Evaluation of Protein Quality for some Protein FeedstuffsUsing Carcass Technique with Growing Chicks

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Two feeding experiments using 126 Dokkyten-day old male chicks were carried out todetermine the net protein utilization (NPU)value and protein efficiency ratio (PER)of Imported fish meal (IFM) from twodifferent sources (IFM, and IFM.,), localfish meal (LFN) poultry by-products meal (PBPM), decorticated cotton seed mea1(DCSM)rice germ meal (BGM), which bran (WB) andrice bran (RB). Carcass analys19 techniqueaccording to Bender and Miller (1953) andAbdel-Salam (1974) procedures was applied.

The chicks were fed the experimental dietsfor 14 days. The percent of crude protein(CP) and the calculated metabolizable energy (ME kcal/kg. diet) values of the dietsinvolved in experiment I (Exp. I) rangedbetween 10.62% and 10.77 % and 3527 kcal.ME and 3533 kcal.ME/kg.diet, respectively.

The corresponding values of the diets usedin Exp.2 ranged between 10.60% and 10.65 %(CP) and 3324 kcal. ME and 3351 kcal.ME/kg.diet , respectively.

The results of Exp. I showed that NPU values of IFM_1, LFM, PBPM , DCSM and RGM by applying Bender and Miller (1953) formula were : 84.10 , 64.33 , 55.10 , 32.28 and 52.28 %. While in Exp.2 the NPU values were 43.52,43.51 & 35.54% for IFM_2,WB and RB,respectively . The corresponding NPU values obtained by using Abdel-Salam (1974) formula were 93.00 , 73.42 , 65.38 , 45.38 and 63.30 % in Exp.I, while they were : 53.16, 53.73 and 44.86% in Exp.2, respectively . The PER values of the above mentioned feedstuffs were : 2.98 , 2.32, 1.91 , 1.35 and 1.48 in Exp. I , while they were : 1.29, 1.25 and 1.23 in Exp.2, respectively . The IFM_1 resulted in the highest NPU and PER values, while DCSM gave the lowest NPU value in Exp. I . In Exp.2 RB showed the lowest PER value. In the same time, LFM maintained satisfactory values for protein quality . It was also concluded that body nitrogen may be predicted precisely from the values of the water content of the carcass.

The net protein utilization (NPU) value indicates the fraction of the total nitrogen intake which is retained in the body and that used for maintenance . It is , therefore , the product of true digestibility and biological value (Mitchell et al., 1936) . The net protein utilization is the most convenient term which evaluates proteins by carcass nitrogen retention procedures with chicks . This method obviates the necessity of separating faecal and urinary nitrogen excretions which is essential for the biological value and digestion coefficient.

Net protein utilization value gives an overall picture of the factors affecting protein quality . However, if one has to use the method proposed by Bender and Miller (1953), he must first confirm that body analysis and nitrogen balance methods lead to the same result. Becker and Harnisch (1958) showed that in the chick and in the pig,

the results given by the nitrogen-balance and body analysis methods agreed closely . Similar results were obtained by DeMueleneare et al.,(1960) and Chalupa and Fisher (1963) by using rats and chickens .

Bender and Miller (1953) and Miller and Bender(1955) have employed the carcass method to determine the N.P.U. of food proteins using the following formula :

$$N.P.U. = \frac{B_f - (B_k - I_k)}{I_f} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where B_f and B_k are the total body nitrogens of the animals on the test and non-protein diets , respectively and I_k and I_f are the nitrogen intakes on the two diets. The formula is based on the assumption that (a) the nitrogen loss in an animal fed a non-protein diet will represent the body nitrogen loss equivalent to the maintenance requirements, (b) the traces of nitrogen in the non-protein diet is utilized with 100 percent efficiency.Later, Bender and Doell (1957) questioned the formula and the assumption of 100 percent utilization of traces of nitrogenous compounds in the non-protein diet and therefore suggested an alternative formula :

$$N.P.U = \frac{(B_f - B_k)}{I_f - I_k} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

where B_f , B_k , I_f and I_k have the same significance as in equation (1) .

Abdel-Salam (1974) suggested a modified procedure for determining the NPU by carcass analysis to eleminate the variable body size of the chicks being fed the nitrogen-free diet and those fed the test protein sources for maintenance nitrogen . The nitrogen used for growth was obtained from the difference between initial and final carcass

nitrogen contents . The maintenance nitrogen was obtained from the difference between initial and final carcass nitrogen contents of the chick fed the nitrogen-free diet plus the amount of nitrogen consuned in the latter diet. As the maintenance requirement is related to metabolic body size , e.g., $W_{kg}^{0.75}$, the maintenance nitrogen for each bird was calculated from its live-weight. This corrected maintenance nitrogen was added to that retained and used for growth and the total amount of nitrogen utilized was divided by the amount of nitrogen intake during the same period to obtain NPU value .

In view of the advantage of applying the carcass method when evaluating protein feedstuffs by chicks , it was decided to determine their NPU values according to Bender and Miller (1953) and Abdel-Salam (1974) procedures . In addition, the body-water nitrogen relationship and its application in carcass analysis was also investigated .

Materials and Methods

A number of 250 one-day old Dokky$_4$ male chicks was fed a commercial chick diet containing 20% CP and 2850 Kcal. ME/kg. diet for 9-day after which they were fasted for 18 hours before weighing . A number of 140 chicks was distributed for 10 groups of similar average live weight for each group . Each group contains two replicates of 7 chicks each. The experimental chicks were treated as follows to determine NPU values of 5 protein feedstuffs in Exp.1 and another 3 feedstuffs in Exp. 2 :

(a) A group of 14 chicks(10-day old) were killed by chloroform administration for carcass analysis to obtain initial body nitrogen and moisture contents .

(b) Nine groups of 126 chicks were housed in commercial batteries and fed ad libitum the experimental diets (Table I) . In Exp. I , the tested feedstuffs were: imported fish meal (IFM_1), local fish meal (LFM), poultry by-products meal (PBPM), decorticated cotton seed meal (DCSM) and rice germ meal (RGM). The IFM_1 was considered as a control diet. The tested feedstuffs in Exp.2 were = imported fish meal (IFM_2), wheat bran (WB) and rice bran (RB). In order to accomodate the low-protein WB and RB , a dietary modification was required and it was decided to test mixtures having a total protein content of 10% obtained by combining 5% of gelatin protein with 5% of protein from materials under test (Table I) . In effect the gelatin was a poor protein and resulting NPU value must be considered as a measure of the ability of the tested low-protein materials to complement a particularly poorly balanced protein (Woodhnm et al., 1972). The IFM_2 + gelatin was considered as a modified control in Exp.2 . The ninth group was fed a nitrogen-free diet (NFD) . Scattered food was collected and weighed at 3-day intervals and weekly food intake per each group was recorded . Fresh water was provided in access to the experimental chicks . The experimental period was continued up to 14 days (from 10 to 24-day old) .

At the end of the experimental period, the chicks were fasted for 18 hours and individually weighed . Two chicks round the average live weight of each group were killed by chloroform administration for carcass analysis to obtain final body nitrogen and moisture contents . The carcass analysis was carried out also in the same way for the chicks fed NFD to obtain maintenance nitrogen . Analysis for carcass nitrogen was carried out using the conventional methods of the A.O.A.C.(1980).The data

TABLE 1 . Percentage composition of the experimental diets used in Exp. I and Exp. 2.

Components	Experimental diets								
	Exp.I					Exp.2			NFD 1
	1	2	3	4	5	1	2	3	
	%	%	%	%	%	%	%	%	%
Imported fish meal (IFM_1)	15.20	--	--	--	--	--	--	--	--
Local fish meal	--	23.50	--	--	--	--	--	--	--
Poultry by-product meal	--	--	16.30	--	--	--	--	--	--
Dec. cotton seed meal	--	--	--	24.50	--	--	--	--	--
Rice germ meal	--	--	--	--	60.50	--	--	--	--
Imported fish meal(IFM_2)	--	--	--	--	--	7.60	--	--	--
Wheat bran	--	--	--	--	--	--	37.80	--	--
Rice bran	--	--	--	--	--	--	--	41.30	--
Gelatine	--	--	--	--	--	5.38	5.38	5.38	--
Corn starch	38.00	46.00	56.00	48.00	11.00	54.80	24.78	22.56	66.70
Glucose	7.00	5.00	6.21	5.50	5.00	15.00	5.00	5.00	15.00
Corn oil	7.65	13.44	9.60	12.40	13.62	5.00	18.00	18.00	6.00
Cellulose	4.85	4.76	4.59	2.30	2.38	4.92	1.73	0.46	5.00
Mineral mix.*	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
Vitamin mix.**	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Choline chloride	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Total	100	100	100	100	100	100	100	100	100
Crude protein	10.71	10.72	10.74	10.77	10.62	10.65	10.61	10.60	10.65
Crude fibre	5.00	5.08	5.02	5.10	5.11	5.01	5.10	5.08	5.01
Calc.M.E.(Kcal/kg.diet)	3527	3529	3529	3533	3528	3351	3351	3324	3531

* Each kg. contains : $CaCO_3$ 250 g. ; $Ca_3(PO_4)_2$ 233.33 g. ; K_2HPO_4 150 g ; Na_2HPO_4 121.66 g ; NaCl 146.66 g ; $MgSO_4$ 40.66 g ; $Fe(C_6H_5O_7)_2$ 6.66 g ; $MnSO_4 . H_2O$ 7 g., KI 0.66 g ; $ZnCO_3$ 0.33g; Glucose 42.71 g. ; $CuSO_4.5H_2O$ 0.33 g.

** Each kg. contains : Thiamin HCl 1g ; Riboflavin 1g ; Pyridoxine 1g ; Calcium pantothenate 3g ; Nicotinic acid 5.5 g ; D-Biotin 0.1 g ; Folic acid 0.4 g ; Cyanocobalamin 0.003 g ; Menaphthon 0.06 g . α-tocopheryl acetate (10%) 2.2 g ; Vit. A + D_3 (500 I.U. Vit. A and 100 I.C.U. Vit. D 3) 100 g ; Corn starch 885.737g.

1 NFD : Nitrogen- free diet .

were subjected to analysis of variance (Snedecor and Cochran, 1967) with separation of means by Duncan's(1955) multiple-range test .

Results and Discussion

1. Growth and protein efficiency ratio (PER) values

Experiment I

The mean values for live body weight, relative growth rate (RGR) and protein efficiency ratio (PER) are shown in Table 2. Statistical analysis revealed significant differences ($P < 0.05$) among weight gain and RGR values for the different experimental groups . The contro diet (IFM_1) resulted in the highest RGR % and PER values being 116.25% and 2.98, respectively. Decorticated cotton seed meal (DCSM) showed the lowest corresponding values being 23.88% and 1.35, respectively. The feed intake varied among the different treatments being the lowest for DCSM , a result might be due to its poor palatability when it was given as a sole source of protein in chick diets. In general, chicks consumed relatively larger amounts from the animal protein sources(IFM_1 , LFM and PBPM) in a comparison to the plant protein sourses (DCSM and RGM). In the same time, it is of interest to record that LFM gave reasonable results concerning RGR % and PER being 76.49 % and 2.32, respectively .

Experiment 2:

The mean values for live weight gain, RGR, feed intake and PER for IFM_2 , WB and RB are shown in Table 2 also it was suprising to record that the live body weight gain and relative growth rate values of the modified control diet (IFM_2) was approximately the same as that for RB. Since it is a well known fact that the quality of FM protein

TABLE 2 . Mean live body weight, relative growth rate, feed intake, crude protein intake and protein efficiency ratio for the experimental chicks fed the different experimental diets used in Exp. 1 and Exp. 2.

Items	Experimental diets							
	Exp. 1					Exp. 2		
	IFH_1	LFH	FRFH	DCSH	RGH	IFH_2	WR	BR
Live body weight, g.								
Initial (W_1)	60.3	60.4	60.3	60.3	60.4	60.3	60.4	60.4
Final (W_2)	130.4	106.6	90.0	74.7	80.8	79.9	76.9	79.7
± SE	1.8	2.6	0.9	1.4	0.8	0.9	1.1	1.07
Gain (W_2-W_1)	70.1[a]	46.2[b]	29.7[c]	14.4[e]	20.4[d]	19.7[f]	16.5[g]	19.3[f]
Relative growth rate* %	116.25[a]	76.49[b]	49.25[c]	23.88[e]	33.77[d]	32.72[f]	27.32[g]	31.95[f]
Feed intake, g.	219.68	185.90	144.90	99.23	114.02	143.32	109.88	140.25
Crude protein intake, g.	23.53	19.91	15.56	10.69	13.81	15.26	13.25	15.71
Protein efficiency ratio**	2.98[a]	2.32[b]	1.91[c]	1.35[e]	1.48[d]	1.29[f]	1.25[f]	1.23[g]
± SE	0.12	0.16	0.11	0.20	0.11	0.22	0.14	0.13

* Relative growth rate (RGR) % = $\frac{W_2 - W_1}{W_1} \times 100$, according to Crampton and Lloyd, 1959 .

** Protein efficiency ratio (PER) = $\frac{\text{Live body weight gain (g.)}}{\text{Crude protein intake (g.)}}$.

abcde = Means having the same letters within a row are not significantly different ($P < 0.05$)

fg = Means having the same letters within a row are not significantly different ($P < 0.05$)

(animal protein source) is higher than that of either WB or RB (cereal proteins), it is expected that the live weight gain, RGR and PER values of the modified control (IFM_2) would be higher than that of WB and RB. However, statistical analysis revealed no significant difference between IFM_2 and RB in live weight gain and RGR and between IFM_2 and WB in PER values. Such discrepancy might be due to the possible deterioration in the quality of fish meal protein because of its prolonged storage under uncontrolled conditions . This result is of good agreement with the findings of Carpenter(1973), El-Sherbiny (1976), Abdella (1981) and El-Sherbiny et al.. (1982) .

The low quality of the IFM_2 used in Exp.2 to formulate the modified control diet would not invalidate the result of the present experiment since the main objective of this work is to compare relatively the quality of WB and RB proteins .

The ranking order of the protein quality of the five feedstuffs used in Exp. 1 by live body weight gain, RGR and PER assayes indicated the superiority of IFM_1 followed by LFM , PBPM , RGM and DCSM , descendingly. In Exp. 2, the ranking order of the protein quality of the three feedstuffs used is as follows : IFM_2 , RB and WB (as measured by live body weight gain and RGR) and IFM_2, WB and RB (as measured by PER assay) .

Net protein utilization (NPU)

Experiment I

In the present work it was found that chicks fed the different protein sources had markedly different sizes particularly when compared with those fed nitrogen-free diet. It follows, therefore, that maintenance requirements

would vary widely . It was diserable to apply the modification introduced by Abdel-Salam (1974) to the formula of Bender and Miller (1953) to allow for varying maintenance requirements . Table 3 shows the net protein utilization values for IFM_1 , LFM , PBPM , DCSM and RGM as obtained by using Bender ani Miller (1953) formula and the modified method introduced by Abdel-Salam (1974) The mean values of nitrogen used for maintenance and the nitrogen retained for growth are shown for the five protein sources . Obviously , the modified method for calculating NPU becomes effective when the difference in body size of experimental chicks on the test protein diet is markedly greater than those on nitrogen-free diet (being 45.8 g. as an average live bidy weight of the group of chicks fed the NFD from 10 to 24-day old) .

In general, NPU values obtained by applying the method of Bender and Miller (1953) were consistently lower than those obtained by using Abdel-Salam (1974) formula .

The ranking order of the protein quality of the five protein sources determined by NPU technique was in harmony with the ranking order according to RGR and PER values. The IFM_1 resulted in the heighst NPU value followed by LFM , PBPM and RGM , while DCSM gave the lowest value .

Experiment 2

The value of NPU for IFM_2 , WB and RB are shown in Table 3 . It is clear from the data presented in Table 3 (Exp. 2) that the modified control diet (IFM_2) was rather low than expected since it is impossible for FM^2 to have similar or even lower protein quality value than WB or RB. This might be due to that the IFM_2 used in this experiment was damaged to the extent that it gave a NPU value approximately similar to that for WB. A fact that it must

TABLE 3 . Net protein utilization (NPU) values of the tested feed-stuffs suggested by Bender and Miller (1953) and Abdel-Salam (1974) using carcass technique data .

(Exp. I and Exp. 2)

Items	Experimental diets							
	Exp. I					Exp. 2		
	IFM_1	LFM	PBFM	DCSM	RGM	IFM_2	WP	RB
Dietary crude protein %	10.71	10.72	10.74	10.77	10.62	10.65	10.61	10.60
Nitrogen intake/chick/14days,g.	3.76	3.19	2.49	1.71	2.21	2.44	2.28	2.51
Maintenance N./chick/14days,g.	0.327	0.282	0.248	0.216	0.229	0.227	0.225	0.226
N.retained for growth/chick/14 days, g.	3.17	2.06	1.38	0.56	1.17	1.07	1.00	0,90
N.retained for maintenance and growth/chick/14days, g.	3.497	2.342	1.628	0.776	1.399	1.297	1.225	1.126
NPU% (Bender and Miller,1953)	84.10	64.33	55.10	32.28	52.58	43.52	43.51	35.54
NPU% (Abdel-Salam, 1974)	93.00	73.42	65.38	45.38	63.30	53.16	53.73	44.86

be taken into consideration in using some deteriorated sources of imported fish meal in chicks' feeding . This result confirmed the findings of Carpenter (1973); El-Sherbiny (1976) , Abdella (1981) and El-Sherbiny et al., (1982).

Body water : nitrogen content :

Experiment I

The mean values for contents of water and of nitrogen in carcasses, the water : nitrogen ratio (g. carcass water/ g. carcass nitrogen) and the values for carcass nitrogen estimated from the carcass water data, are all shown in Table 4. It may be seen from the data that the water: nitrogen ratio values varied between the different experimental treatments being the highest for DCSM(23.07) and the lowest for IFM$_1$(15.78). Such variation in carcass water:nitrogen ratio was reported also by Shahein(1970). Abdel-Salam et al.,(1973), Abdel-Salam (1974) and Mady (1977). However, Bender and Miller (1953) found a constant carcass nitrogen : water ratio with rats fed from zero to 20 percent dietary crude protein for 10 days. Summers and Fisher (1961), Summers and Fisher (1962) and Summers et al. (1964) reported a constant water:nitrogen ratio for chicks fed graded levels of crude protein from zero to 26 percent, despite significant changes in moisture, nitrogen and fat contents of the chick carcass .

Fig.1. shows the relationship between total body-water (x) and total body-nitrogen (Y) , both varieties being expressed in grams. The following linear regression equation was obtained, using the method of least squares according to Snedecor and Cochran (1967); to represent the relationship between the weight of water and nitrogen contents of chick carcass at the age of 24 days :

TABLE 4. Carcass nitrogen and carcass water contents together with the water: N ratio for chicks fed different experimental diets from 10 to 24-day old (Exp. I and Exp. 2).

Items	Experimental diets								
	Exp. I					Exp. 2			NFD
	IFM_1	LFM	EEPM	DCSM	RGM	IFM_2	WB	RB	
Chick weight, g.	130.12	106.69	89.98	74.67	80.99	60.18	78.95	79.72	45.23
Water %	57.74	60.35	61.73	66.42	60.36	61.42	62.04	63.61	64.97
Water, g.	75.13	64.39	55.54	49.60	48.89	49.25	48.98	50.71	29.38
Chick weight(DMB*)	54.99	42.30	34.44	25.07	32.10	30.93	29.97	29.01	15.85
Crude protein %	54.09	54.00	53.95	53.50	53.78	53.96	54.08	53.64	60.34
Crude protein ,g.	29.74	22.84	18.58	13.41	17.26	16.61	16.21	15.56	9.56
Nitrogen %	8.65	8.64	8.63	8.56	8.60	8.63	8.65	8.58	9.65
Nitrogen, g.	4.76	3.65	2.97	2.15	2.76	2.66	2.59	2.49	1.52
Water : N ratio**	15.78	17.64	18.70	23.07	17.71	18.52	18.91	20.37	19.33
Estimated N. values*** from water content, g.	4.47	3.72	3.09	2.67	2.62	2.56	2.54	2.63	1.53

* DMB = Dry matter basis .

** Carcass water (g.) + carcass N-(g.).

*** Estimates from the body-water regression .

$$\hat{Y} = 0.0706 \; x - 0.8294$$

where ($\hat{Y}$) is the calculated nitrogen content of the chick carcass in grams and (x) is the water content of the same carcass in grams.

Satistical analysis indicated that the regression of the weight of water on the weight of nitrogen in the chick carcass is significant ($P < 0.05$). It also showed a significant ($P < 0.05$) positive correlation($r=+0.963$) between the carcass and water contents .

Experiment 2 :

The mean values for body-water and nitrogen contents of the individual carcasses together with the body water: nitrogen ratios are shown in Table 4. It could be observed that the values of water: nitrogen ratio for IFM_2 , WB , RB and NFD are very near.

Fig.2. shows the relationship between body water (x) and body nitrogen contents (Y) .A linear relationship was obtained between the two variables and the regression equation $\hat{Y} = 0.0157 + 0.0516$ x was fitted by the method of least squares . The positive correlation ($r= +0.980$) was significant ($P < 0.05$) between the carcass water and nitrogen contents .

It may be concluded that the chick carcass nitrogen may be predicted from the body-water content . This relationship between carcass water and nitrogen obtained in the present study is in good agreement with those reported by Spray and Widdowson (1950), Bender and Miller (1953), Summers and Fisher (1962), Shahein (1970), abdel-Salam et al.,(1973) , Abdel-Salam (1974) and Mady (1977) .

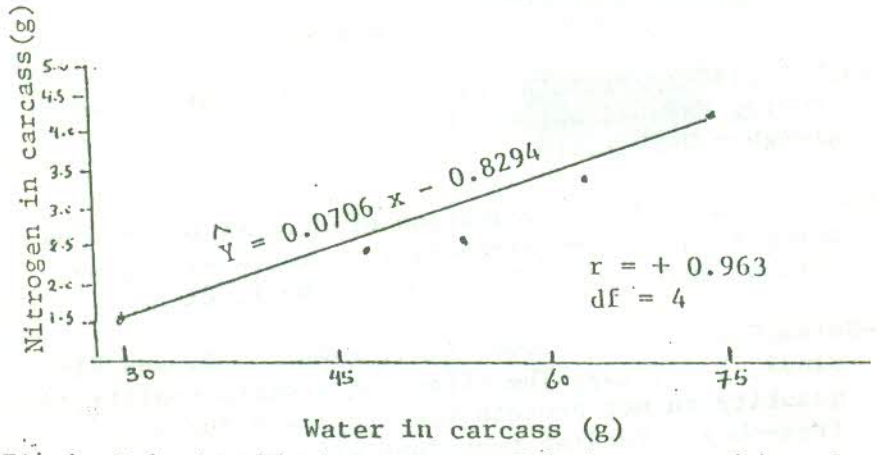

Fig.1. Relationship between total body water (x) and total body nitrogen (Y) in grams per chicks of 24-day old being fed the different experimental diets (Exp.I) , including NFD .

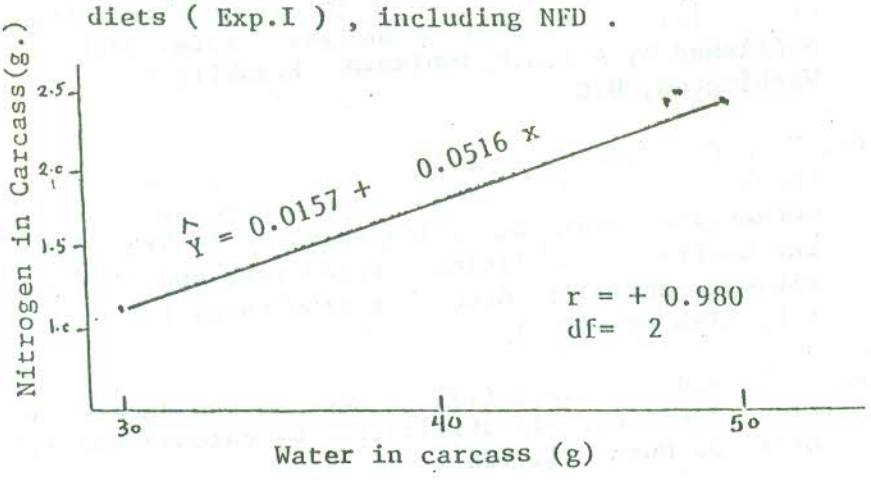

Fig.2. Relationship between total body water(x) and total body nitrogen (Y) in grams per chicks of 24-day old being fed the different experimental diets (Exp. 2), including NFD.

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تقييم دوبة البروتين في بعض مواد العلف البروتينية بأستخدام طريقة تحليل الجسم للكتاكيت النامية .

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طبقي الزراعة بالفيوم والقاهرة ومعهد بحوث الانتاج الحيواني

أجريت تجربتي تغذية على ١٢٦ كتكوت ذكور عمر ١٠ أيام لتقدير قيم معامل الاستفادة الصافي من البروتين (م.أ.ب) والكفاءة النسبية للبروتين (ك.ن.ب) لعينتين من حبة وبن مخلفين من محولي السمك المجفف (م.س. مجفف ١) ، (م.س. مجفف ٢) ، محولي سمك محلي (م.س. محلي) ، مخلفات المجازر الآلية المجففة واجن (م.م.آ.د.) ، كسب القطن المقشور (ك.ق.م) ، كسب جرمة الارز (ك.ج.ر) ، نخالة القمح (ن.ق) ، رجيع الكون (ر.ك) ، وذلك بتطبيق طريقة تحليل جسم الكتكوت بأستخدام معادلة بندر ويللر (١٩٥٢) ، معادلة عبد السلام (١٩٧٤) . ولقد غذيت الكتاكيت على العلائق التجريبية لمدة ١٤ يوم .

تراوحت قيم البروتين الخام والطاقة الممثلة في علائق التجربة الاولى بين ١٠٫٦٢ ٪ ١٠٫٧٧٠ ٪ ٣٥٢٢٠ ٣٥٢٣٠ كيلو كالوري طاقة ممثلة لكل كجم عليقه وتراوحت نفس القيم في علائق التجربة الثانية بين ١٠٫٦٠ ٪ ١٠٫٦٥٠ ٪ ٣٢٢٤ ٣٢٥١٠ كيلو كالوري طاقة ممثلة لكل كجم عليقه .

كانت قيم (م.أ.ب) لمواد العلف المستخدمه في التجربه الاولى بأستخدام معادلة بندر ويللر (١٩٥٢) كما يلي = ١٠٫٨٤ (م.س. مجفف ١) ٦٫٢٢٠ (م.س. محلي) ١٠٠٫٥٥ (م.م.آ.د.) ٢٢٫٢٨ (ك.ق.م) ٥٢٫٢٨٠ (ك.ج.ر) . وفي التجربه الثانيه كانت قيم (م.أ.ب) كما يلي = ٥٢٫٢٣ (م.س. مجفف ٢) ٤٣٫٥١ (ن.ق) ٣٥٫٥٤٠ (ر.ك) . وكانت نفس القيم بتطبيق معادلة عبد السلام (١٩٧٤) كما يلي ١٠٫٩٣ - ٢١٫٩٢ ٢٣٫٧٢ ٣٨٫٦٥ ٣٨٫٦٥ ٣٠٫٦٢ لمواد العلف المستخدمه في التجربه الاولى ١٦٠٫٥٣ ٢٢٠٫٥٢ ، ٨٦٫٤٤ لمواد العلف المستخدمه في التجربه الثانيه على التوالي .

بالنسبه لقيم (ك.ن.ب) لمواد العلف البروتينيه المستخدمه في التجربه الاولى فكانت = ٢٫٩٨ ٢٫٢٢٠ ٢٫٩١٠ ١٫٢٥٠ ١٫٤٨٠ على التوالي .

وبالنسبه لمواد العلف المستخدمه في التجربه الثانيه فكانت = ١٫٢٩ ، ١٫٢٥ ١٫٢٢٠ على التوالي .

في التجربه الاولى أعطى (م.س. مجفف ١) أعلى القيم من حيث (م.أ.ب) ، (ك.ن.ب) بينما كانت نتائج (ك.ق.م) أقلها .

وفي التجربه الثانيه أعطت (ن.ق) أقل القيم في (ك.ن.ب) ، (ر.ك) أعطى أقل القيم في (م.أ.ب) .

أمكن من الدراسه الحاليه معرفة ما يحتويه جسم الكتكوت من آزوت من طريق تقدير الرطوبه فقط وذلك من العلاقه الثابته بينهما .