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EFFECT OF HIGH-DENSITY DIET FEEDING DURATIONS AND INITIAL CHICK WEIGHT CATEGORIES ON GROWTH, CARCASS, SERUM BIOCHEMISTRY AND IMMUNE RESPONSE OF COMMERCIAL BROILERS

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ABSTRACT

The objective of this study was to evaluate the effect of feeding high density diet for different durations on growth performance, carcass characteristics and immune response of commercial broilers affected by initial chick weight categories. A total 600 1-d-old, broiler chicks (Ross 308) were randomly placed according to a completely randomized design under a factorial arrangement, with 03 body weight categories namely C, B, A (i.e., 31-34 g, 35-38 g, 39-42 g, respectively) and 04 high-density diet feeding durations (0, 5, 10, and 15 days) during the starter phase. Each treatment was replicated five times, having 10 birds apiece. The results revealed that the chicks of the A category had higher body weight, better feed conversion ratio and dressing percentage while feed intake and cut-up yield remained unaffected with chick weight categories. The chicks belonging to the higher body weight category also showed a higher antibody titer against Newcastle disease. The birds fed on high protein diet for 15 days showed higher final weight, best feed conversion ratio, the highest percentage of carcass yield, and the highest immunity against Newcastle disease. However, there was a slight difference between the birds fed on high protein diet for 10 days and 15 days. The birds belonging to large chick categories resulted in maximum profit when fed on high protein diet for 10 days whereas the birds belonging to small categories suffered with a greatest loss when fed on a control diet. Therefore, it was concluded from the results that birds having higher initial weight will ultimately have higher weight at slaughter age. In concern to feeding regimes, the birds fed with high density diet remained most economical. It is also concluded that the weight of chicks with lower initial body weight can be compensated till slaughter age by feeding them with high density diet during starter phase.

Keywords: High density diet, chick weight, performance, economics

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INTRODUCTION

Over the last few decades, the advancements in poultry genetics have enabled broiler to reach the market weight within 35 days rather than 120 days during the early phase of poultry industry development (Leeson and Summers, 2009). The poultry industry is working hard to further reduce the market age along with a reduction in the losses at different stages of production. Although, the poultry industry is shaping well for the last decade in terms of production performance but is still facing some issues regarding the marketing of chicks due to variations in their size and quality. Variations in the growth rate within a flock has been observed due to several reasons such as differences between sexes (Choo *et al.,* 2014), initial chick size (Mendes *et al.,* 2011), managemental problems and diseases (Yang *et al.,* 2011). These differences in a flock are neither beneficial for farmers nor the processing plant. Higher the uniformity in the flocks better will be the efficiency in production and higher will be the market price. The reduction of variation also resulted in the smooth functioning of a processing plant and easy fulfillment of customer's demand.

The initial weight of the chick plays a vital role in its final weight. Chicks having higher initial body weight are observed to gain more weight and have higher final body weight (Patbandha *et al.,* 2017). Usually, in a broiler flock, chick weight varies between 30 g to 45 g or sometimes slightly higher (Alsobayel *et al.,* 2013). It is an established fact that the weight of the chick is dependent on 20 egg size and largely on the age of the breeder flock (Lourens *et al.,* 2006). As the broiler breeders grow in age, the weight of eggs they produce and size of the chicks that hatch out of those eggs increases gradually (Christensen *et al.,* 2002; Yildirim, 2005). The eggs produced during the starter phase of production are smaller in size and chicks hatched out from those eggs are also smaller in size (30-34 g) and take more time of about 42 days to attain the required market weight (2 kg). On the other hand, the eggs which broiler breeder hen produces at the age of 36 weeks of age or later in life have a normal size or large size and the chicks hatched out of those eggs are larger in size as compare to starter chicks. These chicks attain the required market bodyweight much earlier (35 days) than those of starter chicks (Iqbal *et al.,* 2016). Similarly, livability percentage was also reported to be affected by initial chick weight; as a higher mortality rate has been reported in chicks hatched from smaller eggs than those of larger eggs (Decuypere and Bruggeman, 2007). These starter or underweight chicks are being produced in a large number and they pose a serious threat to profit margins of breeder farmers and hatchery managers because starter chicks are low in price (25% than the normal chick price). Moreover, a low initial body weight of chick has a negative effect on its weight at slaughter age (Toledo *et al.,* 2011). Early feeding significantly impacts the growth performance, development of the digestive system, and immunity of broiler for the rest of its life and also ensures its good market rate (Prabakar *et al.,* 2016). Among different strategies to cope up with this problem, enrichment of diet with very high levels of proteins for a shorter period of time can be used as a potential solution.

Protein is considered the important component of the body as it plays an important role in the building up and repairing of tissues. Protein in the diet improves growth performance and feed efficiency of a broiler; therefore, to support the genetic ability of chicken broilers, to grow at a very rapid rate, a high amount of proteins is required (Zuidhof *et al.,* 2014). According to Gheisari *et al.* (2015), higher protein levels in the diet results in an increase in the growth performance of the broiler chicks. The chicks offered a higher level of dietary protein gain more weight as compared to those offered a lower level of dietary protein (Liu *et al.,* 2017). Feeding broilers with lower level of crude protein results in poor growth performance (Law *et al.,* 2018) and also reduced level of plasma in blood (Attia *et al.,* 2017). Another study elaborated the interactive effect of different day-old-chick weight categories and dietary protein levels and observed an increase in the growth performance of low weight chicks after eating protein-rich feed (Toledo *et al.,* 2011). However, studies regarding the duration of feeding high density to different initial chick weight are scarce. It was hypothesized that the growth performance of low weight chicks could be increased by feeding high density protein diet and the required market bodyweight can be attained within 35 days rather than 120 days. Thus, this study was planned to investigate the impact of feeding high protein diet on growth performance, carcass characteristics and blood biochemical profile of broilers belonging to different initial chick weight categories.

MATERIALS AND METHODS

Experimental Site: The research under consideration was carried out at Broiler Research Unit of C-Block, University of Veterinary and Animal Sciences, Ravi Campus, Pattoki, Punjab, Pakistan.

Design of Experiment: The bird chosen for the research was broiler belonging to the strain of Ross-308. Total 600 birds were procured from a commercial hatchery named Bird Inn located on main highway, Akhtarabad and stratified into 12 different treatment groups based on three initial chick weight categories (30-34 g, 35-38 g, and 39-42 g) and fed with high-density diet (23 % CP) for 4 different durations (initial 0, 5, 10, 15 days) according to a Completely Randomized Design (CRD) (Daniel, 2010). The complete feed formulation of high density as well as control diets is mentioned in the Table 1 & Table 2.

Table 1: Feed Formulation.

Ingredients	HD Diet Inclusion level (%)	Control diet Inclusion level (%)
Maize	53.05	60.63
Soybean Meal	33.00	25.80
Rice Polishing	1.00	3.05
Soybean Oil	2.50	-----
Canola Meal	3.00	1.00
Guar Meal	4.80	7.00
Sodium Bicarbonate	0.21	0.20
MCP	0.30	0.27
Calcium Carbonate	0.80	0.88
Sodium Chloride	0.22	0.25
L-Lysine HCL	0.29	0.30
DL-Methionine	0.30	0.17
L-Threonine	0.11	0.03
Phytase 1000 FTU	0.02	0.02
Vitamin Mineral Premix	0.40	0.40

Table 2: Nutrient Composition of the diets.

Nutrients	HD Diet %age	Control diet %age
Crude Protein	23.00	21.00
Metab. Energy	3140	2871
Arginine Digestible	1.4754	1.3500
Ash	4.4152	4.3120
Avail. Phos.	0.2430	0.3532
Calcium	0.5612	0.8700
Chlorine	0.2800	0.2591
Ether extract	2.8926	3.420
Crude Fiber	4.2301	4.0970
Cysteine Digestible	0.2642	0.2533
Histidine Digestible	0.5812	0.4600
Isoleucine Digestible	0.8856	0.7437
Leucine Digestible	1.6321	1.5096
Lysine Digestible	1.2800	1.1200

Met + Cys Digestible	0.9500	0.7500
Methionine Digestible	0.6234	0.6063
Moisture	11.53	11.53
Phenylalanine Digestible	0.9963	0.8840
Potassium	1.0000	0.9221
Sodium	0.1600	0.1600
Threonine Digestible	0.8600	0.7000
Tryptophan Digestible	0.2410	0.2126
Valine Digestible	0.8980	0.8311

Bird's husbandry: The chicks were regularly vaccinated against Newcastle disease and Avian Influenza diseases via drinking water. There were total 60 pens made as each treatment was further divided into 05 replicates. The bedding material of rice husk was spread on the floor of each pen. Each pen was given the area of 1 × 1 m^2 and was facilitated with one round feeder and four nipple drinkers providing an *ad libitum* supply of feed and fresh water. Brooding temperature of 33 ± 1.1ºC and relative humidity (**RH**) of 62 ± 3% were maintained for the first week of chick's life, after which, the temperature was reduced 3ºC per week until it reached 24ºC on day 21 with RH ~ 65%. A lighting program of 23L:1D was implemented throughout the study.

Growth performance: In each experimental replicate, daily feed intake (g) and weekly body weight (g) was measured. FCR was calculated on weekly basis by dividing the weekly feed intake by the weight gained in a week. Mortality was recorded on daily basis to calculate the mortality percentage throughout the experimental period.

Carcass characteristics: At 35th day of age, 02 birds (10 per treatment) of average body weight were selected from each replicate and were slaughtered according to the Halal Zabiha method following the ethical standards and guidelines of Ethical Approval Committee of University of Veterinary and Animal Sciences, Lahore. Every live bird was individually weighed before slaughtering. After slaughtering, the feathers as well as skin of the birds was removed. Carcass yield was weighed after the removal of feathers, skin, fat and giblets. Wings, breast, thighs, abdominal fat and every individual giblet such as heart, liver, gizzard and empty intestine was weighed separately. After it, the percentage of the weight of carcass, abdominal fat, liver, gizzard, heart and empty intestine was calculated out of the live body weight and the percentage of wings, thigh and breast was calculated from the carcass weight.

Blood biochemistry and antibody response: At the end of trial, from jugular vein of 02 birds, 5 mL blood, per replicate was collected, and put in vacutainer with no anticoagulant to measure glucose, cholesterol and total protein. Serum was separated and stored at -20ºC. The given test was conducted at UDL and Pet Centre Lab UVAS, Lahore. The test method was colorimetric test for estimation of total protein, cholesterol and glucose. For immune response, 5 mL blood form Jugular vein of 2 birds per replicate was collected and put in vacutainer with no anticoagulant. Serum was separated and was stored at -20ºC. The immunity status of the broilers was assessed through evaluating antibody titers against Newcastle Disease and Avian Influenza via hemagglutinin inhibition (HI) (Rabbani *et al.,* 2001). The tests were conducted at University Diagnostic Lab (UDL), UVAS, Lahore.

Statistical analysis: The collected data were analyzed through factorial ANOVA using GLM procedure in SAS software SAS 9.1. Significant treatment means were compared with Duncan's Multiple Range (DMR) test (Duncan, 1955).

RESULTS AND DISCUSSION

Growth performance: The effects of initial chick weight categories, high density diet durations and their interactions on the bird's live performance are presented in Table 3 and Table 4, respectively.

Table 3: Effect of initial chick weight and high-density diet durations on growth performance of broilers (Means ± SEM).

Treatment[2]		Parameters[1]			
		FI (g)	BW (g)	FCR	M (%)
CWC	S	2982.58±52.39[b]	1867.28±42.47[b]	1.60±0.02	4.07±0.56
	M	3102.08±57.58[ab]	1969.49±48.61[ab]	1.58±0.02	3.43±0.30
	H	3204.33±56.17[a]	2049.26 ±49.43[a]	1.57±0.01	3.26±0.21
HDR	0-Day	3041.11±53.97	1828.74±40.72[c]	1.66±0.01[a]	2.81±0.18
	5-Days	3069±58.81	1912.24±42.13[bc]	1.60±0.02[b]	2.63±0.43
	10-Days	3106.11±80.42	2036.71±55.08[ab]	1.52±0.01[c]	3.02±0.32
	15-Days	3168.56±83.84	2070.33±61.10[a]	1.53±0.02[c]	2.93±0.27
P-value	CWC	0.02	0.03	0.41	0.09
	HDR	0.61	0.006	0.0001	0.18
	CWC × HDR	0.68	0.048	0.001	0.11

Note: Different alphabets on means (in a column) showing significant differences among treatments
[1]FI: feed intake, BW: body weight, FCR: feed conversion ratio, M: mortality.
[2]CWC: chick weight categories, S: small, M: medium, H: heavy, HDR: high density regimes.

Table 4: Interactive effect of initial chick weight and high-density diet durations on growth performance of broilers (Means ± SEM).

Treatment[2]		Parameters[1]			
CWC	**HDR**	**FI(g)**	**BW (g)**	**FCR**	**M (%)**
S	0-Day HD	2936.67±60.64	1746.03±48.61^{d}	1.68±0.01^{a}	3.42±0.12
	5-Days HD	2973.53±90.03	1827.73±56.50^{cd}	1.63±0.03^{c}	3.30±0.3
	10-Days HD	3001.61±154.44	1945.00±93.24^{abcd}	1.54±0.02^{ef}	3.57±0.23
	15-Days HD	3018.31±151.17	1950.33±104.08^{abcd}	1.55±0.03^{e}	3.51±0.14
M	0-Day HD	3051.66±90.84	1839.17±66.74^{bcd}	1.66±0.01^{ab}	3.16±0.09
	5-Days HD	3056.41±106.54	1908.50±72.60^{abcd}	1.60±0.02^{d}	3.08±0.21
	10-Days HD	3110.22±156.31	2041.97±104.37^{abc}	1.52±0.01^{fg}	3.29±0.16
	15-Days HD	3190.17±150.69	2088.33±106.49^{abc}	1.53±0.03^{efg}	3.21±0.11
H	0-Day HD	3135.07±114.49	1901.03±83.62^{abcd}	1.65±0.02^{b}	3.04±0.23
	5-Days HD	3178.35±107.01	2000.50±73.23^{abcd}	1.59±0.01^{d}	2.96±0.15
	10-Days HD	3206.65±137.15	2123.17±94.14^{ab}	1.51±0.02^{g}	3.18±0.27
	15-Days HD	3297.37±137.78	2172.33±100.32^{a}	1.52±0.02^{fg}	3.13±0.13

Note: Different alphabets on means (in a column) showing significant differences among treatments
[1]FI: feed intake, BW: body weight, FCR: feed conversion ratio, M: mortality.
[2]CWC: chick weight categories, S: small, M: medium, H: heavy, HDR: high-density regimes.

Weight gain (g): The chicks belonging to heavyweight category achieved significantly (P<0.05) higher body weight followed by the chicks belonging to medium and small weight categories. This research agrees with the findings of Sklan *et al.* (2003) who stated that chicks with a higher body weight at the time of hatching showed better muscular and skeletal growth resulting in higher market bodyweight. Similarly, Toledo *et al.* (2011) also reported that the birds having higher initial body weight had higher final weight as compared to those with lower initial weight which is proved to be correct by the research under consideration. These results agree with the findings of Mendes *et al.* (2011) who found the chicks having higher initial weight to be heavier at market age than those having lower initial weight. The present results, likewise, consented with Patbandha *et al.* (2017) who observed higher final body weight to be attained by the chicks having higher initial body weight.

As far as different high density feeding durations are concerned, chicks fed with high-density feed for 15 days gained maximum body weight while the control group achieved the least body weight which showed that feeding the birds with high protein in their initial age enhanced their body weight as protein is a king nutrient that promotes growth. There was however a negligible difference between the weigh gained by the birds fed with high protein feed for initial 10 days and 15 days which indicates that high protein has a significant effect on weight gain for initial 10 days only after which protein stops to affect significantly as the body gets hard and reduces its protein absorption ability. The finding of Kamran *et al.* (2008) that feeding broilers with lower levels of protein in the starter phase had a negative effect on the body weight was proved to be correct by the present research. It also consented with the statement of Nguyen and Bunchasak (2005) that feeding birds with a lower level of protein diet at an early age lead to reduction in live body weight and growth rate. Another study (Prabakar *et al.,* 2016) reported that the early feeding of broilers significantly impacts on the growth performance, development of the digestive system, and immunity of broiler for the rest of its life and also ensures its good market rate. Similarly, Liu *et al.* (2017) also stated that chicks offered a higher level of dietary protein gained more weight as compared to those offered a lower level of dietary protein. This research also in agreement with the findings of Law *et al.* (2018) that feeding the broiler with diet containing reduced crude protein (CP) levels resulted in poor growth performance.

Feed Intake (g): The chicks belonging to heavyweight category consumed significantly (P<0.05) higher amount of feed followed by those chicks belonging to medium and small weight categories. These findings could be attributed to the higher growth rate of heavier chicks that resulted in more nutrient requirement and ultimately higher feed consumption in order to meet their body requirements. Similar results were also reported by Mendes *et al.* (2011) who found a directly proportional relationship between the weight of chick on its 1st day and the amount of total feed consumed by it till its slaughter age. Birds having higher initial body weight usually show higher feed consumption as compared to those with lower initial weight (Toledo *et al.,* 2011).

In the present study, feeding high density diets for different periods did not influence (P>0.05) the feed intake as the birds consumed the feed quantity wise ignorant of the ingredients present in the feed. The present research agreed with the findings of Liu *et al.* (2015) who also reported no effect of increased dietary crude protein on the feed intake.

Feed Conversion Ratio (FCR): In the present study, FCR of broilers was found to be not affected by different chick weight categories as the feed and nutrient requirements of a bird is directly proportional to its body size and weight therefore, birds having higher body weight require more feed for their body maintenance and to cope up with their body requirements. These findings were in agreement with the findings of Mendes *et al.* (2011) that the weight of the day-old chick showed no effect on the feed conversion ratio until the 35th day of age.

While, birds fed with high density diet for 10 and 15 days showed significantly (P<0.0001) better FCR whereas birds belonging to the control group showed the poorest FCR as high protein diet enhanced the growth and body weight of the birds ignorant of the amount of feed consumed. However, there was a negligible difference between the weight gain and FCR of birds fed with high protein feed for initial 10 days and 15 days which depicts that high level of protein impacts significantly on growth performance up to 10^{th} day of age after which it stops to show significant effect. These results were in agreement with the findings of Everaert *et al.* (2010) who reported that the broilers fed with a pre-starter diet containing a higher level of crude protein (CP) showed better FCR and higher growth rate compared to those fed with lower protein. Peak *et al.* (2000) also stated that feeding broilers with a low protein diet resulted in poor FCR. Similarly, Toledo *et al.* (2011) also reported that the broiler fed with pre-starter diet having higher level of CP showed better FCR and higher weight at market age ignorant to its initial body weight. Liu *et al.* (2015) showed an improved FCR and growth rate in birds fed with high crude protein than those fed with comparatively lower crude protein which is completely in consent with the present research. The results also agreed with Liu *et al.* (2017) who observed better FCR in broiler fed with a high level of dietary protein than those fed with a comparatively lower level of dietary protein. The present results were also in agreement with the statements of Mahdavia *et al.* (2017) that higher weight gain and better FCR was observed in birds fed with pre-starter diet up to 10 days as compared to those fed with the pre-starter diet for 4 days.

Carcass Traits: The effect of initial chick weight categories and high density diet durations on carcass characteristics is shown in Table 5-7.

Table 5: Effect of initial chick weight and high-density diet durations on carcass characteristics of broilers (Means ± SEM).

Treatment[2]		Parameters[1]			
		C %	W %	BH %	LH %
CWC	S	$7.82{\pm}0.03^{c}$	11.98±0.09	44.95±0.07	40.89±0.05
	M	$7.95{\pm}0.04^{b}$	12.12±0.05	45.06±0.09	40.80±0.08
	H	$8.11{\pm}0.02^{a}$	12.35±0.07	45.02±0.06	41.12±0.10
HDR	0-Day	$7.84{\pm}0.04^{b}$	11.87±0.08	44.88±0.05	41.95±0.09
	5-Days	$7.92{\pm}0.05^{b}$	12.10±0.10	44.72±0.10	41.99±0.10
	10-Days	$8.04{\pm}0.04^{a}$	12.28±0.07	45.06±0.09	42.19±0.08
	15-Days	$8.05{\pm}0.03^{a}$	12.27±0.06	45.15±0.09	42.13±0.07
P-value	CWC	0.0001	0.42	0.51	0.33
	HDR	0.0009	0.53	0.44	0.48
	CWC×HDR	0.0001	0.37	0.43	0.11

Note: Different alphabets on means showing significant difference (P<0.05)
[1]C: carcass, W: wing, BH: breast half, LH: leg half.
[2]CWC: chick weight categories, S: small, M: medium, H: heavy, HDR: high-density regimes.

Table 6: Effect of initial chick weight and high-density diet durations on visceral organs (Means ± SEM).

Treatment[2]		Parameters[1]				
		I %	AF %	H %	L %	G %
CWC	S	2.72±0.04	$0.71{\pm}0.02^{c}$	0.48±0.01	1.94±0.05	1.28±0.04
	M	2.86±0.05	$0.76{\pm}0.03^{b}$	0.49±0.03	2.18±0.07	1.45±0.03
	H	3.11±0.06	$0.84{\pm}0.03^{a}$	0.51±0.02	2.34±0.05	1.63±0.07
HDR	0-Day	2.51±0.05	$0.85{\pm}0.02^{a}$	0.46±0.03	2.28±0.07	1.38±0.05
	5-Days	2.63±0.07	$0.81{\pm}0.01^{b}$	0.48±0.02	2.31±0.1	1.50±0.08
	10-Days	2.88±0.04	$0.74{\pm}0.03^{c}$	0.52±0.02	2.36±0.04	1.44±0.03
	15-Days	2.97±0.06	$0.69{\pm}0.02^{d}$	0.51±0.01	2.38±0.07	1.61±0.05
P-value	CWC	0.26	0.0001	0.23	0.25	0.23
	HDR	0.39	0.0001	0.11	0.37	0.18
	CWC×HDR	0.34	0.0001	0.24	0.16	0.08

Note: Different alphabets on means (in a column) showing significant differences among treatments
[1]I: intestine, AF: abdominal fat, H: heart, L: lever, G: gizzard.
[2]CWC: chick weight categories, S: small, M: medium, H: heavy, HDR: high-density regimes.

Table 7: Interactive effect of initial chick weight and high-density diet durations on carcass characteristics of broilers (Means ± SEM).

Treatment[2]		Parameters[1]	
CWC	**HDR**	**C (%)**	**AF (%)**
S	0-Day HD	64.44±0.13[f]	0.79±0.02[f]
	5-Days HD	65.16±0.17[e]	0.75±0.03[h]
	10-Days HD	66.20±0.12[cd]	0.68±0.03[j]
	15-Days HD	66.25±0.14[cd]	0.63±0.02[k]
M	0-Day HD	65.26±0.13[e]	0.85±0.04[c]
	5-Days HD	65.98±0.07[d]	0.80±0.03[e]
	10-Days HD	67.02±0.06[b]	0.74±0.03[i]
	15-Days HD	67.07±0.05[b]	0.68±0.02[j]
H	0-Day HD	66.38±0.13[c]	0.92±0.04[a]
	5-Days HD	67.10±0.11[b]	0.88±0.03[b]
	10-Days HD	68.14±0.07[a]	0.82±0.05[d]
	15-Days HD	68.20±0.06[a]	0.76±0.04[g]

Note: Different alphabets on means (in a column) showing significant differences among treatments
[1]C: Carcass, AF: Abdominal fat.
[2]CWC: chick weight categories, S: small, M: medium, H: heavy, HDR: high-density diets regimes.

Carcass yield (%): The birds belonging to large chick weight category showed higher dressing percentage and birds belonging to small category showed the lowest, whereas, cut-up percentages, such as wings %, breast % and leg % yield remained unaffected from initial chick weight categories. The reasons behind all the results discussed above are that the final weight of birds largely depends on their initial weight and birds having higher initial weight ultimately attained higher final weight. Therefore, it is evident that birds having higher body weight will have a higher carcass, breast, thigh, and wing weight as the weight of the bird largely depends on its carcass weight. The reason behind the unaffected percentage of wings, breast and thighs was that the percentage of these was calculated out of the carcass weight. As the carcass purely comprises of wings, breast and thighs therefore it is obvious that birds having higher carcass weight will have heavier wings, breast and thighs as these are present in a specific ratio and percentage in every bird.

The birds fed with high density diet for 10 and 15 days had the highest carcass percentage while those in the control group had the least whereas, among different cut-up yield parameters such as wings, breast and leg half yield percentage non-significant ($P>0.05$) differences were observed among different high density diet durations. As mentioned earlier that birds fed with high protein diet gained more weight as compared to those fed with low protein diet and weight of the birds largely depends on the carcass weight. Therefore, it is evident that feeding birds with high protein feed will result in an increase in carcass percentage. The reason behind the negligible difference between the carcass of the birds fed with high protein feed for 10 days and 15 days has already been mentioned above. These results agreed with Abbasi *et al.* (2014) who reported that reduction in CP level resulted in reduced carcass yield. Similarly, Widyaratne *et al.* (2011) also reported that feeding the birds with high protein increased breast yield. This research is also in consent with the statement of Law *et al.* (2018) that reduction of protein level of feed results in the reduction of carcass traits. Contrarily, in their studies, Aletor *et al.* (2000) and Kamran *et al.* (2010) reported no effect of feeding a diet containing low protein on the quality of carcass in broiler. Srilatha *et al.* (2018) also reported no impact of various levels of protein on the carcass traits of a broiler which disagrees with the findings of the research under consideration.

Abdominal Fat (%): The reason that caused the chick weight categories to influence the abdominal fat percentage was that birds having heavier bodyweight had a larger body and consumed more feed as compare to birds belonging to the small category therefore, they contained higher fat reservoirs. That is why chicks belonging to large categories had significantly higher ($P<0.0001$) abdominal fat percentage followed by medium and then small category. Jiang and Yang (2007) reported significantly higher abdominal fat percentage in birds with higher initial body weight which is in accordance with the present research.

As for as high density feeding regimes are concerned abdominal fat percentage that was higher in birds of control group followed by those birds fed with high protein feed for 5 days, 10 days and 15 days. A higher fat percentage in these birds could be related to the reason that the feed having higher protein level was readily digested and absorbed by the body while feed containing low protein was not readily digested and absorbed by the body, therefore was stored in the form of fat. The current research is in accordance with the statement of Gheisari *et al.* (2015) who reported that feed containing low protein caused an increase in the abdominal fat percentage. Similarly, an inversely proportional relationship exists between the level of protein in feed and the amount of abdominal fat (Srilatha *et al.,* 2018; Law *et al.,* 2018).

Giblets & Visceral Organs %: Chick weight categories did not show any significant (P>0.05) effect on heart, liver, gizzard, and intestine percentage because like carcass cut ups, giblets are visceral organs of the birds were calculated in the form of percentage out of the live body weight of the bird and bird having higher body weight will obviously have heavier weigh of giblets and visceral organs.

Similarly, visceral organs percentage also remained unaffected from different feeding durations. Regarding visceral organs, Novel *et al.* (2009) reported that the intestinal length, liver, and gizzard were not affected by feeding low protein diet which is proved to be correct by the current research.

Blood biochemical profile and immune response: The effect of initial chick weight categories and high-density diet durations during the starter phase on blood biochemical profile and immune response is presented in Table 8. The present study showed no effect (P>0.05) of initial chick weight categories on the blood biochemical profile and immune response except antibody titer against ND which was better in heavy chick weight category as the birds having higher initial weight are somewhat healthy, strong and more resistant to diseases. In contrast, Sato (1985) reported an increase in serum protein levels in higher bodyweight birds. Feeding birds with diet containing high protein resulted in a significant increase in antibody titer against Newcastle disease which showed that high protein feeding provided immunity against Newcastle disease. Similarly, it was reported that feeding birds with the diet containing high protein and energy caused immune response and anti-body titer against Newcastle disease to increase in chicken (Perween *et al.,* 2016). In contrast, Ahmad *et al.* (2007) reported that increasing levels of protein had no effect on antibody titer against Newcastle disease. The current research also disagreed with the finding of Attia *et al.* (2017) that a low level of CP level had a negative effect on the plasma level of blood in the broiler.

Table 8: Effect of initial chick weight and high-density diet durations on blood biochemistry and immune status of broilers (Means ± SEM).

Treatment[2]		Parameters[1]				
		G (mg/dL)	P (g/dL)	C (mg/dL)	AND	AAI
CWC	S	127.28±0.24	4.20±0.02	156.42±0.35	4.91±0.02[c]	5.56±0.02
	M	129.41±.013	4.19±0.01	159.33±0.91	4.96±0.05[b]	5.49±0.03
	H	132.25±0.17	4.22±0.03	164.57±0.58	5.04±0.04[a]	5.52±0.2
HDR	0-Day	134.21±0.31	4.28±0.01	164.43±0.86	4.83±0.02[d]	5.40±0.06
	5-Days	132.37±0.27	4.29±0.03	162.25±0.37	4.90±0.01[c]	5.34±0.03
	10-Days	128.03±0.42	4.31±0.02	158.47±0.51	5.01±0.05[b]	5.43±0.04
	15-Days	123.67±0.34	4.32±0.03	155.58±0.48	5.14±0.04[a]	5.38±0.05
P-value	CWC	0.37	0.1528	0.3065	0.0015	0.1017
	HDR	0.198	0.2573	0.2825	0.0001	0.08099
	CWC×HDR	0.07	0.1647	0.1693	0.0007	0.0672

Note: Different alphabets on means (in a column) showing significant differences among treatments
[1]G: glucose, P: protein, C: cholesterol, AND: antibody titer against ND, AAI: antibody titer against AI.
[2]CWC: chick weight categories, S: small, M: medium, H: heavy, HDR: high-density diets regimes.

Conclusions: Based on the results of this study, it can be concluded that the high grade chicks may ultimately results in a higher final weight and better profit. Similarly, the chick having lower initial weight if fed with high protein feed can bring its weight equal to those having higher initial weight and fed with normal protein feed. Birds fed with high protein diet for 15 days may attain maximum weight up to slaughter. The birds with high protein feed for 10 days may provide maximum profit. If both the factors and all the 12 treatments are overall observed, the birds belonging to the large category and fed with high protein feed for 10 days sourced to award with the maximum profit. It is evident from this research that protein plays a vital role in enhancing and regulating the growth of birds but only up to the initial 10 days of age. After that protein shows no significant and negligible effect on the growth performance of birds.

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