77	0.75	1.15	0.59	1.00	0.39	1.15	0.74	0.91	0.84	1.26	0.69
	DW	0.90	0.82	1.29	0.70	1.15	1.01	1.29	0.85	1.07	0.92	1.41	0.82
Ash	WW	31.03	18.63	54.60	60.54	45.76	32.15	54.60	64.10	55.62	34.88	60.15	62.73
	DW	36.37	20.55	61.18	72.01	52.46	34.81	61.18	73.68	65.12	38.18	67.15	74.55
Carbohydrates	WW	6.63	6.56	5.72	6.81	6.58	6.52	5.72	6.66	5.94	6.85	6.82	7.10
	DW	7.78	7.11	7.55	8.10	7.54	7.06	7.55	7.65	8.12	7.5	7.61	8.43
Energy Value (Cal / 100g)	WW	220.97	293.51	144.23	97.07	170.88	245.45	144.23	95.30	123.71	230.12	124.02	89.13
	DW	259.02	321.90	161.73	115.46	195.91	265.81	161.73	109.53	144.87	251.88	138.45	105.90
Yeild of dried product (g/ 100g)		118.49	115.25	119.42	143.26	123.15	117.32	136.59	165.38	166.27	134.28	142.95	182.95
Colour of meal		Light yellow	Light yellow	Dark Yellow	Dark Yellow	Light yellow	Light yellow	Dark Yellow	Dark Yellow	Light yellow	Light yellow	Dark Yellow	Dark Yellow
Flavour of meal		Glue	Glue	Glue	Glue	Glue	Glue	Glue	Glue	Glue	Glue	Glue	Glue

(1) Neutralization carried out by orthophosphric acid.
(2) Neutralization carried out by Hydrocholoric acid.
(3) Neutraliztion carried out by Sodium hydroxide.
(4) Neutralization carried out by potassium hydroxide.

Table 4. Means(+) of the chemical analysis of the chickens , geese and ducks feathers treated by NaOH 4%

Chemical Composition	Wet weight			Dry weight		
	chicken feather meal	Geese feather meal	Ducks feather meal	chicken feather meal	Geese feather meal	Ducks feather meal
Number of replicates	5	5	5	5	5	5
Moisture	8.93	7.96	8.64	—	—	—
protein	65.13	52.75	48.79	71.52	57.12	43.40
Fat	0.75	0.93	0.84	0.82	1.01	0.92
Ash	18.63	32.15	34.88	20.55	34.81	38.18
Carbohydrates	6.56	6.52	6.85	7.11	7.06	7.5

(+) All Mean squares of ANOVA are highly significant ($P< 0.01$)

lowest in ash. Differences between perocentages of HFM components were significant as indicated by statistical analysis given in Table 4.

As HFM of chicken of treatment 2 is the most important, calcium and phosphorus were determined in such meal Table 5. The mentioned HFM had 0.28% Ca and 0.49 P. These percentages are somewhat lesss than the analyzed FM as given by NRC.

b - Amino acid composition

Table 5. Calcium and phosphorus contents (%) of HFM prepared of chicken feather by NaOH HCl treatment.

Minerals	%
Calcium	0.28
Phosphorus	0.49

The nutritional value , based on the contents of the essential amino acid (EAA) composition of HFM of chicken goose and duck prepared by the four methods of hydrolysis Table 6 confirmed the superiority of second treatment which followed by the first, third and finally the fourth treatment . The influence of feather source on amino acids concentration was the same as checked before and after hydrolysis For example leucine (9m/16 g N), before and after hydrolysis was highest for chicken , followed by duck and goose Table 2 and 6.

Hydrolysis is indispensable to digestibility of keration (Liberman and Petrovski 1973) but it caused marked damage of amino acid, being less when using alkalines (and particulary NaOH) than the acids Table 6. The acid hydrolysis seems to destroy tryptophan completely. When compared with the FAO pattern, untreated feathers Table 2 were low in two amino acids (AA) only , i.e. tryptophan (first limiting AA) and lysine (second limiting AA). But after hydrolysis, as inidcated by the A. S. value , the protein of HFM was deficient in 6 to 8 EAA. For KOH, HCl and H_3PO_4 (Treatments 1,3 and 4 resp.) the protein was deficient in all EAA (8 acids) . In the case of NaOH hydrolysis (Treatment 2) the protein was deficient in 8 acids for ducks HFM and 7 acids for geese HFM but for chicken HFM, protein was low in 6 acids only . For the latter HFM, first limiting, second limting and third limiting amino acids were lysine, threonine and tryptophan resp. A.S. value were highest for Na OH chickens HFM, when compared with similar products of geese and ducks feathers (only phenylalanine + tyrosine showd same A. S. value). Therefore, NaOH hydrolysis (Treatment 2) particularly when chicken HFM was concerend , was the best treatment from the nutritional value view's point.

Finally , it might be concluded that because of high protein content , high energy and best amino acid compostion, treatment 2 (NaOH hydrolysis), especially when using chicken feathers was the best method for obtaining HFM of high nutritional value as possible. Fortunately feathers are more available because of raising more chicken than geese or ducks in Egypt , and distribution of automatized slaugther houses for chicken is a real fact in the last decade.

Table 6. Amino acid compostion and amino acid score of hydrolysed meal from chicken , goose and duck feathers after alkaline and acid hydrolysis

Amino acid Composition	FAO reference protein (g/16g N)	Hydrolyzed meal from chicken feather											
		(1) KOH 4%			(2) NaOH 4%			(3) HCl 6 N			(4) H_3PO_4 9N		
		g/16 gN	* A.S	g/100 g	g/16 gN	* A.S	g/100 g	g/16 gN	* A.S	g/100 g	g/16 gN	* A.S	g/100 g
Leucine	7.0	6.03	0.86	2.82	6.54	0.93	4.26	3.15	0.50	2.83	2.83	0.40	0.46
Isoleucine	4.0	3.73	0.93	1.75	4.04	1.01	2.63	2.17	0.54	1.75	1.75	0.44	0.23
Phenylalnine		1.96		0.92	2.01		1.31	1.41		0.56	0.56		0.09
Valine	5.0	2.49	0.50	1.17	2.65	0.53	1.73	1.86	0.37	0.62	0.62	0.12	0.10
Methionine		0.31		0.15	0.38		0.25	0.23		0.18	0.18		0.03
Methionine+Cystine	3.5	2.87	0.82	1.35	4.08	1.17	2.66	1.12	0.32	0.75	0.75	0.21	0.12
Tyroisne		1.53		0.72	1.60		1.04	1.45		0.79	0.79		0.13
phenylalarine+Tyrosine	6.0	3.49	0.58	1.63	3.16	0.60	2.35	2.86	0.48	1.35	1.35	0.23	0.22
Proline		4.45		2.09	4.69		3.05	3.71		0.84	0.84		0.14
Alanine+ glutamic		11.63		5.45	12.89		8.40	9.83		3.54	3.54		0.57
Threonine		1.35		0.63	1.43		0.93	1.03		0.33	0.33		0.05
Glysine + aspartic	4.0	12.43	0.34	5.83	13.56	0.36	8.83	8.15	0.26	2.75	2.75	0.08	0.45
Serine		4.58		2.15	4.90		3.19	2.35		0.68	0.68		0.11
Arginine		2.47		1.16	2.76		1.80	1.25		0.63	0.63		0.10
Histidine		0.93		0.44	0.99		0.65	0.62		0.23	0.23		0.04
Lysine		0.86		0.40	0.91		0.59	0.56		0.36	0.36		0.06
Cystine													
Tryptophan	5.5	2.58	0.16	1.20	3.70	0.17	2.41	0.89	0.10	0.27	0.57	0.07	0.09
	1.0	0.28	0.28	0.13	0.39	0.39	0.25	—	—	—	—	—	—

Table 6. Cont.

Amino acid Composition	FAO reference protein (g/ 16g N)	Hydrolyzed meal from chicken feather											
		(1) KOH 4%			(2) NaOH 4%			(3) HCl 6 N			(4) H_3PO_4 9N		
		g/16 gN	* A.S	g/100 g	g/16 gN	* A.S	g/100 g	g/16 gN	* A.S	g/100 g	g/16 gN	* A.S	g/100 g
Leucine	7.0	5.15	0.74	1.75	1.75	0.81	3.00	0.74	0.43	0.74	2.32	0.33	0.36
Isoleucine	4.0	3.19	0.80	1.08	3.15	0.88	1.85	0.46	0.46	0.46	1.44	0.36	0.22
Phenylalanine		1.65		0.56	1.78		0.94	0.33		0.3	0.49		0.08
Valine	5.0	2.61	0.43	0.73	2.43	0.49	1.28	0.43	0.35	0.43	0.59	0.12	0.09
Methionine		0.29		0.10	0.32		0.17	0.05		0.05	0.11		0.02
Methionine+Cystine	3.5	2.59	0.74	0.88	3.83	1.09	2.02	0.24	0.28	0.24	0.64	0.18	0.10
tyroisne		1.45		0.49	1.86		0.98	0.39		0.39	0.86		0.13
phenvlalnine+Tyrosine	6.0	3.10	0.52	1.05	3.64	0.61	1.92	0.72	0.48	0.72	1.35	0.23	0.21
Proline		4.53		1.54	4.77		2.52	0.94		0.94	0.83		0.14
Alanine+ glutamic		11.78		3.99	12.92		6.82	2.82		2.28	3.24		0.50
Threonine		1.64		0.56	1.87		0.99	0.29		0.29	0.39		0.06
Glysine + aspartic	4.0	12.15	0.41	4.11	12.48	0.47	6.77	1.90	0.29	1.90	2.64	0.10	0.41
Serine		5.72		1.94	5.83		3.08	0.62		0.62	0.72		0.11
Arginine		2.85		0.97	2.91		1.54	0.33		0.33	0.69		0.11
Histidine		0.86		0.29	0.93		0.49	0.14		0.14	0.18		0.03
Lysine		0.78		0.26	0.85		0.45	0.11		0.11	0.19		0.03
Cystine													
Tryptophan	5.5	2.30	0.41	0.78	3.51	0.15	1.85	0.19	0.08	0.19	0.53	0.03	0.08
	1.0	0.19	0.19	0.06	0.25	0.25	0.13	—	—	—	—	—	—

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Table 6. Cont.

Amino acid Composition	FAO reference protein (g/ 16g N)	Hydrolyzed meal from chicken feather											
		(1) KOH 4%			(2) NaOH 4%			(3) HCL 6 N			(4) H_3Po_4 9N		
		g/16 gN	* A.S	g/100 g	g/16 gN	* A.S	g/100 g	g/16 gN	* A.S	g/100 g	g/16 gN	* A.S	g/100 g
Leucine	7.0	5.89	0.84	1.29	6.25	0.89	3.05	3.44	0.49	0.74	2.76	0.39	0.38
Isoleucine	4.0	3.64	0.91	0.80	3.87	0.97	1.89	2.12	0.53	0.45	1.71	0.34	0.23
Phenylalanine		1.92		0.42	1.95		0.95	1.36		0.29	0.35		0.07
Valine	5.0	2.03	0.41	0.45	2.14	0.43	1.04	1.61	0.32	0.34	0.55	0.11	0.07
Methionine		0.24		0.05	0.28		0.14	0.16		0.03	0.09		0.01
Methionine+ Cystine	3.5	2.38	0.68	0.52	3.43	0.98	1.68	1.11	0.32	0.23	0.68	0.19	0.09
Tyroisne		1.51		0.33	1.93		0.94	1.64		0.35	0.91		0.12
phenvlalnine+Tyrosine	6.0	3.43	0.57	0.75	3.88	0.65	1.86	3.00	0.50	0.64	1.44	0.24	0.19
Proline		5.18		1.14	5.57		2.72	4.12		0.88	0.94		0.13
Alanine+ glutamic		11.16		2.45	11.86		5.79	8.31		1.77	2.76		0.38
Threonine		1.23		0.27	1.33		0.65	0.98		0.21	0.27		0.04
Glysine + aspartic	4.0	11.86	0.31	2.61	12.06	0.33	6.08	7.23	0.25	1.54	2.08	0.07	0.28
Serine		4.31		0.95	4.45		2.17	2.19		0.47	0.67		0.09
Arginine		2.96		0.64	3.01		1.47	1.48		0.32	0.78		0.11
Histidine		0.71		0.16	0.76		0.37	0.53		0.11	0.16		0.02
Lysine		0.83		0.18	0.87		0.42	0.51		0.11	0.34		0.05
Cystine													
Tryptophan	5.5	2.14	0.15	0.47	3.15	0.16	1.54	0.95	0.09	0.20	0.59	0.06	0.08
	1.0	0.16	0.16	0.04	0.19	0.19	0.09	—	—	—	—	—	—

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الإستفاده من ريش الدواجن في الطعام وفي العلائق: ١- التركيب الكيماوي وتركيب الأحماض الأمينية للريش ولمسحوق الريش المحلل (ر.د.م)

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أجري تقييم لريش ولمسحوق الريش المحلل (ر.د.م) للدجاج والأوز والبط وقد تم تجهيز (ر.د.م) بالتحليل المائي القلوي باستخدام بوايد (معامله ١) أو ص أيد (معامله ٢) ، بينما أجري التحليل المائي الحامضي باستخدام حامض يد كل (معامله ٣) أو حامض الارثوفوسفوريك (يد $_٣$ فوأ$_٤$) - معامله ٤ وقد أجري التسخين أثناء التحليل المائي القلوي أو الحامضي تحت الضغط الجوي العادي. وبعد التحليل المائي تمت المعادلة يليها التجفيف تحت تفريغ.

وقد كان الريش غنيا بالبروتين الذي كان ٩٣,٥٤ - ٩٥,٩٥٪ من المادة الجافة (٨٢,٢١ ٪ ٨٣,٧٧). من العينه الرطبة) . وأتضح أن ريش الدجاج يحتوي علي أعلي نسبة من البروتين . كما وجد أن بروتين أنواع الريش المختلفه كان غنيا بشكل ملحوظ في السستين والسيرين والبروليسن والفالين والليوسين والمثيونين + ستين ولكن عند المقارنه بالبروتين النموذجي لهيئة الأغذية والزراعة كان بروتين الريش ناقصا في الليسين والتربتوفان.

والتحليل المائي القلوي وخاصة باستخدام ص أيد (معامله ٢) سبب أقل هدم في الأحماض الأمينية الأساسية بالمقارنة بالتحليل الحامضي الذي علي ما يبدو أدي إلي هدم كامل للتربنوفان . كما أن مسحوق الريش المحلل الناتج من المعامله ٢ كان يحتوي علي أعلي نسبه من البروتين والطاقة وأقل نسبه من الرماد. وفي حالة ريش الدجاج فان هذه المعامله أدت إلي الحصول علي أفضل مسحوق ريش محلل نتيجة احتواء المسحوق علي أعلي نسبه بروتين ٧١,٥٢ ٪ وأعلي مستوي للطاقة ٣٢١,٩٠ كالوري / ١٠٠جم) وكان مقدار المسحوق الناتج ١١٥٪ من وزن الريش المستخدم علاوة علي ذلك فقد تبين أن لبروتين مسحوق ريش الدجاج المحلل في المعامله ٢ أفضل تركيب للأحماض الأمينيه الأساسية عند المقارنة بالبروتين النموذجي لهيئةالأغذية والزراعة بالاضافة إلي أن تركيز الأحماض الأمينه في المسحوق نفسه (جم/١٠٠ جم عينه) كان أعلي منه في باقي العينات.