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The Biological Value of Blood and Feather Meal Proteins Using Purified Diets on Chickens

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Protein is considered as the most important and expensive part of the diet, its supplementation in poultry rations should be chosen carefully, specially for its biological value and price.

Protein evaluations were carried out with chicks to elucidate certain problems encountered in earlier studies.

The following items were recorded:

1. Blood and feather meals were unsatisfactory supplements in the purified diets as the sole protein source for chicks.

2. Feather meal gave the lower digestibility values, net protein utilization, biological value and protein efficiency as compared to albumin, casein, blood meal and dried skinmilk.

3. Net gain in weight per chick was negative in case of supplementing the rations for both F.and R.I.R.chicks with either blood meal or feather meal.

4. Nitrogen balance method gave higher values than the modified one and this may be due to the reagent used in separating urinary nitrogen and faecal nitrogen from droppings.

5. The high mortality rate was found with both F. and RIR chicks fed on blood meal and feather meal proteins as compared to other sources of proteins.

The slaughter houses by-products such as blood and feathers are cheap scurces of animal proteins. Their qualities should be determined before being included in poultry rations. Their digestibilities, net protein utilization and biological value would be useful guide for practical application.

Therefore, this work was undertaken to study the feeding qualities of blood meal and feather, when fed under local conditions to poultry.

Farbs and Yohe (1955) found that the NPU of commercial blood fibrin at 100% level to young albino rats was 76.6% $\pm$ 1.57 by the Thomas Mitchel nitrogen balance technique. A shorter method employing carcass analysis yielded results of 77.2 1.83, when carcass nitrogen was determined directly and 80.8 $\pm$ 2.88 when carcass nitrogen was calculated from carcass water analysis and predetermined N/H_2O.

Although Summers *et al.*, (1965) reported that blood meal gave very low NPU, yet El Zeiny, (1969) in his trials with rats on blood meal, found negative BV and NPU although the true digestibility of protein was 83.19 ± 4.17. He concluded that results concerning the biological value of blood meal consistently, indicated that such local by-products had a deleterious effect on growth despite its relatively high digestibility.

Ewing (1963) stated that nitrogen retention studies showed that chicks receiving feather meal suppliemented rations, retain ingested nitrogen as well as chicks fed protein from other sources. Edward *et al.* (1961) concluded that experimental processing of feathers for meat production showed that the method employed affects the nutritive value of the product. Stmmers *et al.*, (1965) reported that feather meal alone did not improve NPU. In the practical diet of maize and soybean, 3% extra protein from meat meal was as 3% from soybean.

It was clear that some points regarding the feeding qualities of blood meal and feather were still obscure particularly with poultry.

Material and Methods

Experimental birds

Chicks were chosen from the flock of the Experimental Station of Animal Nutrition Section, Faculty of Agriculture, Cairo University, in the hatching season, 1969. The number of chicks was 90 Fayoumi (F) and 90 Rhode Island Red (RIR) 7 days old chicks. The experiment lasted for 10 days. Chicks of every breed were divided into 6 groups of 15 of nearly equal live weights.

Birds were kept under similar conditions of management. They were under close veterinary supervision and kept in warm brooders. At the end of the experiment, chicks were killed and prepared for chemical analysis.

Rations

Table (1) shows the formula and chemical analysis of rations 1, 2, 3, 4, 5, and 6 used for feeding F. and chicks in experiments, mineral and vitamin mixtures were added according to Moran *et al.* (1966) as follows :

Mineral mixture : The following were added in g per kg of complete ration :— Ca_3 (PO_4), 8.5 ; KH_2PO_4, 12.0 ; NaCl, 4.0 ; $CaCO_3$, 19.0 ; $CaCl. 6H_2O_4$ 0.02 ; $MnSO_4$ 2 : 5 ; $FeSO_4$ 0.1 ; $Mn SO_4. H_2O$, 0.2; KI, 0.006; $CuSO_4$ 0.012 ; ; $ZnCO_3$, 0.2 ; Na_2MoO_4, $2H_2O_3$ 0.01.

Vitamin mixture : The following were added per kg of complete ration : Thiamin HCl, 20mg ; riboflavin, 12 mg. ; Ca pantothenate 20 mg ; pyridoxine HCl, 6mg ; biotin, 0.3mg menadione, 4 mg ; vitamin B_{12} 0.0 2mg ; ascorbic

acid. 150mg ; niacin, 60 mg , folic acid, 3mg ; vitamin A, 5,000 I.U, vitamin D_3, 595 I.C.U. ; vitamin E, 7.5. I.U. Colaine, 1, 300 mg .; proceoine penicilline, 6.4 g.

TABLE 1. **Formula and chemical analysis of purified diets.**

Items	Ration No. and protein source					
	Ration 1 NFD	Ration 2 albumin	Ration 3 casein	Ration 4 blood meal	Ration 5 dried skimmilk	Ration 6 feather-meal
	%	%	%	%	%	%
Ingredients						
Starch	68.00	49.60	49.28	51.20	27.00	51.44
Glucose mono-hydrate	17.00	12.40	12.32	12.80	6.80	12.76
Corn oil	4.00	4.00	4.00	4.00	4.00	4.00
Sawdust	5.00	5.00	5.00	5.00	5.00	5.00
Source of animal protein	Zero	23.00	23.40	21.00	51.00	20.00
Mineral mixture .	5.80	5.80	5.80	5.80	5.80	5.80
Vitamin mixture .	0.20	0.20	0.20	0.20	0.20	0.20
Chemical analysis % :						
Moisture	10.97	11.66	10.15	10.79	9.46	9.83
Crude protein . .	0.91	17.08	17.13	17.22	17.17	14.21
Ether extract . .	5.14	4.58	5.32	4.82	4.59	5.19
Crude fiber . . .	3.44	3.90	3.84	4.06	3.63	5.03
Nitrogen free extract	76.36	56.59	56.90	57.16	55.79	57.36
Ash	3.18	6.19	6.66	5.95	9.36	7.88
Calcium calculated %	0.41	0.41	0.41	0.42	1.08	0.50
Phosphorous calculated	0.17	0.17	0.17	0.19	0.70	0.16

Regarded in formulating the rations :—

1. Corn oil was added in constant proportions (4%) to all rations.
2. Sawdust was added as a source of fiber in constant proportion (5%).
3. Starch and glucose-mono-hydrate were added at a ratio of 4 : 1 as a source of carbohydrates.
4. Mineral mixture and vitamin mixture were added according to Moran, *et al.*, (1966).

Using the N-free diet enabled to determine total endogenous N needed for maintonance. Albumin and skim milk proteins were used as standard proteins for comparison with blood meal and feather, under the same experimental conditions. For completion milk casein was also tested.

Management

Chicks were raised in electrically heated battaries and each group was fed and watered ad-lib. Feed consumption was recorded daily. Chicks within each group were individually weighed every 3 days through the whole experimental period.

Preparing chicks for analysis

At the end of the experimental period, the food throughs were removed from pens to keep the birds for about 18 hr to empty the alimentary tract from food and residues, water was only offered to chicks.

On the morning of the following day, chicks were weighed, killed by chloroform administration, re-weighed in tares lined with absorbant paper on top of thin polythene sheets. The carcasses were opened up by a knife in a cerain manner to hasten complete srying and to receive any free blood or fluids in the body comty. The gizzards were found to be vertually empty. All the carasses were dried in forced air-draught oven at 95°C until constant dry-weight was reached (about 72 hr). From the difference between final dead-weight and the dried veight, the body-water content was obtained. The dried carcasses or chicks were analysed individually.

Determination of biological value of proteins

1. *True digestibility* (D)

The true digestibility is defined as the truly absorbed nitrogen as percentage from nitrogen intake, as shown in the following formula according to Mitchell, (1924) :

$$D\,\% = \frac{NI-(FN-MFN)}{NI} \times 100$$

2. *Biological vaule : BV*

The biological value is defined as the truly retained nitrogen as percentage from the truly absorbed nitrogen, (Mitchel, 1924) as follows :

$$BV\ \% = \frac{NI-[(FN-MFN)-(UN-EUN)]}{NI-(FN-MFN)} \times 100$$

3. *Net protein utilization :* NFU

The NPU was determined by three methods

a) *Nitrogen balance method*

It was calculated according to Mitchell, (1924) using the following formula :

$$NP\ \% = \frac{NI-[(FN-MFN)-(UN-EUN)]}{NI} \times 100$$

Where : NI = nitrogen intake.
FN = faecal nitrogen.
UN = urinary N.
MFN = metaboiic faecal nitrogen.
EUN = endogeneous urinary nitrogen.

FN was seperated from UN using the method of Jakobsen *et al.*, 1960, using trichloracetic acid. Total endogenous N (EUN + MFN was that in the excreta when using N-free diat. ENU was found to be 0.183g/one kg metabolic body size $W_{kg}^{\ 7}$ with F being 0.099 with R.I.R. The MFN was found to be 0.573 gN/kg food for F and 2.1739 with R.I.R.

b) *Carcass retention method*

Bender and Miller, (1953) had desenibed a method for determining the nitrogen retained which was called the method of net protein utilization. In their method they used to feed two groups of animals one on the tested ration and the other on a nitrogen free diet (NFD) or having low level of nitrogen. They gave the following formula for calculating the NPU.

$$NPU\ \% = \frac{B_f - B_k + I_k}{I_f} \times 100$$

where : B and I denotes carcass nitrogen and nitrogen intake in the tested diet, and B_k and I_k denotes carcass nitrogen and nitrogen intake in the nitrogen free diet, NFD.

c) *NPU m modified*

Abdel Salam, (1964) suggested a modified procedure for determining the NPU by carcass analysis :—

$$\text{NFU m} = \frac{N_f}{I_f}$$

Where N_f = Nretained for growth and maintenance
I_f = Nintest protein ration.

Results and Discussion

True digestibility (D)

The true digestibility of proteins in the experimental rations as obtained by correcting the amount of the metabolic faecal nitrogen excretion : $(N_1\text{-}(F\text{-}M))$ and calculating the percentage of the nitrogen intake that has been truely absorbed. Tables 2 and 3 show the data necessary for these calculations with F. and R.I.R. chicks respectively.

TABLE 2. **The mean true digestibility (D) biological value (BV)and Net protein utilizaton (NPU) of different proteins fed to Fayoumi chicks.**

Ration No.	1	2	3	4	5
Source of animal protein	Albumin	Casein	Dried blood	Dried skimmilk	Feather-meal
Items					
Dietary crude protein (N × 6.25)	17.08	16.82	17.22	17.18	14.35
Nitrogen intake mg	2178	1888	875	2882	818
True absorbed nitrogen mg .	2136	1885	859	2856	648
True retained nitrogen mg .	2170	1476	711	2889	354
True digestibility (D) % . .	98.09	98.78	98.14	99.08	57.17
Biological value (B.V.) % . .	100.00	79.07	82.76	100.00	75.63
(NPU) by nitrogen balance %	99.63	78.16	81.22	100.00	43.24
(NPU) by carcass analysis %	45.50	36.75	9.83	15.85	15.35
(NPU) modified	50.26	40.62	10.29	18.61	14.74

Metabolic faecal nitrogen = 0.573 g per kg food intake on dry matter basis
Endogeneous urinary nitrogen = 0.183 g per 0.75 per day.

TABLE 3. The mean true digestibility (D), biological value (B.V.) and net protein utilization (NPU) of different proteins fed to R.I.R chicks.

Ration No.	1	2	3	4	5
Source of animal protein	Albumin	Casein	Dried blood	D. Skim milk	Feather meal
Items					
Dietary crude protein (N × 6.25) %	17.08	16.82	17.22	17.18	14.35
Nitrogen intake mg	2173	2222	1075	2179	1177
True absorbed nitrogen mg .	2273	2314	1130	2294	880
True retained nitrogen mg .	1771	1962	925	1804	815
True digestibility (D) % . .	100.00	100.00	100.00	100.00	74.76
Biological value (B·V.) % . .	76.57	84.81	81.81	78.62	92.64
(NPU) by nirogen balance %	81.48	88.31	86.00	82.76	69.25
(NPU) by carcass analysis %	46.20	36.77	8.56	24.19	2.38
(NPU) modified %	54.95	41.18	9.72	27.81	11.30

Metabolic faecal nitrogen = 2.173 g per kg food intake (DMB).
Endogeneous urinary nitrogen = 0.099 g per 0.75 per day.

It was found that high digestibility values recorded for albumin, casein, bloodmeal and dried skimmilk, but feather meal gave the lower digestibility value as compared to the former proteins.

Results with F. chick, indicated that there was a good agreement among the different proteins (ranged between 98.14-99.08%) with blood meal and Skimmilk respectively, except with Feather meal (57.17).

The true digestibility with R.I.R. were 100% different proteins, while it was lower with feather meal (74.76 %).

The lower digestibility obtained here with feather meal was also found by Naber *et al.* (1961) who claimed that feather meal as primary source of protein for the chicks in practical rations was never as good as comparable corn-soya bean meal diets, regardless of amino acids supplementation. They reported that not the feather meal protein was imbaland with respect to the chick's requirement for amino acids but also it was poorly absorbed.

The bological value (BV)

The obtained biological values of experimental diets for F. chicks were 100, 79.07, 82.76, 100 and 75.63 % for albumin, casein, blood meal, dried skimmilk and feather meal respectively. The corresponding figures for R.I.R. chicks were 76.57, 84.81, 81.81 78.62 and 92.64 % respectively.

In this connection, John *et al.* (1934) pointed out that the biological value of proteins decreased somewhat as the level of total protein in the ration increased. At 13%protein level, the BV value exhibled (78.68-88.00%) but at 15 % the BV was from (29.74-88.46 %) to (57.54-83.03 =) at 24 % level. Michel (1943) suggested that the protein level in the diet should be just adequate to cover the nitrogen requirements of the animal to promote an optimal nitrogen retention in the body. The level of 10% crude protein, suggested by Mitchel for the conventional determination of BV value using the rat as the experimentall animal has been adopted by other workers for a wide variety of feeds and animal proteins. In this study, the BV values obtained were at a suitable level 14.35-17.22% crude protein.

Net protein utilization (NPU)

Generally, there was agreement NPU values obtained by either Bender and Miller equation or the Abdel Salam's modified one. Nitrogen balance method gave higher values than the latters. It was suggested that these differences resulted primarily from a somewhat lower protein intake . Therefore, better utilization was due to the equalized feeding practice with the nitrogen balance method. NPU of albumin using the three methods (Mitchell, 1924; Bender and Miller, 1953; and the modified method by Abdel Salam, (1964) was 99.63, 45.50 and 50.26% by F. chicks, and 81 48, 46.20 and 54.95%by R.I.R. chicks, The NPU of casein by the corresponding methods was 78.16, 36.75 and 40.62 % by F. chicks and 88.31, 36.77 and 41.18 % by R.I.R. chicks. Dried skimmilk gave lower results of NPU by using Bender and Miller and modified method being 15.85 and 18.61 by F. chicks, and 24.19 and 27.81 % by R.I.R. chicks. However, it gave higher (NPU) values by using Mitchell method being 100 % by F. chicks and 82.76 % by R.I.R. chicks.

Blood meal gave 81.22, 86.00 % NPU values by F. and R.I.R. chicks respectively when Mitchell method was followed. These values decreased greatly when the other methods were followed. Values were 9.83 and 10.29 % for F. chicks, and 8.56 and 9.72 % for R.I.R. chicks by using Bender and Miller and modified method respectively.

However, feather meal gave NPU values of 43.24 15.3. and 14.74 for F. chicks, and 69.25, 2.38 and 11.30% for R.I.R. chicks by using the three methods respectively.

The lower NPU values obtained when blood meal and feather meal were used, may be due to the deficiency of some limiting amino acids. Such lower values might be also due to the unpalatability of meals and the unvariability of some amino acids in them.

These results indicated that NPU value caried according to the method followed in its calculation. The NPU had recorded the highest figures when the low nitrogen ration was taken as a reference (Abou-El-Hassan *et al.* (1970). The least figures of the NPU were recorded when NFD was used as reference. It was concluded that nitrogen balance method gave higher value than the modified one and this may be due to the reagent used in preparing urinary nitrogen and faecal nitrogen from droppings.

The mortality rate

Results in Table 4 indicated that the most outstanding feature of these results within both breeds was the high morality percentage recorded at the end of experimental period (10 days) by groups fed on dried blood meal and feather meal as it was respectively 66.7% and 86.7% for the F. chicks and 60.0 %and 40 % for R.I.R. chicks.

In view of the mortality found in this experiment and the vetrinary postmortem examination reporting that the case was probably due to the failure of chicks in assimilating the amounts of protein consumed.

TABLE 4. **The mortality rate of F. and R·I.R. chicks fed semipurified diet containing different sources of animal proteins.**

Ration and group No.	1	2	3	4	5	6
Sources of protein in the ration	NFD	Albumin	Casein	Blood meal	D. Skim-milk	Feather meal
Items						
a) F. chicks						
No. of Chicks . Initial	15	15	15	15	15	15
Final	12	13	15	5	10	2
Mortality % . .	20.0	13.3	Zero	66.7	33.3	86.7
b) R.I.R. chicks :						
No of chicks Initial	15	15	15	15	15	15
Final	13	15	14	6	10	9
Mortality % . .	13.3	Zero	6.7	60.0	33.3	40.0

Protein efficiency ratio PER

It can be concluded from the results in Table 5 that there was a marked increase of protein consumed in case of albumin, casein and dried skimmilk by the two breeds, F. and R.I.R. chicks ranged between (11.8 to 18.0 g). However there was a marked decrease of protein consumed in case of blood meal and feather meal in the two breeds which ranged between (5.1 to 7.4 g). It appeared that when either blood or feather meals were supplemented in the rations of growing chicks food (protein) consumption was depressed. It was worthy to notice that chicks lost their appetite after the first few days of being fed one the experimental rations.

It could be seen from these results that albumin and casein gave good results for the two breeds. Net gain per chick was negative in case of supplementing the rations of both breeds with either blood meal or feather meal.

TABLE 5. Protein efficiency ratio (PER), net protein retention (NPR) and feed efficiency (FE) for both F. and R.I.R. chicks for rations supplemented by different sources of animal proteins

Items	Albumin 1	Casein 2	Dried blood 3	Skimmilk 4	Feather meal 5
F. chicks					
Net gain/chick g	15.3	9.9	—7.5	3.0	—4.5
Protein consumed g	13.6	11.8	5.5	18.0	5.1
(PER)	1.12	0.84	—1.33	0.17	—0.88
(NPR)	2.11	1.70	0.15	1.11	0.77
(F.E.)	0.19	0.14	0.14	0.03	—0.13
R.I.R. chicks					
Net gan/chick g	17.4	11.6	—4.6	5.4	—7.8
Protein consumed g	13.6	13.9	6.7	13.7	7.4
(PER)	1.28	0.84	—0.68	0.39	—1.05

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القيمة الحيوية لبروتين الدم والريش باستعمال عليقة خالية من النتروجين مع الكتاكيت

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يعتبر البروتين أهم وأغلى جزء فى العليقة . لذا لابد من اختياره بعناية عند اضافته لعلائق الدواجن نظرا لقيمته الحيوية وارتفاع ثمنه .

ان تقييم البروتين بواسطة الكتاكيت يحل كثيرا من المشاكل فى الدراسات الحالية وقد سجلت النقاط الاتية :ـ

(١) اذ ظهر أن أضافة الدم المجفف والريش للعليقة الخالية من النتروجين كمصدر وحيد للبروتين غير مرضى .

(٢) أعطى الريش قيمة هضمية وقيمة حيوية ومعدل استفادة من البروتين أقل عند مقارنته بالالبيومين ، الكازين ، والدم المجفف .

(٣) كان النمو المكتسب يوميا سالبا مع كتاكيت الفيومى وكتاكيت الرودايلاند رد فى حالة أضافة الريش والدم المجفف .

(٤) أعطت طريقة ميزان الازوت قيمة عالية عن الطريقة المعدلة ويرجع هذا للمواد الكيماوية المستعملة لفصل ازوت البول عن ازوت الروث من الزرق .

(٥) وجدت نسبة التفوق فى كتاكيت الفيومى والرودايلاند اعلا عند مقارنة بروتين الريش والدم المجفف بمصادر البروتين الاخرى .