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The Role of Amino Acids in Growth and Efficiency of Feed Conversion of Chicks

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702 DAY old chickens were divided into 6 groups. Two groups 19% were considered as control and received a ration containing crude protein irrespective to the ratio of amino acids. The other 4 groups received rations containing ingredients balanced to contain the 10 essential amino acids, in a ratio similar as far as possible to the ratio of these amino acids in meat of chickens, with almost the same crude protein perrent. Two of the experimental groups fed rations of high balanced levels of amino acids, and the others received low level. Each two similar groups received different source of animal protein, one received liquid skim milk, and the other received sardin meal.

The groups that received rations containing balanced ratio of amino acids either in high or low levels gave heavier weights, better relative growth rate, the best efficiency of food utilization and efficiency of protein utilization than the control. However, the best results were for the chicks that fed rations containing high balanced level of amino acids. In general, the groups that received skim milk gave better results, when the ratio of amino acids was high. However, better results were observed for the groups that were fed fish meal when the amino acids were not balanced or balanced but with low levels.

Most of studies done on amino acids were investigated each amino acid alone in relation to growth or feed utilization. Few investigators approcahed the problem taking in consideration the different essential amino acids as a group. However, most of the optimum requirements of each amino acid was determined by trying different levels of each amino acid. In this study, it was tried to compose a ration containing the different amino acids in a ratio similar to that found in chickens meat and/or recommended by different workers.

On crystalline amino acid diets, containing mixtures of essential amino acids, the first in amounts, simulating those found in fat free chick carcass, and the second in amounts simulating those found in chicken tissue. The requirements for each amino acid was determined by feeding graded levels of it to establish the best level of growth. The calculated essental amino acids requirements as a percentage of the diet recommended by two investigators were as follows :

	Klain *et al.*, 1958 and 1960	Dobson *et al.*, 1964
L- Lysine	1.01 — 1.23	1.15
L-Tryptophane	0.17 — 0.18	0.20
L-Threonine	0.58 — 1.68	0.78
L-Lucine	1.66	1.30
L-Histidine	0.41	0.43
DL-Methionine (Cystine in absent)	0.60	—
DL-Methionine (+ 40 % cystine)	0.18 — 0.20	0.73
L-Phenylalanine + L-tyrosine	0.59	1.33
Tyrosine + L-Phenylalanine 0.44%	0.71 — 0.80	—
L-Isolencine	0.73 — 0.84	0.80
L-Valine	0.83 — 0.96	0.95
L-Arginine	1.80 — 1.16	1.28
L-Glutamic acid	15.77	—

When calculating the sulphur amino acids average requirements from the data of feed conversion, it was found to be 3.51% of the total protein (Nelson *et al.*, 1960), or 0.93 % of the diet for the best growth (Reyntens and Groote, 1962).

Material and Methods

702 day old Fayoumi chicks were divided into six groups, each contained 117 chicks. Each group was brooded in a separtae floor prooder until 16 weeks of age. They were managed and treated alike, except the feeding rations which differed according to the treatment. The average weight of food consumed per bird, in each period, was calculated from the total amount of food supplied to the group, minus the weight of unconsumed food (collected daily), and with a further correction to allow for the estimated weight of food consumed by chicks which died during the period. The number of dead chicks was recorded daily. Cumulative corrected food consumption per bird was also calculated. The sex was recorded for each bird as soon as it could be distinguished morphologically. Both accumulative and per bird protein consumption were determined by multiplying the protein ratio, in the ration taken by each group by the food consumption of the same group, for each period. The efficiency of food or protein utilization were calculated by the dividing the consumed amounts on the gain of each period or body weight at each age. The six ratoins used are shown in Table 1. The liquid skim milk was offered to the chicks to drink. The 32.4 kilograms of liquid skim milk support 0.98% digestable protein to the ration, while the 180 kilograms of liquid skim milk provide 5.1% digestable protein to the ration. The amino acid content of each ingredient was calculated according to the tables of amino acids in foods and feeding stuffs found in the technical communication No. 19 published by the Commonwealth Agricultural Bureau (Bureau of Animal Nutrition in 1959).

TABLE 1. The composition and ingredients used in the different treatments

Ingredients % and composition	Control		Treatments			
	1	2	3	4	5	6
Corn	12	12	38	38	16	16
Rice pollishings	12	12	0	0	17.5	17.5
Wheat bran	12	12	1	1	15	15
Horse beans	16	16	4	4	16	16
Cotton seed cake	20	20	0	0	22	22
Season cake	0	0	16	16	0	0
Barely mault	25	25	30	30	10	10
Bone meal	1	1	1	1	1	1
Salt	0.5	0.5	0.5	0.5	0.5	0.5
Liquid skim milk kg.	32.4	0	180	0	32.4	0
Fish meal	0	2	0	11	0	2
Crude protein	19.22	19.22	18.71	18.71	19.30	19.30
Starch equivalent	57.34	57.34	49.40	49.40	63.70	63.70
Methionine 1	0.23	0.23	0.38	0.43	0.24	0.25
Methionine 2	1.21	1.19	2.05	2.32	1.30	1.31
Arginine 1	1.16	1.17	1.03	1.09	1.35	1.36
Arginine 2	6.28	6.11	5.51	5.83	7.00	7.50
Histidine 1	0.43	0.42	0.51	0.49	0.48	0.48
Histidine 2	2.23	2.18	2.71	2.60	2.50	2.50
Leucine 1	1.12	1.07	1.55	1.44	1.32	1.29
Leucine 2	5.83	5.59	8.27	7.70	6.80	6.70
Isoleucine 1	0 88	0.84	1.01	0.89	0.84	0.82
Isoleucine 2	4.57	4.35	5.37	4.74	4.30	4.20
Lysine 1	0 83	0.81	0.85	0.95	0.86	0.87
Lysine 2	4.34	4.21	4.52	5.07	4.40	4.50
Cystine 1	0 30	0.29	0 37	0.40	0.33	0.33
Cystine 2	1.56	1.50	1.96	2.13	1.70	1.70
Phenylalanine 1	0.76	0.73	0.86	0.76	0.82	0.80
Phenylalanine 2	3.98	3.79	4.60	4.06	4.20	4.10
Threonine 1	0.57	0.47	0.65	0.64	0.55	0.55
Threonine 2	2.97	2.47	3.44	3.44	2.80	2.80
Valine 1	0.99	0 93	0.89	0.90	0.95	0.95
Valine 2	5.13	4.84	4.73	4.81	4.90	4.90

1. % of amino acids to the total ration.
2. % of amino acids to the protein in the ration.

The treatments in this experiment were designed to contain amino acids in a ratio simulating that found in the chicken meat. This ratio was also calculated in the light of recommended ratios by Klain *et al.*, (1958) and (1960) and Dobson *et al.* (1964). The ratio contents of amino acids was given once in a higher level and the other in a lower level than the ratio found in chicken meat or recommended by the previous authors. Also, animal protein was once supplied as liquid skim milk and the other as Sardine meal. All the 6 groups received green foder as Egyptian clover at winter and chopped grain maize leaves at summer in similar quantities.

Results and Discussion

Absolute body weight

Body weight of both sexes at different ages of the whole experimental period for the groups that received rations containing high balanced levels of amino acids group 3 and 4 were almost heavier than the other groups. This was true wheather the animal protein source was fishmeal or liquid skim milk. However, the groups that received skim milk surpassed that which received fish meal in their two levels, in most of the ages of the study (Table 2 and 3). The differences between treatments at different ages were highly significant. When the rations that were fed low balanced level of amino acids, or when the amino acids content was unbalanced, the supplementation of fishmeal as the source of animal protein, increased body weight than the alternative groups that fed skim milk, especially in the older ages. The fishmeal seems to have amino acids content in a balanced ratio similar to the requirements of the chickens, as it was found to increase body weight when the rations contained unbalanced or low balanced levels of amino acid.

Relative growth rates

The treatments that received rations containing balanced ratio of amino acids, showed almost the highest relative growth rates at the first 16 weeks of age, especially those that received higher levels of amino acids (Table 4). Also, the supplementation of fish meal gave better results for groups of unbalanced or low balanced amino acid contents.

Food consumption and utilization

The highest amount of feed consumed was observed for group 1 and 2, while the least was observed for group 3 and 6 (Table 5 and 6).

With the progress of age feed efficiency was reduced as normally known (Table 7). However, group 3 and 6 showed somewhat high values at the first age interval, then declined in the subsequent age interval. Also, these two groups showed the least feed consumed. The best efficiency of food utilization was observed for the two groups which received rations that contained high balanced levels of amino acids. The efficiency ratio obtained in group 3, approached the standards recorded for meat production efficiency of food utilization in standard commercial broilers (Table 8).

TABLE 2. The effect of amino acid content on absolute body weight of Fayoumi chicks, from hatch until 16 weeks of age (Weights in g).

	Age	Treatments					
		1	2	3	4	5	6
Male	0	31	30.2	29.8	30.0	29.3	30.0
Female		29	30.0	29.0	29.5	29.1	29.4
Average		30	30.1	29.4	29.8	29.2	29.7
Male	4	155.5	171.3	162.1	164.1	162.5	157.2
Female		127.1	136.3	139.3	139.0	124.5	131.4
Average		141.3	153.8	150.7	151.5	143.5	144.3
Male	8	311.0	333.1	344.6	353.3	292.2	341.1
Female		276.8	284.2	305.0	318.3	243.0	281.3
Average		293.9	308.6	324.8	325.8	267.6	311.2
Male	12	506.1	565.2	592.0	383.3	503.4	378.3
Female		447.3	465.8	523.8	533.5	433.4	478.9
Average		476.7	515.5	557.9	558.4	468.4	528.6
Male	16	730.1	836.8	843.3	806.0	644.5	785.8
Female		650.5	688.0	754.7	756.1	555.3	656.0
Average		690.3	762.4	799.0	781.0	599.9	720.9

* F value = at 8 weeks of age between treatments = 16.3** (highly significant).
= at 12 weeks of age between treatments = 25.2** (highly significant).
= at 16 weeks of age between treatments = 50.2** (highly significant).

Protein consumption and utilization

The least protein consumed was observed for group 3 and 4, either for age intervals or for the accumulative protein consumption (Table 9 and 10). On the other hand the two control groups consumed the highest protein quantities. The chicks that drink skim milk consumed the least protein. Accordingly, group 3 and 4 showed the best efficiency of protein utilization for both accumulative and age interval values.

TABLE 3. The effect of amino acid contents on absolute weight of Fayoumi chicks from 20 to 48 weeks of age (weights in gs).

Age	Sex	Treatments					
		1	2	3	4	5	6
20	Male	833	993	1178	997	908	998
	Female	765	800	942	946	750	807
	Av.	778	839	989	954	781	846
24	Male	1016	1174	1309	1089	1073	1200
	Female	903	1025	1003	922	922	992
	Av.	885	982	1081	1002	952	1003
28	Male	1181	1359	1464	1331	1344	1374
	Female	963	1047	1122	1147	944	1133
	Av.	1007	1108	1191	1184	1024	1181
32	Male	1303	1526	1684	1453	1458	1526
	Female	1140	1171	1232	1220	1062	1196
	Av.	1173	1241	1322	1266	1141	1262
36	Male	1459	1579	1774	1575	1472	1655
	Female	1183	1202	1292	1291	1092	1202
	Av.	1262	1310	1421	1372	1199	1332
40	Male	1578	1679	1805	1758	1587	1748
	Female	1238	1293	1400	1346	1167	1268
	Av.	1335	1403	1516	1464	1278	1405
44	Male	1693	1796	1881	1824	1678	1856
	Female	1357	1349	1531	1714	1270	1403
	Av.	1453	1477	1631	1746	1386	1533
48	Male	1850	1825	2096	2011	1767	1957
	Female	1483	1491	1634	1822	1341	1503
	Av.	1582	1587	1766	1876	1463	1633

F value = at 24 weeks of age between treatments = 505** (Highly significant).
= at 48 weeks of age between treatments = 7.9** (Highly significant).

TABLE 4. Relative growth rates of different treatments at different ages (0 - 16).

Period in weeks	Treatments					
	1	2	3	4	5	6
0 — 4	154.2	134 6	134.6	134 2	134.3	132.6
4 — 8	70.1	66.7	73.2	73 0	60.6	73.3
8 — 12	74.4	50.2	52.8	52.4	54.6	51.9
12 — 16	36.6	38.6	35.5	33.2	24.6	30.8
0 — 16	176.1	18 7	185.8	185.3	180.8	184.1

TABLE 5. Weight of food (grams) consumed per bird at each age interval for the different treatments (average for both sexes)

Period in weeks	Treatments					
	1	2	3	4	5	6
0 — 4	359.8	392.8	347.9	352.9	379.6	374.1
4 — 8	526.8	601.6	332.9	534.3	571.1	333.7
8 — 12	679.2	752.0	678.7	685.2	691.3	620.1
12 — 16	1042.4	1051.4	923.5	943.8	996.8	943.7

TABLE 6. Accumulative weight of food (grams) consumed per bird at each age for the different treatments (averages for both sexes).

Age in weeks	Treatments					
	1	2	3	4	5	6
4	359.8	392.8	347.9	352.9	379.6	374·1
8	886.6	994.4	680.8	887.2	950.7	707.8
12	1565.8	1747.4	1359.5	1522.4	1642.0	1327.9
16	2608.2	2798.8	2283.0	2516.2	2638.8	2271.6

TABLE 7. Weight of food in kilograms needed to gain one-kilogram of live-weight at at each age interval for the different treatments. (Averages for both sexes).

Period in weeks	Treatments					
	1	2	3	4	5	6
0 — 4	3.23	3.18	2.87	2.90	3.33	3.27
4 — 8	3.45	3.90	1.91	3.07	4.59	1.99
8 — 12	3.72	3.64	2.91	2.95	3.44	2.85
12 — 16	4.88	4.26	3.83	4.24	7.58	4.91
0 — 48	12.50	12.73	9.90	9.71	13.87	12.35

TABLE 8. Weight of food (kilograms) used to produce on kilogram of live-weight at each age for the different treatments (Average for both sexes)

Age	Treatments					
	1	2	3	4	5	6
4	2.54	2.55	2.31	2.33	2.65	2.59
8	3.02	3.22	2.10	2.72	3.55	2.27
12	3.28	3.39	2.44	2.82	3.51	2.51
16	3.78	3.67	2.86	3.22	4.40	3.15

General discussion

The Fayoumi chickens can approach the standards of the known commercial birds specialized for meat production with respect to rate of growth and efficiency of food and protein utilization if we give them a protein mixture either from plant or animal origin that contain the essential amino acids in a balanced ratio, simulating that found in the protein of produced meat. When the balancing of amino acids is combined with the increase of animal protein percentage, without the increase in total protein, the improvement in the previous characters was increased. It seems that balancing the amino acids content of the ration limits the role of either total digestable or animal protein in the ration. Also, the good effect of animal protein seems to exist from its high content of balanced amino acids.

TABLE 9. Protein consumption per period (grams) per bird at each age interval for the different treatments (Average of both sexes).

Period	Treatments					
	1	2	3	4	5	6
0 — 4	69.14	75.49	65.10	66.02	73.25	72 19
4 — 8	101.25	115.63	62.29	99.97	110.22	64.40
8 — 12	130.54	144.73	126.98	128,20	133.42	119.68
12 — 16	200.35	202.08	172.79	176.58	192.38	182.13
16 — 20	283.82	286.72	273.62	265.06	288.26	291.58
0 — 48	3800 09	3882.00	3012.42	3195.16	3916.93	3893.33

TABLE 10. Accumulative protein consumption (grams) per bird at each age for the different treatments (Average of both sexes).

Age	Treatments					
	1	2	3	4	5	6
4	69.14	75.49	65.1	66.02	74.21	72.28
8	170.65	191.12	127.39	165.99	184.43	136.68
12	301.19	335.85	254.37	294.19	317.85	256.36
16	501.54	537.93	427.16	470.77	510.23	438.49

N.B. : The percentage of protein in the ration was constant during the period of the study.

Group I	19.22	Group II	19.22
Group III	18.71	Group IV	18.71
Group V	19.30	Group VI	19.30

TABLE 11. **Body weight gain (kilograms) produced by one kilogram of protein at each age interval for the different treatments (Averages for both sexes).**

Period	Treatments					
	1	2	3	4	5	6
0 — 4	1.61	1.64	1.86	1.84	1.54	1.59
4 — 8	1.51	1.33	2.79	1.74	1.13	2.60
8 — 12	1.40	1.43	1.84	1.81	1.51	1.82
12 — 16	1.07	1.22	1.39	1.26	0.68	1.06
0 — 48	0.41	0.41	0.58	0.58	0.37	0.41

TABLE 12. **Body weight gain in kilograms produced by one kilogram of dietary protein of each age for the different treatments (Averages for both sexes).**

Age	Treatments					
	1	2	3	4	5	6
4	1.61	1.61	1.86	1.84	1.54	1.59
8	1.55	1.45	2.32	1.78	1.29	2.06
12	1.48	1.44	2.08	1.80	1.38	1.95
16	1.32	1.39	1.08	1.60	1.12	1.58

The beneficial effect of balancing the amino acids may be due to the direction of the greatest part of the available protein to the production of meat. This is accompanied by the decrease of the waste, because none of the amino acids can be limiting to the use of the others, as all of them are available almost in the ratio needed to compose the protein produced. That also, may decrease the energy needed to select the suitable amino acid ratio to compose self protein, and excrete unneeded excess, from the unbalanced ratio. Accordingly, the saved energy is directed to encourage other productive aims.

However, it could be said that most of the improvement in the growth is not entirely related to the increased percentage of animal protein in the ration, as the levels given here were lower than that recommended by other workers (Halnan and Graner, 1944 and Kreig, 1960).

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دور الأحماض الأمينية فى النمو ، والكفاءة التحويلية للغذاء فى الدجاج الفيومى

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تتكون مادة هذه الدراسة من ٧٠٢ كتكوتا عمر يوم ، مقسمة الى ستة مجموعات متساوية ، موضوعة تحت ظروف ومعاملات موحدة ، وغذيت كل مجموعة على عليقة مختلفة ، بحيث استخدمت مجموعتان للمقارنة وهذه كونت علائقها بدون مراعاة لنسب الأحماض الأمينية بها بل فقط روعى أن تكون نسبة البروتين الكلى بها مماثلة للمجموعات التجريبية . والمجموعات التجريبية الأربعة كونت علائقها بحيث تحوى الأحماض الأمينية الأساسية العشرة بنسب تماثل بقدر الامكان نسبتها الى بعضها فى كل من لحم وبيض الدجاج ، أى متوازنة ، وبحيث تأخذ مجموعتان منها مستوى مرتفع من الاحماض المتوازنة ، ومجموعتان تغذى على مستوى منخفض من الأحماض الأمينية المتوازنة النسبية .

وبذلك تكونت ثلاثة مستويات ، مستوى المقارنة ، ومستوى مرتفع متوازى ومستوى منخفض متوازن وفى كل من المستويات ثلاث مجموعتان احداهما أعطيت اللبن الفرز كمصدر للبروتين الحيوانى والأخرى أعطيت مسحوق السمك المجفف (سردين) .

كانت أوزان الطيور بالمجموعات التجريبية المغذاة على علائق المتوازنة الأحماض الأمينية أكبر من أوزانها فى مجموعات المقارنة ، وكذلك فان معدل النمو فى المجموعات التجريبية تفوق على معدل النمو فى مجموعات المقارنة . ولوحظ أن العلائق المتوازنة الأحماض الأمينية سواء فى المستوى المرتفع أو المستوى المنخفض أعطت نتائج أفضل من المجموعات المقارنة .

كانت الكفاءة التحويلية للغذاء فى المجموعات التجريبية الأربع اكبر منها فى المجموعات المقارنة وكذلك كانت كفاءة تحويل البروتين اى ان العلائق متوازنة الاحماض الأمينية سواء كانت مرتفعة المستوى أو منخفضة ، تفوقت على العلائق المقارنة الغير متزنة .

الا أن المجموعات المغذاة على علائق متوازنة الأحماض الامينية وتحوى مستوى مرتفع منها أعطت أفضل النتائج من حيث الوزن ومعدل النمو وكفاءة تحويل الغذاء وكفاءة تحويل البروتين وتفوقت على المجموعات المغذاة على مستوى منخفض من الأحماض الأمينية وكذلك على مجموعات المقارنة . وكذلك لوحظ أنه فى حالة ارتفاع مستوى الأحماض الامينية المتوازنة فان استعمال اللبن الفرز كمصدر للبروتين الحيوانى أفضل من استعمال مسحوق السمك المجفف ، بينما بالعكس فى حالة انخفاض مستوى الأحماض الأمينية المتوازنة فى العليقة أو فى حالة عدم التوازن كان مسحوق السمك المجفف أفضل من اللبن الفرز من حيث النتائج .