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EFFECT OF QUANTITATIVE FEED RESTRICTION AND SUBSEQUENT REFEEDING ON PERFORMANCE AND CARCASS TRAITS OF BROILERS

(With 9 Tables)

By

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**دراسة تأثير تقليل الغذاء مع إعادة التغذية على كفاءة الأداء وصفات الذبيحة
في بدارى التسمين**

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أجريت هذه الدراسة في تجربتين لدراسة تأثير تقليل الغذاء مع إعادة التغذية الاختيارية خلال فترتي النامي والناهي على أداء الكتاكيت وصفات الذبيحة. تقليل الغذاء تم من خلال تقليل الطاقة والبروتين في المحاولة الأولى ومن خلال تقليل الكمية المأكولة في المحاولة الثانية. تم استخدام عدد ١٨٠ كتكوت هابرد عمر يوم في هذه الدراسة، وزعت الى ٦ مجموعات متساوية تحتوي كل منها على ٣٠ كتكوت. غذيت المجموعة الأولى (الضابطة) طوال فترة التجربة على عليقة النامي القياسية التي تعتمد على الذرة والصويا والتي تحتوي على ٢٠% بروتين خام و ٣٢٠٠ كيلوكالورى طاقة ممثلة/كجم عليقة وبدأت الخمس مجموعات الأخرى بالتغذية الاختيارية على نفس عليقة النامي القياسية خلال فترة البادي حتى عمر ٢١ يوم. مع بداية فترة النامي غذيت المجموعتين الثانية والثالثة في المحاولة الأولى على عليقتين منخفضين في الطاقة والبروتين (٣٠٥٠ كيلوكالورى طاقة ممثلة /كجم عليقة ، ١٩% بروتين خام للأولى ، ٢٩٠٠ كيلوكالورى طاقة ممثلة /كجم عليقة و ١٨% بروتين خام للثانية). في المحاولة الثانية تم تقليل الكميات المأكولة من العليقة فى المجموعات الرابعة والخامسة والسادسة بمعدل ٨٠ ، ٧٠ ، ٦٠% على الترتيب من معدل استهلاك العليقة الضابطة فى الأسبوع الرابع والسادس ثم يعاد تغذية الكتاكيت إختياريا على عليقة المجموعة الضابطة فى الأسبوعين الخامس والسابع. ويمكن إيجاز نتائج هذه الدراسة فيما يلي: الزيادة في وزن الجسم في المجموعة المغذاة على مستوى منخفض من الطاقة والبروتين قلت بنسبة ٢٢% ، ٣٢,٥% في المجموعتين الثانية والثالثة في عمر ٤٢ يوم مقارنة بالمجموعة الضابطة ولكن زادت بعد إعادة التغذية في عمر ٣٥ يوم بنسبة ٧,٥% ، ٣,٨% في نفس المجموعتين على الترتيب. سجلت المجموعة المغذاة على ٨٠% من

الاستهلاك أعلى معدل زيادة في وزن الجسم في نهاية الأسبوع الخامس تلتها المجموعة الخامسة والسادسة حيث بلغت النسبة ١٣٥,٤، ١٢٩,٤، ١٠٥,٢% مقارنة بالمجموعة الضابطة على الترتيب. عدم وجود أي فروق في معدل التصافي وكذلك بعض أوزان الأعضاء الداخلية بين المجموعات المختبرة بينما قل محتوى دهون البطن في ذبائح المجموعات المعاملة بالمقارنة بالمجموعة الضابطة. نستخلص من هذه الدراسة أن أوزان الطيور المغذاة على ٨٠% من الاستهلاك والمجموعة المغذاة على علفه تحتوي على ٣٠٥٠ كيلوكالوري طاقة ممثلة /كجم عليفة، ١٩% بروتين خام كانت قريبة لأوزان الطيور في المجموعة الضابطة.

SUMMARY

This experiment was performed to investigate the effect of different approaches of feed restriction and the implication of realimentation in alternative weeks on chick performance and carcass traits. The restriction approaches involved restriction of nutrients, protein and energy and feed intake. One hundred and eighty, day-old chicks of the Hubbard breed were weighed and allocated, at random, into six experimental groups each of 30 chicks in two trials. Birds in the first group (control) were fed ad-libitum on a broiler grower diet containing 20% crude protein (CP) and 3200 kcal ME/kg. The diet was offered all over the experimental period from hatch to 7 weeks old. Chicks of the other five groups were offered the same diet in the starting stage (0-3 weeks). For the second and third groups (trial I), restriction was applied on the dietary CP level, keeping the C/P ratio as that of the control. The CP% was reduced by 5% for group 2 to reach 19 and 3050 Kcal ME/Kg diet and by 10% for group 3 to reach 18% and 2900 Kcal ME/kg diet. In the last three groups 4, 5 & 6 (trial II), the reduction was not experimented on the nutrient density but on feed intake, restricting the intake to 80, 70 & 60% of that consumed by the control group, in a respective order. As a trial to overcome the negativity and to get advantage of the "compensatory growth" phenomenon the restriction weeks were interrupted by weeks of the ad-libitum feeding the control diet, on an alternative basis. So in the 4th & 6th weeks was the restriction and in the 5th & 7th was realimentation. Live weight gains of birds fed on energy-protein restricted diets were reduced by 22% in the second and 32.5% in the third group at 6th weeks of age compared to the control one, while energy-protein realimentation at 5th week of age resulted in an increase of weight gains by 7.3 and 3.8%. The weekly body weight gain and relative growth rate of birds submitted to food restriction at 4th and 6th weeks of age was significantly ($P<0.05$) lower when compared to the birds fed ad-libitum. Birds were restricted to 80% had highest gains and

best feed conversion ratio followed by 70 and 60% treatments, where the weight gains reached 135.4, 129.4 and 105.2% of that recorded in the control at 5th week of age. No difference between treated groups and control in carcass dressing value and weights of internal organs. However the abdominal fat content was decreased in slaughtered restricted-refed birds. It could be concluded that, birds which were restricted-refed to 80% of the ad-libitum intake and those fed on 19% CP & 3050 kcal ME/kg had a nearly similar final body weight to that of the control one. Incomplete body weight recovery was obtained with the other of great restrictions.

Key words: Feed restriction, broiler performance, carcass traits.

INTRODUCTION

The fundamental objective of poultry nutrition is to maximize the economic production performance of birds. Diets are formulated by least cost linear programming to provide specified levels of nutrients that are needed for optimum performance. In poultry free-choice and dry-mash feeding are both commonly applied practice. The birds have been thought to be able to regulate their intake according to their requirement and growth potential. Now food prices are so high and saving intake of food or expensive ingredient, which does not affect performance is worth to be investigated. Controlling of feed intake, diluting the nutrient density, or dispensing with an expensive distinctive ingredient, systems of restricted feeding, now command very great interest in an attempt to minimize development of excessive carcass fat or reducing the feeding cost. Early studies of food restriction resulted in better food utilization and reduced carcass fat content without reduction in final body weight (Plavnik & Hurwitz, 1985, 1988, 1991; Jones & Farrel, 1992 & Santoso *et al.*, 1995). However, others have failed to confirm this effect (Yu *et al.*, 1990; Fontana *et al.*, 1993; Deaton, 1995; and Zubair & Leeson, 1996). Improvement in feed efficiency noted with the use of feed restriction programs is due to reduced overall maintenance requirements. This reduction seems to be due to a transient decrease in basal metabolic rate of feed-restricted birds (Zubair and Leeson, 1994). Lippens *et al.*, (2000) found that, chickens subjected to an early food restriction of about 90% of the ad-libitum intake during 4 days have a comparable final body weight to that of the control group. Incomplete body weight recovery was obtained with the other more severe restrictions. Reduction in body weight gains in energy-protein restricted birds has been noted by

Holsheimer & Veerkamp (1992); Moran *et al.* (1992) and Bregendahl *et al.* (2002). An important factor influencing the variability observed in compensatory growth might be the condition of realimentation, greater feed intake relative to body size and nutrient requirements during the refeeding period (Zubair & Leeson, 1996; Lippens *et al.*, 2000 & 2002). Adequate compensatory growth seems to be an essential condition for an improvement of the nitrogen retention of retarded birds in comparison with the ad-libitum fed birds. As the results obtained from feed restriction programs to reduce the carcass fat content in broiler chicken have been inconsistent, the present study was planned to investigate the effect of different approaches of feed restriction and the implication of realimentation in alternative weeks on chick performance and carcass traits. The restriction approaches involved restriction of nutrients, protein and energy as well as feed intake.

MATERIALS and METHODS

Experimental chicks

One hundred and eighty, day-old chicks of the Hubbard breed were weighed and allocated, at random, into six experimental groups each of 30 chicks. The chicks were floor-reared in a hygienic pen, of separate compartments which were bedded with chopped wheat straw. Fresh and clean water was constantly supplied and the diets were formulated and offered according to the designed feeding system in each trial. All birds were kept under hygienic conditions and were subjected to a prophylactic vaccination and pharmacological program against viral and bacterial diseases.

Experimental design:

To investigate how to reduce the feeding cost and to minimize the development of excessive carcass fat, quantitative feed restriction and realimentation was tried in this experiment which was conducted in two feeding trials. In the first trial, the crude protein (CP) and energy density of the control diet were adjusted at two levels, while the feed intake was restricted at three levels, as percentages of that consumed by the control group, in the second trial.

Diets and feeding:

Birds in the first group which were considered as control were fed ad-libitum on a broiler grower diet (one diet-system) containing 20% CP and 3200 kcal ME/kg. The diet was offered allover the experimental period from one-day to 7 weeks old. Chicks of the other five groups were offered the same diet in the starting stage (0-3 weeks), then each of

them was treated according to the suggested design going to be tested. In groups 2 and 3, restriction was tried on the dietary CP level, keeping the calorie/protein ratio as that of the control. The CP% was reduced by 5% for group 2 to reach 19 (and 3050 Kcal ME/Kg diet) and by 10 % for group 3 to reach 18 % (and 2900 Kcal ME/kg diet). In the last three groups 4, 5 & 6, the reduction was not tried on the nutrient density but on feed intake, by restricting the intake to 80, 70 & 60% of that consumed by the control group, in a respective order. For the amount of food, specified for each group to be known, feeding of the control group started a week earlier than the restricted intake-ones. The restriction approaches, either in nutrient densities or feed intake, were executed after 3 weeks of age. The most rapid rate, is curtailed. Also, the restriction in a week was alternatively followed by another week of realimentation in order to get use of the "compensatory growth" phenomenon as animals have the tendency to "store" their growth potential and regain what is lost in their growth curves. So restrictions were followed on the 4th and 6th weeks, and realimentations on the 5th and 7th weeks of age. The following table summarizes the applied experimental design.

Phases Weeks	Control group 1	Trial I groups		Trial II Groups		
		2	3	4	5	6
Starting phase (0 – 3 weeks)						
Feed intake				Ad-libitum		
CP %				20 %		
ME (Kcal/kg)				3200		
Growing-finishing phase (4 – 7 weeks)						
Weeks 4 & 6 (restriction)						
Feed intake	Ad-libitum		80 % 70 % 60 %			
CP %	20	19	18	20 %		
ME (Kcal/kg)	3200	3050	2900	3200		
Weeks 5 & 7 (realimentation)						
Ad-libitum refeeding of the control diet which contained 20 % CP & 3200 Kcal ME/kg diet						

The tested diets were formulated from the commonly used ingredients which were chemically analyzed for their nutrient composition following AOAC procedures (1984), while their ME value, calcium, phosphorous, methionine, lysine and cystine contents were derived from the feed composition tables given in the NRC publication (1994).

Table 1: Chemical composition (%) and metabolizable energy value of the used diet ingredients

Feedstuff Nutrient composition	Yellow corn	Fish meal (herring)	Soybean oil meal	Wheat bran	Dried fat **
Dry matter	89.40	92.60	89.50	88.80	99.00
Crude protein	8.30	71.20	45.00	15.90	—
Ether extract	4.00	9.60	0.90	3.30	99.00
Crude fibre	2.40	0.77	7.90	5.20	—
Ash	5.00	9.10	6.30	10.50	—
Nitrogen free-extract	69.70	1.93	29.40	53.90	—
ME Kcal/Kg *	3350.0	3190.0	2230.0	1300.0	7500.0
Ca % *	0.02	2.29	0.29	0.14	—
Available P % *	0.08	1.7	0.27	0.20	—
Lysine % *	0.26	5.47	2.69	0.61	—
Methionine % *	0.18	2.16	0.62	0.23	—
Cystine % *	0.18	0.72	0.66	0.32	—

* Derived from NRC publication (1994)

** Ultracal dried fat (EGAVET)

Table 2: The ingredient and chemical composition (% or Kcal / Kg) of the diets fed for the different experimental groups

Item	Control diet	C/P restricted diets	
		19% CP	18% CP
Ingredient composition			
Corn (yellow)	59.48	63.05	64.30
Soybean oil meal	27.15	22.82	18.66
Fish meal	4.00	4.00	4.00
Dried Fat	6.32	3.31	1.15
Wheat bran, fine	—	4.00	9.00
Dicalcium phosphate	1.23	0.97	0.95
Limestone (ground)	1.18	1.24	1.34
Common salt	0.32	0.31	0.30
D-Methionine	0.02	—	—
Premix*	0.30	0.30	0.30
Chemical composition and energy value			
Metabolizable energy, Kcal/kg	3200	3050	2900
Crude Protein (%)	20.01	19.00	18.00
Calorie/protein ratio	159.9	160.5	161.1
Ca %	0.90	0.90	0.90
Available P %	0.35	0.30	0.30
Lysine %	1.10	1.02	1.01
Methionine %	0.22	0.35	0.35

* Vigora premix (vitamins and Minerals)

The studied measurements:

Growth performance and feed conversion:

The amount of feed consumed was weekly recorded for the different groups. The average amount consumed by each bird was calculated by dividing the weekly consumed food by its respective number of birds in each group at this week. Regarding the development of the body weight and weight gain, the birds were individually weighed every week and the live weight changes were taken as the criteria of the effect of the different treatments, and as a measure for growth. The standard deviations and errors were calculated. The measured growth was expressed in percentage relative to the body weight in order to compare the different groups in relation to their relative rate of growth.

The amount of feed consumed was divided by the body weight gain of the bird in order to calculate the feed conversion ratio. Experimental crude data were subjected to several statistical analysis, from which the means, standard errors were calculated and differences were tested for significance using (t) test (SAS, 1990).

Carcass traits, and chemical composition:

Five randomly selected birds from each group were slaughtered at the end of the experiment for evaluating carcass traits and meat chemical composition. Feed but not water was unavailable for birds 12 hours prior to slaughtering. Dressed carcass weight as the weight of the slaughtered birds after removal of feathers, head and feet but including all the offal's, (edible or not) was recorded. The weights of some internal organs of birds including gizzard, proventriculus, liver, spleen and heart as well as visible abdominal fat were recorded as an absolute weight or relative to the weight of the dressed carcass.

Monetary value:

Total production cost was calculated including prices of one day old chicks, feeds, heating, veterinary care, management and housing. Selling price was calculated by multiplying total live body weight of the birds produced by the price per unit weight commonly offered in the market.

Net revenue = Selling price – Total production costs

$$\text{Economic feed efficiency (EFE)} = \frac{\text{Net revenue}}{\text{Total production costs}}$$

$$\text{Relative economic feed efficiency (REFE)} = \frac{\text{EFE of group}}{\text{EFE of control}} \times 100$$

RESULTS

The results obtained for chick performance in terms of body weight development, relative growth rate, feed intake and feed conversion are presented in Tables 3, 4, 5 and 6. Chemical composition of broiler meat and carcass traits are given in Tables 7 & 8. The economical evaluation of broiler performance in different experimental groups in the two trials is shown in Table 9.

Table 3: Body weight development of broiler chicks in trials I and II compared with the control

AGE (Weeks)	Control	Trial I Groups			Trial II Groups	
	1	2	3	4	5	5
0	45.4 ±1.36 ^a	46.3 ±1.35 ^a	46.4 ±1.08 ^a	46.4 ±1.08 ^a	46.8 ±1.46 ^a	45.6 ±1.69 ^a
1	166.2 ±2.59 ^a	164.2 ±3.62 ^a	164.5 ±4.54 ^a	161.0 ±4.09 ^a	165.8 ±4.58 ^a	156.8 ±5.55 ^{ab}
2	329.0 ±9.27 ^a	327.5 ±7.39 ^a	321.0 ±9.51 ^a	323.0 ±8.80 ^a	321.7 ±7.74 ^a	334.0 ±7.97 ^a
3	698.0 ±9.69 ^a	684.0 ±8.48 ^{ab}	669.0 ±12.08 ^b	685.0 ±13.29 ^{ab}	657.0 ±8.00 ^b	675.0 ±9.75 ^{ab}
4	1056.0 ±12.99 ^a	1038.0 ±18.55 ^a	992.5 ±11.99 ^b	920.0 ±19.49 ^c	839.0 ±10.88 ^d	813.0 ±10.91 ^c
5	1440.0 ±11.83 ^a	1452.0 ±16.44 ^a	1392.0 ±10.68 ^b	1440.0 ±16.43 ^a	1336.0 ±15.03 ^c	1217.0 ±11.19 ^d
6	1686.0 ±15.47 ^a	1644.0 ±14.27 ^{ab}	1558.0 ±10.19 ^c	1608.0 ±10.19 ^b	1468.0 ±8.60 ^d	1359.0 ±14.18 ^e
7	1965.0 ±27.94 ^a	1875.0 ±21.46 ^a	1816.0 ±22.27 ^b	1896.0 ±19.8 ^b	1773.0 ±21.6 ^c	1626.0 ±20.66 ^d
Times of initial	43.28	40.41	39.14	40.68	37.88	35.66
Mortality	3	2	2	3	2	2

Figures in the same row having the same superscripts are not significantly different ($P < 0.05$)

Table 4: Relative growth rate of the different experimental groups

Experimental period (weeks)	Control group	Trial I groups			Trial II Groups	
	1	2	3	4	5	6
0-1	114.18	111.87	111.99	110.51	111.95	109.88
1-2	65.75	66.42	64.47	66.94	63.96	72.21
2-3	71.86	70.49	70.30	71.83	68.52	67.59
3-4	40.82	41.11	38.94	29.28	24.33	18.55
4-5	30.77	30.54	33.51	44.07	45.70	39.80
5-6	14.55	12.02	11.25	11.72	9.42	11.02
6-7	8.23	13.13	15.84	13.78	18.82	17.89

Table 5: The weekly feed consumption (g/chick) of the different treated groups

Experimental period (weeks)	Control group	Trial I groups		Trial II Groups		
	1	2	3	4	5	6
0-1	131.3	125.3	127	128.3	135.9	120
1-2	341.5	319.6	306.3	337.5	341.4	339.1
2-3	512.7	581.8	551.7	565.4	553.6	585.2
3-4	607	722.14	690.3	487.9	412.5	352.9
4-5	880.3	946.8	925.5	928.3	997.3	958
5-6	917.9	984.6	972.9	735	647.1	550.6
6-7	1000	1004.3	1033.3	976.9	996.4	1014.4
0-7	4390.7	4684.5	4607.0	4159.3	3984.2	3899.8

Table 6: Chick performance of the experimental groups in trials I and II compared with the control

Experimental period (weeks)	Control group	Trial I Groups		Trial II Groups		
	1	2	3	4	5	6
Feed intake						
4 th weeks	607.0	722.1	690.3	487.9	412.5	352.9
5 th weeks	880.3	946.6	925.5	926.3	997.3	958.0
6 th weeks	917.9	984.6	972.3	735.0	647.1	550.6
7 th weeks	1000.0	1004.3	1033.3	976.9	996.4	1014.4
0-7	4390.7	4684.5	4607.0	4159.3	3984.2	3899.8
Body weight gain						
4 th weeks	358±15.9	354±7.9	323.5±12.2	235±8.4	182±13.7	138±3.6
5 th weeks	384±16.7	414±15.6	399.5±9.9	520±5.5	497±7.4	404±12.2
6 th weeks	246±14.0	192±10.6	166±7.45	168±7.4	132±8.0	142±8.6
7 th weeks	279±19.8	231±18.7	258±12.8	288±17.3	305±11.9	267±17.1
0-7	1919.6 ±56.59 ^a	1828.6 ±41.23 ^b	1769.6 ±21.71 ^b	1849.6 ±46.15 ^a	1726.2 ±47.89 ^e	1580.4 ±49.15 ^d
Feed conversion ratio						
4 th weeks	1.69	2.04	2.13	2.08	2.27	2.56
5 th weeks	2.29	2.29	2.31	1.79	2.01	2.37
6 th weeks	3.73	5.13	5.86	4.38	4.90	3.88
7 th weeks	3.58	4.35	4.01	3.39	3.27	3.79
0-7	2.29	2.53	2.60	2.25	2.31	2.47

Figures in the same row having the same superscripts are not significantly different (P<0.05)

Table 7: Dressed carcass and some internal organs as a percentage of live body weight of the chicks in different experimental groups

Item (%)	Control group	Trial I Groups			Trial II Groups	
	1	2	3	4	5	6
Dressed carcass	82.90	78.93	76.65	79.69	83.42	84.69
Gizzard	2.65	2.27	2.37	2.28	2.62	2.39
Proventriculus	0.72	0.66	0.75	0.62	0.67	0.65
Liver	3.24	2.28	2.19	2.21	2.87	2.55
Spleen	0.19	0.16	0.16	0.17	0.17	0.15
Heart	0.59	0.59	0.73	0.57	0.75	0.76
Abdominal fat	1.38	1.18	1.10	1.07	1.11	1.09

Table 8: Chemical composition (%) of broiler's meat in different experimental groups

ITEM \ GROUPS	DM	ON DM BASIS		
		CP	EE	Ash
Control 1	24.46	82.60	130.0	3.66
Trial I 2	28.30	81.88	12.85	3.95
3	27.20	80.83	12.96	4.00
Trial II 4	26.84	83.25	13.02	3.61
5	26.76	81.63	12.50	3.92
6	25.90	80.25	12.46	3.21

Table 9: Economical evaluation of broiler performance in different experimental groups compared with the control.

Parameters	Control	Trial I Groups		Trial II Groups		
	1	2	3	4	5	6
Total feed cost (L.E)	6.98	7.18	7.08	6.57	6.454	6.19
Total production cost (L.E)	9.48	9.68	9.58	9.07	8.95	8.69
Body weight (g/chick)	1965	1875	1816	1896	1773	1626
Price of body weight (L.E)	11.79	11.25	10.89	11.38	10.64	9.76
Net revenue (L.E)	2.31	1.57	1.31	2.31	1.69	1.07
Economic feed efficiency (%)	33.1	21.9	18.5	35.2	26.2	17.3
Relative economic feed efficiency %	100	66.2	55.9	106.3	79.2	52.3

DISCUSSION

Broilers are fed multiple-stage diets, meaning that the composition is changed with advancing age. Alternatively, a two-stage system with a starter and finisher diet may be used. A third conventionally known system is the feeding of one diet containing from 20-22% CP all over the feeding period from hatch to marketing at 7 or 8 weeks (Allam, 1986). In this experiment the one-diet system was followed using the 20% level for CP and 3200 kcal / kg diet for ME, the nutrient densities of the grower diet.

Chick performance:

In the starting phase (0-3 weeks), there were no significant difference in the live body weight between all treated groups in trial I & II and control where chicks consumed the same diet containing 20% CP and 3200 kcal/kg ME. The average body weight in all groups ranged from 657 to 698 gm.

A- Energy- protein restriction (nutrient density dilution, trial I):

In this trial, protein as the most expensive nutrient besides, energy and their content was reduced in growing and finishing diets, taking advantage of growth storage potential and compensatory growth as a biological phenomenon (Doyle & lesson, 1996 and Lawrence & Fowler, 1997).

Live body weight of broiler chicks at four week of age fed energy-protein restricted diet (2900 Kcal/kg ME & 18% CP) was decreased compared to those fed control diet. On the other hand, chicks in the second group fed on diet containing 3050 Kcal/kg ME & 19%CP had no significant effect ($P < 0.05$) on mean body weight at the same previous age. Live weight gains of birds fed on energy-protein restricted diets were reduced by 22% in the second and 32.5% in the third group at 6th weeks of age compared to control one. Reduction in body weight gains in dietary energy-protein restricted birds is in agreement with observations of Holsheimer & Veerkamp (1992); Moran *et al.* (1992) and Bregendahl *et al.* (2002). Energy and protein realimentation at 5th weeks of age resulted in an increase of weight gain by 7.3 and 3.8% in the second and third groups, respectively. These results indicated that protein restriction increases the ability of the chicken to absorb some amino acids (Gous, 1977) when the limiting nutrient is supplied in the recovery period, and it is not a matter of growth compensation but a matter of potential increasing. Similar results have been reported by Abdel-Hafeez *et al.* (2001).

Birds in the second and third groups recorded high feed consumption when compared with control at restricted and realimentation periods. In the whole experimental period, broilers consumed an average of 89.6, 95.6 and 94.0 g/bird daily for control and two restricted groups respectively. Zubair & Leeson (1994, 1996) stated that enhancement of feed intake in restricted-refed broilers might be attributed to the relative enlargement of digestive organs, especially crop, pancreas and liver and this help to support compensatory growth. Fisher (1984) stated that broilers tend to increase their feed intake to make up for deficiencies when fed diets that are marginally deficient in crude protein. In contrary Plavnik & Hurwitz (1990) found that feed intake is depressed by feeding diets that are severely deficient in crude protein. The feed efficiency reduced and feed conversion indices increased during restriction periods (4th and 6th weeks), while feed conversion was nearly similar after energy and protein realimentation at 5th weeks of age.

B- Feed intake- restriction (trial II):

The weekly body weight gain and relative growth rate of birds submitted to food restriction at 4th and 6th weeks of age was significantly ($P<0.05$) lower when compared to the birds fed ad-libitum. The retardation of growth was more pronounced for the 70 & 60%-restricted birds (182 and 138g Vs 358 g for control) in the first stage and (132 & 142 g vs 246 g for control) in the second stage of restriction. Concerning the weight gain, relative growth rate and feed conversion index during the first realimentation period (5th weeks), there were significant ($P<0.05$) differences between the different experimental groups and control. Birds of the 80% restricted group had highest gains and lowest feed conversion index followed by 70 and 60% treatments, where the weight gains reached 135.4, 129.4 and 105.2% of that recorded in the control. In the second realimentation period (7th weeks), the weight gain and feed conversion index was nearly similar between different experimental groups and control. An important factor influencing the variability observed in compensatory growth might be the condition of realimentation and nutrient requirements during the refeeding period (Lippens *et al.*, 2000 & 2002). Adequate compensatory growth seems to be an essential condition for an improvement of the nitrogen retention of retarded birds in comparison with the ad-libitum fed birds. According to Buyse *et al.* (1996) and Kuehn *et al.* (1996), the enhanced nitrogen efficiency can be attributed to higher concentrations of circulating growth hormone (GH) and insulin-like growth factor-1

during compensatory growth. Ad-libitum feeding increased feed intake in the different experimental groups (80, 70 and 60%) by 16.8, 13.2 and 8.8% respectively when compared with control at the end of first realimentation period while, feed consumption was nearly similar at 7th weeks of age. A full compensation for the weight retardation during restriction periods was not obtained within a growth period of 5 and 7 weeks with the highest restriction levels (60 and 70%). However, final body weight of 80% restricted birds did not differ significantly from those of the ad-libitum-fed control. This may be due to restricted birds converted their food more efficiently in comparison with the control. Besides, greater efficiency, there was a positive effect of food restrictions on mortality. These results agree with those reported by Leeson & Zubair (1997), Lippens *et al.* (2000, 2002) who found that 80% food restriction gave complete recovery of the body weight at the age of 42 day.

Carcass traits:

Slaughter studies revealed no significant difference ($P < 0.05$) among energy-protein and feed intake-restricted groups in carcass dressing value and weights of internal organs (Table 7) except restriction feed intake to 60% of ad-libitum caused a slightly improvement in dressing carcass values. These coincide with the findings of Palo *et al.* (1995); Walaa Abdel-Razik (1995); Leeson & Zubair (1997) and Abdel-Hafeez *et al.* (2001). Also Leeson *et al.* (1991), Zubair & Leeson (1994) and Palo *et al.* (1995) could not demonstrate any effect of food restriction on dressing percentage. On the other hand, Saleh *et al.* (1996) showed a trend of increasing dressing percentage for restricted birds as well as an improvement in breast meat yield.

At the age of 49-day, the visible abdominal fat as a percentage of live body weight was decreased in slaughtered restricted-refed birds. Such a reduction in abdominal fat is in accord with results from Jones & Wiseman (1985), Plavnik & Hurwitz (1985), and Urdaneta-Rincon & Leeson (2002). In contrast to the result obtained in current experiment, Walaa Abdel-Razik (1995) and Alleman *et al.* (2000) found that abdominal fat weight increased with reducing crude protein levels in the diets of broilers. Reduction in the abdominal fat deposition in feed restricted birds may be attributed to differential effect of fat depots by the altered growth trajectory induced by temporary growth retardation. Also the effect of food restriction on total fat content remains unclear. Differences in type of broiler, environmental circumstances or perhaps

the rate of compensatory growth might be some of the other reasons for variable results (Lippens *et al.*, 2002).

Chemical composition of the meat:

Dry matter, crude protein, fat and ash content (Table 8) were not altered by energy-protein or feed intake restriction, indeed, restricting chickens to 80% of ad-libitum intake slightly increased the protein content. These results are in agreement with Palo *et al.* (1995) who reported that percentages of carcass fat, crude protein, ash and dry matter were not affected by feed restriction.

Economical evaluation (Monetary value):

Economical feed efficiency of 70%-restricted group (fifth group) was reduced by about 26.2% when compared with control. The reducing effect became more clear in the chicks fed on energy and protein restricted diets (second and third groups) and also in the 60% restricted group during the whole experimental period (66.2, 55.9 and 52.3 %). On the contrary, the third group fed on 80% restricted diet had an increasing economical feed efficiency by about 6% when compared with control (Table 9). The present experiment concluded that, birds which were restricted-refed to 80% of the ad-libitum intake and others fed on 19% CP & 3050 kcal/kg ME containing diet had a near final body weight to that of the control one. Incomplete body weight recovery was obtained for the others of great restricted groups.

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