ISSN 1110-0419

Annals Of Agric. Sc., Moshtohor,
Vol. 43(1): 149-169, (2005).

EFFECTS OF DIETARY PROTEIN LEVEL ON COMPENSATORY GROWTH, CARCASS CHARACTERISTICS AND SOME BLOOD PARAMETERS OF BROILER CHICKS

BY

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ABSTRACT

Effects of dietary protein level on compensatory growth, carcass characteristics and some blood parameters of broiler chicks were studied by experimenting five crude protein (CP) phase feeding programs. Two hundred one-day old unsexed Ross broiler chicks were divided into five groups of which the first was fed the NRC (1994) system that was considered as control. The NRC levels of protein in the three age phases starting (0-3wks), growing (3-6wks), and finishing (6-7 wks) were 23, 20 and 18% respectively. While the second group received diet containing 23, 18, and 20%CP, the third group received diet containing 20, 23, and 18%CP, the fourth group received diet containing 18, 23, and 20%CP and the fifth group received diet containing 20% allover the three periods. The results obtained can be summarized as follows:

No significant difference ($p<0.05$) was observed in body weight gain in different groups during 0-3wks of age as compared to the control group. While, there was a significant increase in body weight gain in group which received program (18, 23, 20%CP) during the period 6-7 wks of age as compared to control and the other groups. During 3-6 wks of age, as well as the whole experimental period (0-7wks) there was significant ($P<0.05$) increase in body weight gain in groups which received feeding programs (20, 23, 18%CP) and (18, 23, 20%CP) as compared to the control and the other groups.

On the other hand, significant increase ($P<0.05$) in total amount of feed intake was observed during the whole experimental period (0-7wks) in groups which received feeding programs (20, 23, 18%CP) and (20, 20, 20%CP) as compared to the control and the other groups.

Data of feed conversion ratio (FCR) showed significant ($P<0.05$) increases in FCR between the groups which received diets contained 18 or 20% CP as compared to the control and the group received diet contained 23% CP at period 0-3 wks of age. During the finishing period (6-7 wks of age) as well as the whole experimental period (0-7 wks) FCR was improved significantly ($P<0.05$)

in group which received feeding program (18, 23, 20%CP) as compared to the control and the other groups. The improvement in the overall FCR averaged 9.21% as compared to the control group. It was shown that the different feeding programs did not affect mortality percent.

Heart weight, carcass weight and total edible portions weight were significantly increased ($P<0.05$) in groups which received feeding programs (20, 23, 18%CP) and (18, 23, 20%CP) as compared to the control and the other treated groups

Plasma total protein and uric acid were increased significantly in groups which received feeding programs (20, 23, 18%CP) and (18, 23, 20%CP) as compared to the control and the other groups. While, Plasma albumin and total cholesterol levels did not show any significant changes due to dietary protein levels in all groups as compared to the control group. The data obtained for plasma total lipid and creatinine revealed significant increases ($P<0.05$) in groups which received feeding programs (20, 23, 18%CP), (18, 23, 20%CP) and (20, 20, 20%CP) as compared to the control group.

Feeding programs (20, 23, 18%CP) and (18, 23, 20%CP) improved economic efficiency as compared to the control and the other treated groups. These improvements in economic efficiency were 1.62 and 14.04% respectively than the control group.

The results showed that protein restriction in the starter phase to 18% and increase protein level in grower phase to 23% affected the performance and feed utilization. In addition, the group received feeding program (18, 23, 20 %CP) was the best for increased body weight gain, improved overall FCR (9.21%) and improved economic efficiency (14.04%).

Key words: Broilers, protein level, compensatory growth, carcass and blood parameters.

INTRODUCTION

Protein is one of the most expensive component of broiler chicken diets. Overfeeding of protein may reduce broiler production profit as well as polluting soil through extra nitrogen excretion. Many attempts have been made to reduce dietary crude protein (CP) level with no adverse effect on broiler performance; as protein per se is no longer a requirement for growing chicken. Lowering crude protein is effective in decreasing N excretion in poultry litter (Ferguson *et al.*, 1998; and Emmert *et al.*, 2000) and decreased growth performance (Ferguson *et al.*, 1998; and Blair *et al.*, 1999). On contrast, excess dietary protein also increases heat production and water consumption that increases moisture content of litter (Alleman and Leclercq, 1997).

Reduction of dietary CP by two percentage in growing broiler diets, without amino acid supplementation, dramatically reduced growth performance,

weight gain and carcass leanness (Alleman *et al.*2000). Moreover, Ferguson *et al.* (1998) demonstrated that litter N could be reduced more than 16% when dietary CP was reduced by 2%, while maintaining similar levels of dietary amino acids. Recently, the use of low CP diets, amino acid supplemented as means of lowering expenses, particularly when the cost of dietary protein sources is high was recommended (Banerjee, 1992).

Leeson and Zubair (1997) studied the nutrition of broiler chicken during period of compensatory growth by feed restriction and realimentation programs. They found that this program succeeded in improving feed efficiency and allowing full body weight recovery. Studies of Plavnik and Hurwitz (1991); Zubiar and Leeson (1994) have demonstrated the potential for early-life under-nutrition followed by full-feeding to reduce increased fat deposition and high incidence of skeletal and metabolic diseases as ascites, sudden death syndrome and leg problems.

Madrigal *et al.* (1994) examined different crude protein percentages of iso-caloric feeding programs designed to modify early growth rates in broilers compared with that stated by NRC (1994) and found little difference in the performance of birds. Leeson *et al.* (1996) stated that the bird must preferentially meet its energy requirement; in many cases it consumes excess protein with the result that a leaner carcass is produced. Conversely, if a deficiency of protein results, the bird will over consume energy in an attempt to meet its protein requirement leading to 'fatter' bird (Zubair and Leeson, 1994). Alleman *et al.* (2000) found that reducing crude protein significantly reduced breast muscle proportion.

Animals do not always have sufficient food available at particular times to allow a full expression of their genetic potential for growth, when this occurs growth falls. It has been shown in many experiments that when, food supplies again become abundant, growth rates accelerate and exceed those achieved by comparable animals fed well and continuously. This phenomenon is known as compensatory growth (Doyle and Leeson 1996; Saleh, *et al.*1996 and Lawrance and Fowler, 1997). This apparent tendency of animals to regain the position lost on their growth curves by storing their growth potential is both fascinating biologically and important economically.

The nutrient requirements stated by NRC (1994) for broilers are generally minimum levels that satisfy productive activities and prevent deficiency syndromes. The levels of nutrients and the NRC feeding program, dividing the period into three age intervals (0-3, 3-6 and 6-7 wks), were followed and recommended as they are the most optimal. In this study protein content as the most expensive nutrient in the three age-diets was tried to be reorganized, taking advantage of growth storage potential and compensatory growth as a biological phenomenon (Lawrance and Fowler, 1997).

The objective of this study was to evaluate the growth performance, carcass quality, and blood biochemical parameters of broiler chicks as a response

to different phase feeding dietary protein levels and realimentation in isocaloric feeding programs.

MATERIALS AND METHODS

Birds, housing and management

Two hundred one-day-old unsexed Ross broilers chicks were obtained from Ismailia Misr Poultry Company and used for this study. Birds were housed in brooder batteries with raised wire floors at the Poultry Experimental Farm, Faculty of Agriculture, Suez Canal University. Chicks were weighed, wing banded and randomly allotted to five groups. Within each group, 40 chicks were divided randomly to four replicates of 10 chicks each. Diet and water were provided *ad-libitum*. Photoperiod was maintained at 24 hours light throughout the study, which lasted 7 weeks. Individual body weights and feed consumption per replicate were recorded weekly to calculate feed conversion ratio (g feed consumed/g weight gain) and total mortality percentages were registered. The routine scheme for vaccination of the five groups was followed during the whole period .

Experimental diets and feeding programs:

Five isocaloric experimental diets were formulated to meet NRC (1994) requirement recommendations for all the nutrients except the protein percent, during the three intervals periods, starting (0-3wks), growing (3-6wks), and finishing periods (6-7wks). A typical five feed programs were allowed to each of the five groups. The 1st group (control) received NRC (1994) program (23, 20, and 18% CP) during the three periods. While 2nd, 3rd, 4th and 5th groups received diet protein according to the following table:-

Feeding programs and protein levels in the three feeding phases.

Groups	Experimental diets		
	Starter CP %	Grower CP%	Finisher CP%
1(control)	23	20	18
2	23	18	20
3	20	23	18
4	18	23	20
5	20	20	20

The diets composition and its calculated composition according to NRC (1994) are shown in (Table1).

Carcass characteristics

At the end of the experiment (7 weeks old) five males were taken randomly from each group for slaughter test. Weights of liver, heart, spleen, empty gizzard, eviscerated carcass, abdominal fat, were recorded to the nearest gram. Giblets, carcass, and total edible portions were calculated as percentage of live body weight.

Table (1): Composition of the experimental diets fed during starting, growing and finishing periods.

Ingredients (%)	Starter CP%			Grower CP%			Finisher CP%	
	23	20	18	23	20	18	20	18
Yellow corn ground	54.498	60.889	65.800	55.048	63.644	67.883	63.610	67.837
Soybean meai (44%)	24.363	22.796	20.759	25.003	20.129	18.980	20.955	20.000
Corn gluten (60%)	12.319	7.325	4.606	12.060	9.122	5.877	8.895	5.563
Sunflower oil	4.700	4.700	4.400	4.500	3.500	3.500	3.500	3.500
Dicalcium phosphate	1.800	1.810	1.850	1.230	1.300	1.340	1.010	1.400
Limestone	1.470	1.470	1.450	1.490	1.480	1.490	1.400	1.020
Sodium chloride	0.350	0.350	0.350	0.350	0.350	0.350	0.350	0.350
Vit. and min. Premix*	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250
DL- methionine	0.070	0.150	0.215	----	0.015	0.070	-----	-----
L-lysine	0.180	0.260	0.320	0.070	0.210	0.260	0.030	0.080
Total	100	100	100	100	100	100	100	100
Calculated composition**								
ME(kcal/Kg)	3200	3200	3200	3200	3200	3200	3200	3198.67
Crude Protein	23	20	18	23	20	18	20	18
Calcium	1.009	1.008	1.004	0.902	0.900	0.909	0.813	0.813
Phosphorous, available	0.451	0.447	0.448	0.350	0.352	0.355	0.302	0.300
Lysine	1.100	1.102	1.091	1.001	1.007	1.002	0.850	0.850
Methionine	0.501	0.507	0.526	0.433	0.390	0.396	0.377	0.329
TSAA**	0.940	0.900	0.890	0.876	0.790	0.766	0.781	0.703
Price of ton diet (LE), 2003	1409.60	1404.26	1388.19	1392.54	1337.83	1333.04	1325.45	1316.55

* Composition of the vitamins and minerals premix

Each2.5 kg of vitamin and minerals mixture contain: 12,000,000 IU vitamin A; 2,000,000 IU D3'; I0, 000 mg E; 1,000 mg K3; 1,000 mg BI; 5,000 mg B2; 1,500 mg B6; I0 mg B12; 10,000 mg pantothenic acid; 20,000 mg Nicotinic acid, 1,000 mg Folic acid; 50 mg Biotin; 500,000 mg choline chloride, 4,000 mg Copper, 300 mg Iodine; 30,000 mg Iron; 60,000 mg Manganese; 50,000 mg Zinc, and 100 mg Selenium.

**According to NRC 1994

***TSAA: Total sulfur amino acid

Biochemical parameters

At 7th weeks of age. blood samples were collected from five males in each group. Blood samples were collected from brachial veins into heparinzed tubes, centrifuged at 3000 rpm for 10 min. to separate plasma. Plasma samples were stored at -20^{0}C until used for determination of total protein (Peters, 1968). albumin, (Doumas *et al*.1971). total lipids (Zollner and Kirsch, 1962). cholesterol (Waston, 1960), creatinine (Husdan, 1968). and uric acid (Caraway. 1963) by using available commercial kits Bio-Merieux, France. The globulin values were obtained by subtracting the values of albumin from the corresponding values of total protein (Coles, 1974). In addition, albumin/globulin ratio (A/G) was calculated.

Economic efficiency

At the end of this work. the economical efficiency of the experimental diet was calculated from the input-output analysis based upon the differences in both growth rate and feeding cost as described by Bayoumi (1980).

Statistical Analysis

The data of body weight, body weight gain, feed consumption, feed conversion, slaughter test and blood parameters were statistically analyzed using one-way analysis of variance using SAS computer program (SAS, 1986). Differences among treatment means were tested using Duncan's Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

Body weight

The effects of five protein phase feeding programs on weekly body weight and body weight gain are shown in Table (2). No significant difference ($P<0.05$) was observed in body weight at 1st week of age between the groups received different protein levels as compared to the control group. At the 2nd week of age, there was significant decrease ($P<0.05$) in body weight of group received diet contained 18%CP as compared to the control and other groups. At the end of starting period (3rd week), there was significant decrease ($P<0.05$) in body weight of group received diet contained 18%CP as compared to the control and group received diet contained 23%CP

Leeson and Summers (1988) in addition to NRC (1994) suggested a relatively high concentration of protein (23%) is needed to support the rapid growth in the starting period 0-3 wks of age. The data of this experiment not fully support this suggestion. The growth of the groups received diets contained 23% CP was higher in the first three weeks. Also groups received diets contained 20% CP at the 2nd and 3rd weeks of age attained similar body weight, while the group received diet contained 18% CP at the 2nd and 3rd weeks of age had the lowest body weight (Table 2). It can be noted that in this stage feeding 20 % is adequate to supply the chicks by their needs for protein and essential amino acids, although the 23% protein was regarded to be more supporting in the first two weeks as recommended by Leeson and Summers (1988), Plavnik and Hurwitz (1989) and NRC (1994)

Table (2): **Body weight and body weigh gain of broiler chicks during the experiment (mean ± SE).**

Age or Period (weeks)	Experimental groups				
	1 (control)	2	3	4	5
	23/20/18%CP	23/18/20%CP	20/23/18%CP	18/23/20%CP	20/20/20%CP
Body weight (g)					
0	48.15±1.5^{a}	48.31±1.7^{a}	47.91±1.9^{a}	48.30 ± 1.7^{a}	47.95 ± 1.8^{a}
1	149.23±3.7^{a}	150.33±4.3^{a}	148.52±3.4^{a}	146.26 ± 3.8^{a}	147.93 ± 4.1^{a}
2	335.62±8.5^{a}	338.17±8.9^{a}	328.85±5.3^{a}	317.33 ± 5.1^{b}	326.67 ± 7.3^{a}
3	567.86±10.2^{a}	570.30±11.0^{a}	560.10±12.1^{ab}	551.47 ± 8.5^{b}	555.22 ± 10.9^{ab}
4	850.70±20.2^{b}	829.24±18.0^{b}	838.00±20.8^{b}	880.06 ± 21.1^{a}	820.40 ± 23.1^{b}
5	1230.26±37.2^{b}	1129.44±27.39^{c}	1233.1±26.2^{b}	1285.16 ± 28.3^{a}	1115.30 ± 28.6^{c}
6	1600.90±32.5^{c}	1450.60±42.4^{d}	1683.50±33.9^{b}	1735.16 ± 35.2^{a}	1490.30 ± 39.9^{d}
7	1991.80±41.8^{c}	1860.45±50.1^{d}	2098.36±38.4^{b}	2195.45 ± 45.7^{a}	1885.3 ± 44.2^{d}
Weight gain (g)					
(0-3)	519.71±12.5^{a}	521.99±15.3^{a}	512.19±17.1^{a}	503.17±14.2^{a}	507.27±14.7^{a}
(3-6)	1033.04±35.5^{c}	880.30 ± 44.4^{d}	1123.4 ± 28.9^{b}	1183.69±30.3^{a}	935.08±33.2^{d}
(6-7)	390.90±32.5^{b}	409.85 ± 30.3^{b}	414.86 ± 33.1^{b}	460.29±29.6^{a}	395.00±28.9^{b}
Total gain(0-7)	1943.65±40.7^{c}	1812.14 ± 32.1^{d}	2050.45 ± 34.2^{b}	2147.15±30.1^{a}	1837.35±38.5^{d}

a-d Means with different superscripts within each row are significantly different ($P< 0.05$)

In the 4th group received feeding programs (18, 23, 20%CP) at the 4th and 5th weeks of age (growing period), there were significant increases ($P<0.05$) in body weight as compared to the control and the other groups. On other hand, at the 6th and 7th weeks of age there were significant increases ($P<0.05$) in body weight in the 3rd and 4th groups which received feeding programs (20, 23, 18%CP) and (18, 23, 20%CP) contained 23%CP during the growing period as compared to the control group and the other groups. These increases in body weight at the 7th week were 5.35 and 10.22% than the control group respectively (Table 2).

Starting from 5th week and continued until 7th week of age, there were significant decreases ($P<0.05$) in body weight in the 2nd and 5th groups which received feeding programs (23, 18, 20%CP) and (20, 20, 20%CP) as compared to the control and other groups.

In the 3 rd and 4th groups which received 23% during the growing period (3-6 wk) stored a growth potential high enough to attain the highest weights 1683.5 and 1735.16g respectively as compared to the control and the other groups (1600.90, 1450.60 and 1490.30 g respectively). The restriction in diet protein at the starting period (20 and 18%) resulted in greater rate of growth after protein realimentation to 23%, a finding that coincides with that cited by Lawrance and Fowler (I997). The results add a suggestion 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 increases.

The supply of high protein-diet during the recovery period followed a period of diet restriction was stressed by Fontana *et al.* (I992) who found that protein might be a limiting nutrient during the recovery after a period of restriction, even if the restriction of the protein was to a level that limits and decreases the growth, the bird can compensate growth in the recovery period (Leeson and Summers, 1988).

In the finishing period 6-7 wks, the 3rd and 4th groups received diet contained 18 and 20%CP instead of 23% for both during the growing period, The chicks of both groups maintained their surpassing growth and attained 2098.36 and 2195.45g respectively as compared to the control and other groups which attained only 1991.80, 1860.45 and 1885.30 g respectively. The results of this study parallel with those reported previously by Wilson and Osbourn (1960) who stated that the more severe the protein restriction, the greater the initial rate of gain immediately after realimentation. Concerning the age during the different stages, Plavnik and Hurwitz (I991) suggested that the response to any nutrient is most likely to be maximized immediately following the period of restriction, and it seems to be reasonable to assume that such responses will diminish with age.

Body weight gain

Data of body weight gain are shown in Table (2). No significant difference ($p<0.05$) was observed in body weight gain in the treated groups which

received diets supplemented with different protein levels during 0-3wks of age as compared to the control group. While, there was a significant increase in body weight gain in group which received feeding program (18, 23, 20%CP) during the period 6-7 wks of age as compared to control and other groups.

During 3-6 wks of age, as well as the whole experimental period (0-7wks) there was a significant ($P<0.05$) increase in body weight gain in groups which received feeding programs (20, 23, 18%CP) and (18, 23, 20%CP) as compared to the control and the other treated groups. Garcia *et al* (2000) reported that lowering dietary CP content from 24 to 17% without addition of appropriate amino acid levels resulted in a decrease of chick weight gain by 20% and an increase in feed conversion ratio by 13%. In the same respect, Solangi *et al.* (2003) revealed that weight gain increased significantly by increasing dietary protein in broiler diets from 17to26 %.

The chicks of the first group (control) fed on the NRC (1994) program gained in the 7 weeks 1943.65g. When considered as 100% the other groups scored 93.23, 105.49, 110.47 and 94.53% respectively. This means that the 3rd and 4th systems of feeding are the best from the growth performance point of view. Similarly, many authors described how birds that had been feed-restricted, exhibited greater rates of gain once the restriction was removed (Plavnik and Hurwiz, 1991; Zubair and Leeson, 1994).

Feed intake

During the starting period (0-3wks), there was significant increase ($P<0.05$) in feed intake in groups which received feeding programs (20, 23, 18%CP), (18, 23, 20%CP) and (20, 20, 20%CP) as compared to the control and the other group (Table3). In the growing period (3-6 wks), there was significant decrease ($P<0.05$) in feed intake in groups which received feeding programs (23, 18, 20%CP) and (18, 23, 20%CP) as compared to the control and the other groups. While, in the finishing period (6-7 wks), a significant increase ($P<0.05$) in feed intake was observed in all groups received the four feeding programs as compared to the control group.

On the other hand, significant increase ($P<0.05$) in total amount of feed intake was observed during the whole experimental period (0-7wks) in groups which received feeding programs (20, 23, 18%CP) and (20, 20, 20%CP) as compared to the control and the other groups (Table 3).

In the first three weeks of age, the low CP (18 and 20%) increased feed intake as compared to the control and the other groups. Lipstein *et al.* (1975) stated that broilers would try to eat more to meet their particular requirement for protein and/or essential amino acids. Al-Rabdawi and Singh (1989) observed similar result. However, Lee *et al.* (1990) and Solangi *et al.* (2003) reported that feed intake was increased significantly by increasing level of dietary protein.

Table (3): Feed intake (g) and feed conversion ratio of broiler chicks during the experiment (mean ± SE).

Age period (weeks)	Experimental groups				
	1 (control)	2	3	4	5
	23/20/18%CP	23/18/20%CP	20/23/18%CP	18/23/20%CP	20/20/20%CP
Feed intake (g)					
(0-3)	884.03±8.2^{c}	890.23±10.3^{c}	931.67±9.3^{a}	915.85±11.6^{b}	925.90±12.1^{ab}
(3-6)	2358.43±32.9^{a}	2230.50±48.3^{c}	2335.70±40.1^{ab}	2300.10±45.5^{b}	2350.80±35.9^{ab}
(6-7)	1063.25±18.6^{b}	1127.09±22.8^{a}	1134.83±25.4^{a}	1100.96±30.1^{a}	1115.60±34.6^{a}
Total (0-7)	4305.71±53.2^{b}	4247.82±49.1^{b}	4402.20±35.0^{a}	4316.91±50.7^{b}	4392.30±40.2^{a}
Feed conversion					
(0-3)	1.701±0.03^{b}	1.705±0.04^{b}	1.819±0.04^{a}	1.820±0.02^{a}	1.825±0.03^{a}
(3-6)	2.283±0.04^{b}	2.534±0.11^{a}	2.079±0.13^{c}	1.943±0.12^{c}	2.514±0.12^{a}
(6-7)	2.720± 0.06^{a}	2.750±0.08^{a}	2.735±0.10^{a}	2.392±0.11^{b}	2.824±0.09^{a}
Total (0-7)	2.215± 0.05^{b}	2.344±0.04^{a}	2.147±0.06^{b}	2.011±0.09^{c}	2.391±0.06^{a}
Mortality rate	5.0	5.0	2.5	,2.5	5.0

a-d Means with different superscripts within each row are significantly different (P< 0.05)

Feed conversion ratio (FCR)

Data of feed conversion ratio are shown in Table (3). There were significant ($P<0.05$) increases in feed conversion ratio between groups received diets which contained 18 or 20% CP as compared to the control and the group which received diet contained that 23% CP during the period 0-3 wks of age. It was showed that restriction of dietary protein in starter diets (0-3wks) by feeding 18 or 20% instead of 23% has a negative effect. FCR was significantly improved ($P<0.05$) in groups received diets contained 23% CP (3rd and 4th groups) during 3-6 wks of age as compared to the control and other groups. In this experiment good feed conversion was observed with increasing protein level and this result was supported by the results obtained by Nigra and Sethi (1993) and Kassim and Suwanpradit (1996). In addition, Solangi *et al.* (2003) revealed that feed conversion ratio was improved significantly by increasing level of dietary protein.

During the finishing period (6-7 wks of age) as well as the whole experimental period (0-7 wks) FCR was significantly improved ($P<0.05$) in group which received protein feeding program (18, 23, 20%CP) as compared to the control and the other groups. The improvement in the overall FCR averaged 9.21 % as compared to the control value (Table 3).

During the finishing period (6-7 wks of age), decreasing protein level from 23% to 18% in the 3th group had no effect on FCR while decreasing it to 20% only as in the 4th group improved FCR or allowed the grower realimentation improvement to continue. These results agree with those mentioned by Zubair and Leeson (1994) who reported that the broiler chickens could perform quite well on diets of low protein content. When body weight and gross feed efficiency are the main parameters of concern, the broiler chicken appears to be able to benefit a period of early "under nutrition" in that subsequent compensatory growth results in no overall loss weight, and will likely improve feed utilization. The present data showed that broilers which received feeding program containing 18, 23, 20 %CP improved FCR significantly ($P<0.05$) for the whole experimental period as shown in Table (3).

Mortality percent

The mortality percentages are presented in Table (3). It was shown that the different feeding programs did not affect on mortality percent. These results are in agreement with those reported by Lin and Jenn (1995) who found that the dietary protein level and feed intake had no effect on mortality. The mortality, observed in this study was insignificant and may be caused by other factors than dietary protein.

Carcass characteristics

The effects of dietary protein level on carcass characteristics of broiler chicks are presented in Table (4). No significant differences were observed between the treated groups, which received, diets supplemented with different protein levels compared to the control group concerning liver weight, spleen weight, empty gizzard weight, giblets percentage, carcass percentage and total edible portions percentages. Also, Mahapatra, *et al.* (1984), Lee *et al.* (1990) and

Leeson *et al.* (1996) reported similar results, where diets containing different protein levels had no significant effect on carcass characteristics. Heart weight, carcass weight and total edible portions weight were significantly increased ($P<0.05$) in groups (3^{rd} and 4^{th}) which received feeding programs (20, 23, 18%CP) and (18, 23, 20%CP) as compared to the control and the other treated groups (Table 4). Similar results were observed by Solangi *et al.* (2003), who revealed that carcass parameters were affected significantly by level of dietary protein in broiler diets. Giblets weights were significantly increased ($P<0.05$) in group which received program (18, 23, 20%CP) as compared with the control and the other groups except the group which received feeding program (20, 23, 18%CP). In addition, there were significant increases ($P<0.05$) in abdominal fat weight and percentages in groups (4^{th} and 5^{th}) which received feeding programs (18, 23, 20%CP) and (20, 20, 20%CP) as compared to the control group, indicating that feeding low protein level in the starter diet significantly increased ($P<0.05$) abdominal fat deposition compared to high protein level. Attia *et al.* (1998) and (2001) reported similar results.

Biochemical parameters

The effects of dietary protein level on blood parameters of broiler chicks are presented in Table (5). Plasma total protein was increased significantly in groups which received feeding programs (20, 23, 18%CP) and (18, 23, 20%CP) as compared to the control and the other groups. These results are in agreement with those of Leveille and Sauberlich (1961) who stated that serum proteins are affected by the level of protein nutrition. They also, added that most serum proteins are synthesized in the liver from amino acids derived from the food or the catabolism of tissues. Sturkie (1986) reported that the state of hydration and level of dietary protein influence the level of plasma protein. The observed increase in plasma total protein in this experiment may be attributed to increase in protein consumption in some groups and thus increase rate of metabolism. Some investigators reported that the increase in plasma total protein level could be considered as an indicator for the poor utilization of digested protein by the body tissues (Berrong and Washburn 1998).

Plasma albumin levels did not show any significant changes due to dietary protein levels in all treated groups as compared to the control group. The obtained data revealed a significant increase in plasma total globulin in groups which received feeding programs (20, 23, 18%CP) and (18, 23, 20%CP) as compared to the control and other groups.

Concerning albumin-globulin ratio (A/G), significant decreases were observed in A/G of 3^{rd} group which received feeding program (20, 23, 18%CP) as compared to the control and 2^{nd} group which received feeding program (23, 18, 20%CP). Abdel-Azeem *et al.* (2001) reported that plasma total protein, and albumin, were not significantly affected by different levels of protein in quail diets, but globulin and A/G ratio were significantly influenced ($P<0.05$) at 3 weeks of age.

Table (4): Effects of dietary protein level on carcass characteristics of broiler chicks at 7 wks old (mean ± SE).

Item	Experimental groups				
	1(control)	2	3	4	5
	23/20/18%CP	23/18/20%CP	20/23/18%CP	18/23/20%CP	20/20/20%CP
Live body weight, g.	1932.50±46.3	1870.72±48.5	2030.49±53.9	2120.43±45.20	1900.79±51.3
Liver weight, g.	42.10±5.30^{a}	41.93±2.90^{a}	43.20±4.80^{a}	45.75±3.22^{a}	41.80±5.20^{a}
Heart weight , g.	9.30±1.03^{b}	9.70±0.68^{b}	11.80±0.85^{a}	12.10±1.05^{a}	10.25±1.13^{b}
Spleen weight, g.	4.37±0.30^{a}	4.60±0.23^{a}	4.23± 0.38^{a}	4.54± 0.65^{a}	4.35±0.52^{a}
Empty gizzard, g.	35.30 ±3.70^{a}	33.00±2.95^{a}	36.25±2.18^{a}	35.90±3.65^{a}	34.21±2.99^{a}
Giblets weight[1] ,g.	91.07±4.28^{b}	89.23±5.50^{b}	95.48±4.17^{ab}	98.29±5.20^{a}	90.61±4.80^{b}
Giblets %	4.71±0.32^{a}	4.77±0.25^{a}	4.70± 0.29^{a}	4.64± 0.18^{a}	4.77±0.22^{a}
Carcass weight[2],g.	1328.40±44.1^{b}	1273.96±60.2^{b}	1420.33±49.5^{a}	1487.48±50.3^{a}	1290.45±48.1^{b}
Carcass %	68.74±1.25^{ab}	68.10±1.05^{b}	69.95±0.99^{a}	70.15±1.19^{a}	67.89±1.4^{b}
Total edible portions[3], g	1419.47±34.2^{b}	1362.19±52.3^{b}	1515.81±60.1^{a}	1585.77±46.2^{a}	1381.06±50.1^{b}
Total edible portions,%	73.45±1.10^{ab}	72.82±1.09^{b}	74.65±1.18^{a}	74.79±0.95^{a}	72.66±1.2^{b}
Abdominal fat, g.	40.50±4.85^{c}	40.86±5.1^{c}	46.95±4.5^{bc}	68.32±3.97^{a}	48.65±4.10^{b}
Abdominal fat,%	2.10±0.40^{c}	2.18±0.32^{c}	2.31±0.25^{bc}	3.22±0.22^{a}	2.56±0.19^{b}

a – c Means with different letters within each row are significantly different ($p< 0.05$)

1-Giblets (liver, heart, spleen and empty gizzard)

2-Carcass weight = Eviscerated weight

3- Total edible portions = carcass weight + giblets weight

Table (5): Biochemical Parameters of broiler chicks fed different dietary protein levels.

Blood measure	Experimental groups				
	1(control)	2	3	4	5
	23/20/18%CP	23/18/20%CP	20/23/18%CP	18/23/20%CP	20/20/20%CP
Total Protein (g/dl)	4.35±0.13^{b}	4.47±0.15^{b}	4.82±0.12^{a}	4.98±0.16^{a}	4.39±0.19^{b}
Albumen (g/dl)	2.32±0.09^{a}	2.35±0.12^{a}	2.30±0.23^{a}	2.41±0.20^{a}	2.29±0.25^{a}
Globulin (g/dl)	2.03±0.18^{b}	2.12±0.11^{b}	2.52±0.25^{a}	2.57±0.16^{a}	2.10±0.15^{b}
A\G ratio	1.14±0.13^{a}	1.11±0.10^{a}	0.91±0.09^{b}	0.94±0.23^{ab}	1.09±0.18^{ab}
Total Lipids(mg/dl)	4.26±0.30^{c}	4.69±0.45^{bc}	5.95±0.39^{a}	6.01±0.43^{a}	4.82±0.42^{b}
Cholesterol (mg/dl)	150.20±12.50^{a}	163.10±11.45^{a}	158.13±8.61^{a}	168.30±23.3^{a}	159.33±14.50^{a}
Creatinine (mg/dl)	1.10±0.02^{c}	1.13±0.04^{c}	1.26±0.05^{b}	1.32±0.03^{a}	1.22±0.05^{b}
Uric acid (mg/dl)	4.93±1.01^{b}	5.06±0.29^{b}	6.12±0.31^{a}	6.28±0.85^{a}	4.85±0.36^{b}

a-c Means with different letters within each row are significantly different ($P < 0.05$).

The data obtained for plasma total lipid revealed significant increases ($P<0.05$) in the 3rd, 4th and 5th groups which received feeding programs (20, 23, 18%CP), (18, 23, 20%CP) and (20, 20, 20%CP) as compared to the control group. Sturkie (1986) and Abdel-Azeem *et al.* (2001) reported that the effect on plasma lipid concentration was related to the dietary protein levels, since increasing the dietary protein level was more effective in increasing serum total lipids.

Regarding plasma total cholesterol, data showed non-significant differences among groups, which received different protein feeding programs as compared to the control group. In the same respect, Abdel-Azeem *et al.* (2001) reported that different dietary protein levels did not affect the total plasma cholesterol.

The data obtained for plasma creatinine revealed significant increases ($P<0.05$) in the 3rd, 4th and 5th groups which received feeding programs (20, 23, 18%CP), (18, 23, 20%CP) and (20, 20, 20%CP) as compared to the control and 2nd group which received feeding program (23, 18, 20%CP). On the contrary, Abdel-Azeem *et al.* (2001) reported that creatinine was not significantly affected by different levels of protein in diets.

Meanwhile, plasma uric acid values revealed significant increases ($P<0.05$) in groups which received feeding programs (20, 23, 18%CP) and (18, 23, 20%CP) as compared to the control and the other groups (Table 5). Abdel Malak *et al.*,(1995) and Kaneko *et al.*, (1997) reported that dietary protein content rather than any other factor strongly affects plasma uric acid.

The economical study

The study for economic evaluation of broiler chicks fed the experimental diets are summarized in Table (6). It was observed that groups which received feeding programs (20, 23, 18%CP) and (18, 23, 20%CP) improved economic efficiency as compared to the control and the other groups. These improvements in economic efficiency were 1.62 and 14.04% respectively compared to the control group. From economic point of view, it was clear that group which received feeding program of 18, 23 and 20%CP have the best economic efficiency. While groups received feeding programs (23, 18, 20%CP) and (20, 20, 20%CP) recorded the lowest economic efficiency as compared to the control group.

These results are in agreement with those reported by Leeson *et al.* (1996) who explained that relatively low protein levels had little effect on early growth rate in broilers, as body weight of birds is initially reduced with lower-protein starter diets. Also, Solangi *et al.* (2003) revealed that groups received diets contained 17% or 26% CP were less economical against 23% and 20% CP levels.

Table (6): Input-output analysis and economical efficiency of different experimental groups.

Items	Experimental groups				
	1 (control)	2	3	4	5
	23/20/18%CP	23/18/20%CP	20/23/18%CP	18/23/20%CP	20/20/20%CP
Average feed consumed (kg)	4.306	4.248	4.402	4.317	4.392
Price/kg feed consumed (PT)[1]	134.722	134.843	137.550	137.448	134.885
Total feed cost (PT)	580.113	572.813	605.495	593.363	592.415
Average live Weight (kg)	1.992	1.860	2.098	2.195	1.885
Price/kg live Weight (PT)[2]	650.0	650.0	650.0	650.0	650.0
Total revenue (PT)	1294.80	1209.00	1363.70	1426.75	1225.25
Net revenue (PT)	714.687	636.187	758.205	833.387	632.835
Economic efficiency (EE)[3]	1.232	1.111	1.252	1.405	1.068
Relative economic efficiency[4]	100	90.18	101.62	114.04	86.688

1 Total price of feed consumed at starting, growing and finishing periods / total feed consumed
2 According to the local market price at the experimental time (2003).
3 Net revenue per unit food cost.
4 Assuming the E.E. of control diet equals 100.

In conclusion, these results provide evidence that feeding protein program 18, 23 and 20%CP in the three age intervals 0-3, 3-6 and 6-7 weeks, was more effective for improving growth performance and economic efficiency of Ross broiler chicks

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تأثير مستوى بروتين العليقة على النمو التعويضى وصفات الذبيحة وبعض مقاييس الدم لكتاكيت اللحم

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أجريت هذه التجربة لدراسة تأثير مستوى بروتين العليقة على النمو التعويضى وصفات الذبيحة وبعض مقاييس الدم والكفاءة الأقتصاديه لكتاكيت اللحم وذلك باستخدام ٥ برامج تغذية تختلف فى مراحل العمر الثلاثة فى نسب البروتين. تم أجراء التجربة علي ٢٠٠ كتكوت تسمين روس (غيرمجنس) عمر يوم قسمت عشوائيا إلى ٥ مجاميع تجريبية كانت المجموعة الأولى منها كنترول غذيت على النظام الموصى به من المجلس القومى للأبحاث بأمريكا عام ١٩٩٤ حيث وضع المجلس القومى للأبحاث ٣مستويات للبروتين لعلائق الدواجن خلال مراحل العمر الثلاثة (صفر-٣ أسابيع) و(٣-٦ أسابيع) و(٦- ٨ أسابيع) وهى ٢٣و٢٠ و١٨% بروتين خام على التوالي. بينما المجموعة الثانية كانت ٢٣ و ١٨ و٢٠% والمجموعة الثالثة٢٠و٢٣و١٨% والمجموعة الرابعة ١٨و٢٣و٢٠% والمجموعة الخامسة ٢٠و٢٠و٢٠و% واستمرت التجربة لمدة سبع أسابيع. وكانت نتائج التجربة ما يلي:-

١ - لم يكن هناك اختلاف معنوي في الزيادة فى وزن الجسم خلال الفترة صفر-٣ أسابيع بالنسبة لكتاكيت كل المجاميع التجريبية المغذاة علي برامج تغذية تختلف فى نسب البروتين بالمقارنة بالمجموعة الكنترول.بينما كان هناك اختلاف معنوي في الزيادة فى وزن الجسم خلال الفترة ٦-٧ أسابيع بالنسبة للكتاكيت المغذاة علي البرنامج ١٨و٢٣و٢٠% بالمقارنة بالمجموعة الكنترول والمجاميع التجريبية الأخرى. كما كان هناك تحسن معنوي للزيادة وزن الجسم خلال الفترة ٣-٦ أسابيع والزيادة المكتسبة الكلية فى وزن الجسم خلال الفترة صفر- ٧ أسابيع بالنسبة للكتاكيت المغذاة علي برامج التغذية (٢٠و٢٣و١٨%) و(١٨و٢٣و ٢٠%) بالمقارنة بالمجموعة الكنترول والمجاميع التجريبية الأخرى.

٢- كان هناك زيادة معنوية في كمية الغذاء المستهلك طول فترة التجربة للكتاكيت المغذاة علي برامج التغذية (٢٠و٢٣و١٨%) و(٢٠و٢٠و٢٠%) بالمقارنة بالكنترول والمجاميع التجريبية الأخرى.

٣ - حدث زيادة معنوية في نسبة تحويل الغذاء خلال الفترة صفر-٣ أسابيع بين والمجاميع التجريبية للكتاكيت المغذاة علي علائق تحتوى على ١٨و٢٠% بروتين بالمقارنة بالمجموعة الكنترول والمجموعة المغذاة على عليقة تحتوى على ٢٣% بروتين. بينما حدث تحسن معنوي في نسبة تحويل الغذاء خلال الفترة ٦-٧ أسابيع وكذلك طول فترة التجربة صفر-٧ أسابيع بالنسبة للكتاكيت المغذاة علي البرنامج ١٨و٢٣و٢٠% بالمقارنة بالمجموعة الكنترول والمجاميع التجريبية الأخرى. وكان التحسن في كفاءة تحويل الغذاء بنسبة ٩,٢١% بالمقارنة بالمجموعة الكنترول.

٤- كما لم تظهر برامج التغذية المختلفة فى مستوى البروتين أى تأثير على معدل الوفيات.

٥- كان هناك زيادة معنوية فى وزن القلب ووزن الذبيحة و اللأجزاء الكلية المأكولة بالنسبة للكتاكيت المغذاة علي برامج التغذية (٢٠و٢٣و١٨%) و(١٨و٢٣و٢٠%) بالمقارنة بالمجموعة الكنترول والمجاميع التجريبية الأخرى.

٦- كانت هناك زيادة معنوية في بلازما البروتين الكلي وحمض اليوريك بالنسبة للكتاكيت المغذاة علي برامج التغذية (٢٠و٢٣و١٨%) و(١٨و٢٣و٢٠%) بالمقارنة بالمجموعة الكنترول والمجاميع التجريبية الأخرى. بينما لم يتأثر البيومين البلازما و والكوليسترول الكلى بمستوى بروتين العليقة فى المجاميع التجريبية بالمقارنة بالكنترول. وظهرت زيادة معنوية في مستوى اللبيدات الكلية للبلازما و الكرياتينين بالنسبة للكتاكيت المغذاة علي برامج التغذية (٢٠و٢٣و١٨%) و(١٨و٢٣و٢٠%) و(٢٠و٢٠و٢٠%) بالمقارنة بالمجموعة الكنترول.

٧- حدث تحسن في الكفاءة الأقتصاديه للعلائق بالنسبة للكتاكيت المغذاة علي برامج التغذية (٢٠و٢٣و١٨%) و (١٨و٢٣و٢٠%) بالمقارنة بالمجموعة الكنترول والمجاميع التجريبية الأخرى.وكان هذا التحسن بنسبة ١,٦٢ و ١٤,٠٤ % على التوالي بالمقارنة بالمجموعة الكنترول.

أوضحت نتائج هذة الدراسة أن تحديد مستوى البروتين فى فترة البادى لكتاكيت اللحم روس الى ١٨% بروتين خام لة تاثيرعلى الأداء وأن زيادة مستوى البروتين فى فترة النموالى٢٣%أدى الى تحسين معدل النمو وكذلك معامل التحويل الغذائى.بالأضافة الى أن التغذية علي البرنامج ١٨و٢٣و٢٠% كان الأكثر كفاءة فى تحسين أداء الكتاكيت من حيث الزيادة فى وزن الجسم وتحسين الكفاءة الغذائية (٩,٢١%) كما أدى الى تحسين الكفاءة الأقتصاديه(١٤,٠٤%).