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Effect of different energy and protein levels on growth performances and carcass yields of *Sonali* chicken

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ABSTRACT

This study evaluated how varied energy and protein levels affect the growth and carcass traits of Sonali chickens. A 63-day experiment was conducted on 400-day-old Sonali chicks that were raised straight. The chicks were split into four groups of 100 birds apiece, which were then further separated into four subgroups of 25 birds each. The treatment groups were: T1 (2900 kcal/kg ME, 20% CP for starter and 3000 kcal/kg ME, 19% CP for grower); T2 (2900 kcal/kg ME, 21% CP for starter and 3000 kcal/kg ME, 20% CP for grower); T3 (2950 kcal/kg ME, 20% CP for starter and 3050 kcal/kg ME, 19% CP for grower) and T4 (2950 kcal/kg ME, 21% CP for starter and 3050 kcal/kg ME, 20% CP for grower) group. Sonali chicks were fed on starter diets from day old to 5 weeks of age and grower diets from 6 to 9 weeks of age. Results revealed that body weight was significantly ($P<0.05$) higher in the group having 2950 kcal/kg ME, 21% CP for starter and 3050 kcal/kg ME, 20% CP for grower at 9th weeks of age. In addition, FCR and total body weight gain showed significantly ($P<0.05$) better in the high nutrition group compared to other treated groups. Dressing percentage was numerically and abdominal fat was significantly ($P<0.05$) higher in the group having 2950 kcal/kg ME, 21% CP for starter and 3050 kcal/kg ME, 20% CP for grower compared to other groups. However, there were no significant differences ($P>0.05$) in skin, head, leg, liver, heart, gizzard, breast meat, drumstick meat, wing meat and thigh bone weight in relation to body weight among different dietary groups. Furthermore, despite the higher feed costs, the high nutrition group had higher selling price and profit margins per bird than the low nutrition diet. So, taken together, it can be concluded that a diet with high energy and high protein increases body weight and body weight gain and gives better FCR. Moreover, higher nutrition diet improves dressing yield, abdominal fat percentage and profit margins than the low nutrition diet. It is suggested that provision of energy (2950 kcal/kg ME for starter and 3050 kcal/kg ME for grower) and protein (21% CP for starter and 20% CP for grower) in the diet could be a potential energy and protein level for better performances of Sonali chicken.

Introduction

People of all religions and ages are fond of chicken meat. People of any age can take poultry meat without hesitation for less content of fat compared to other meats. In Bangladeshi food culture, people always try to find the indigenous cock for its tenderness and good taste. One of the reasons is that poultry meat is still compact to heat, but in broiler meat, some portions are separated from the bone, which is why this is not suitable for making roast. The

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demand for meat is 7.61 MMT, and for eggs are 1806.48 crore number per year (DLS, 2023). The demand for Sonali chicken is bigger than that of production. Local chicks could not meet the demand of the people in an overpopulated country where about 1124 people live in an area of per square kilometer (BBS, 2020).

The Sonali chicken, which is a cross-breed of Rhode Island Red cocks and Fayoumi hens with phenotypic appearances similar to deshi chickens of Bangladesh, was first raised in the northern part of the country between 1996 and 2000 under the Smallholder Livestock Development Project (SLDP) and the Participatory Livestock Development Project (PLDP), which involved almost one million women beneficiaries. Moreover, they have tenderness and good taste like desi chicks. Since sonali birds are more suited to the nation's climate than other breeds, raising them is easier for women and kids because they require less care and attention (Saleque and Saha, 2013). The market demand for colored birds led small and marginal farmers to begin commercially rearing Sonali birds. According to Huque (2011), more than 60 hatcheries of different sizes supply Sonali chicks to small and marginal farmers, which have increased rapidly. Protein, vitamins, and minerals are referred to as nutrients in the diet of chickens; energy, on the other hand, is a form of energy-yielding nutrients. Carbohydrates, fats, and proteins are dietary components that provide energy. Therefore, one of the main determinants of poultry growth, feed efficiency, and carcass composition is metabolizable energy (ME), a macronutrient composition of the diet. Crude protein (CP) is the most important component of diets for poultry since, together with other essential nutrients including water, fat, carbohydrates, vitamins, and minerals, protein is necessary for life (Cheeke, 2005). Therefore, CP is given top priority when creating diets for poultry. Protein is an important constituent of the biologically active compounds in the body. It also assists in the synthesis of body tissue, for the renovation and growth of the body. Moreover, proteins can be found in the form of hormones and enzymes, both of which are crucial to the physiology of every living thing (Robert et al., 2015). Sonali strain is gaining popularity among farmers in Bangladesh because of the low input cost of production. However, scanty information is available on the nutritional requirements of Sonali chickens for sustainable poultry production. About 90% of the entire cost of feed is made up of two main ingredients, protein and energy, which should be used as efficiently as possible to achieve the intended economy of production and poultry ration formulation. In consideration of this, the current study was conducted to look into the impact of various protein and energy levels on the dressing characteristics and growth performance of Sonali chickens between the ages of one and sixty-three days.

Materials and Methods

Statement of research work

The experiment was conducted at Bangladesh Agricultural University Poultry Farm for 63 days on 400-day-old chicks, which were individually weighed and in a completely randomized design. The experimental Sonali chicks were equally and randomly divided and distributed into four dietary groups and each group was replicated into 4 sub-groups. Each dietary group consists of 100 chicks distributed into 4 replicated pens having 25 chicks in each replication. The layout of the experiment is shown in Table 1.

Table 1. Layout of the experiment

Treatments	Birds per replication				Total
	R1	R2	R3	R4	
T1 (ME, 2900 kcal/kg & CP, 20% (starter); ME, 3000 kcal/kg & CP, 19% (grower)	25	25	25	25	100
T2 (ME, 2900 kcal/kg & CP, 21% (starter); ME, 3000 kcal/kg & CP, 20% (grower)	25	25	25	25	100
T3 (ME, 2950 kcal/kg & CP, 20% (starter); ME, 3050 kcal/kg & CP, 19% (grower)	25	25	25	25	100
T4 (ME, 2950 kcal/kg & CP, 21% (starter); ME, 3050 kcal/kg & CP, 20% (grower)	25	25	25	25	100
				Total =	**400**

Diets were formulated using locally available feedstuffs. Feed and water were supplied *ad libitum* throughout the experimental period. The ingredients were purchased from the local market. Ingredients composition and calculated nutrient composition of the starter diet (0-4 weeks) and grower diet (5-9 weeks) are shown in Table 2 and 3 respectively.

Management practices

The experimental chicks were exposed to similar care and management in all dietary groups throughout the study period. A gable type open-sided house was used for the experiment. The room area was 500 square feet. Shed and required equipment were professionally cleaned, washed, dried, disinfected and subsequently kept unused for a week before the arrival of chicks. Feeders were cleaned in every week and drinkers were cleaned twice daily.

Table 2. Ration formulation for Sonali chicken

Ingredients (kg)	Starter diet (0-4 weeks)				Grower diet (5-9 weeks)			
	T1	T2	T3	T4	T1	T2	T3	T4
Maize Crushed	518	510	553	537	560	550	565	560
Protein Concentrate (CP-60%)	35	55	45	60	30	48	40	60
Rice Polish	90	78	50	40	55	40	43	30
Soybean Meal	290	290	280	288	275	280	265	263
Limestone	10	10	10	10	10	10	10	10
Di-Calciam Phosphate	20	20	20	20	20	20	20	20
Soybean Oil	20	20	25	28	33	35	40	40
Vitamin-Mineral Premix*	5	5	5	5	5	5	5	5
Lysine	2	2	2	2	2	2	2	2
Methionine	2	2	2	2	2	2	2	2
Enzyme (Ronozyme®)	1	1	1	1	1	1	1	1
Toxin Binder	1	1	1	1	1	1	1	1
Choline Chloride	1	1	1	1	1	1	1	1
Salt	5	5	5	5	5	5	5	5
Cost/kg feed (taka)	51.65	53.61	52.96	55.01	52.26	54.40	53.74	55.64
Total	**1000**	**1000**	**1000**	**1000**	**1000**	**1000**	**1000**	**1000**

*Vitamin mineral premix (Rena-broiler; 2.5kg); Vitamin A 12000000IU, D3 2400000IU, E 23g, K3 2g, B1 2.5g, B2 5g, B6 4g, B12 12mg, Niacinamide 40g, D pantothenete 12.5g, Folate 800mg, Biotin 100mg, Co 400mg, Cu 10g, Fe 60g, I 400mg, Mn 60g, Zn 50g, Se 150mg, Methionine 100g, Lysine 60g, Calcium 679.58g.

Table 3. Calculated nutrient composition of the ration for Sonali chicken

Nutrients	Starter diet				Grower diet			
	T1	T2	T3	T4	T1	T2	T3	T4
Metabolizable Energy (kcal/kg)	2900	2900	2950	2950	3000	3000	3050	3050
Crude Protein (%)	20	21	20	21	19	20	19	20
Calcium (%)	1.05	1.16	1.10	1.19	1.01	1.12	1.07	1.18
Av. Phosphorous (%)	0.52	0.56	0.52	0.54	0.50	0.52	0.51	0.53
Lysine (%)	1.24	1.26	1.21	1.25	1.18	1.21	1.16	1.17
Methionine (%)	0.53	0.55	0.53	0.55	0.52	0.54	0.52	0.54
Meth + Cyst (%)	0.77	0.81	0.78	0.82	0.75	0.79	0.76	0.79
Tryptophan (%)	0.43	0.45	0.44	0.45	0.43	0.44	0.43	0.45
Cystine (%)	0.24	0.26	0.24	0.26	0.23	0.24	0.23	0.25

In all cases, ad libitum feed and water were offered to the birds. Feed was supplied two times daily, once in the morning and another at afternoon in such a way that feeder was not kept empty. Fresh and clean water was made available at all times. The ground was covered with three cm of fresh and dried rice husk litter. The chicks were brooded in respective pens using one 100-watt electric bulbs in each pen. The chicks were provided with a temperature of 35°C at first week of age, decreasing gradually at the rate of 2.5°C per week continued up to 4 weeks of age. Vaccination and other routine poultry management practices were carried out neatly. A footbath was used in front of the shed during the experimental period. $KMnO_4$ solution was used in the footbath. The shed was sprayed with broad spectrum disinfectant solution named Ultraxide (Zagro Asia Limited, Singapore) daily.

Record keeping and calculation

Records were kept on initial live weight and live weight at 7, 21, 35, 49 and 63 days of age for each treatment. By subtracting the initial body weight from the final body weight, the average body weight gain of the chicks in each treatment was determined. FCR was calculated as the unit of feed consumed per unit of body weight gain. At the end of experimental period, 16 birds were randomly selected to have meat yield characteristics and dressing parameters. Each chick was slaughtered, bled, scalded, eviscerated, dressed, dissected and meat was stripped out of the carcass according to Jones (1984).

Statistical analysis

All recorded and calculated data of the experiment were statistically analyzed using Analysis of Variance (ANOVA) technique in accordance with the principles of Completely Randomized Design (CRD). Duncan Multiple Range Test procedure was used to determine the significant differences among different means at 5% significance level (SAS, 2009).

Results and Discussions

Body weight and body weight gain

Body weight and body weight gain of Sonali chicken fed different diets are presented in Table 4 and Figure 1.

Table 4. Cumulative body weight (g/bird) of Sonali chicken in different dietary treatments

Parameter	Treatments[$]				P-Value	LS
	T1	T2	T3	T4		
DOC weight	31.62±0.32	31.50±0.24	31.62±0.32	31.50±0.24	0.97	NS
1st week	63.90±0.86	61.70±0.92	62.77±1.07	65.20±2.20	0.36	NS
3rd week	176.70^{b}±1.73	174.80^{b}±2.12	180.90^{ab}±3.31	185.40^{a}±2.54	0.04	*
5th week	352.43^{b}±7.44	356.50^{b}±12.94	380.80^{ab}±5.11	390.40^{a}±9.75	0.03	*
7th week	470.00^{b}±10.80	485.89^{b}±18.06	508.50^{ab}±5.88	529.40^{a}±10.70	0.02	*
9th week	617.50^{c}±11.81	662.50^{bc}±18.87	693.75^{ab}±14.63	715.00^{a}±17.07	0.01	**

^{a,b,c}= Means with different superscript in the same row differ significantly. Data presented as mean±SE. *= (P<0.05), **= (P<0.01), NS= Non-significant (P>0.05), LS= Level of significance. *T1= ME, 2900 kcal/kg & CP, 20% (starter); ME, 3000 kcal/kg & CP, 19% (grower); T2= ME, 2900 kcal/kg & CP, 21% (starter); ME, 3000 kcal/kg & CP, 20% (grower); T3= ME, 2950 kcal/kg & CP, 20% (starter); ME, 3050 kcal/kg & CP, 19% (grower); T4= ME, 2950 kcal/kg & CP, 21% (starter); ME, 3050 kcal/kg & CP, 20% (grower).

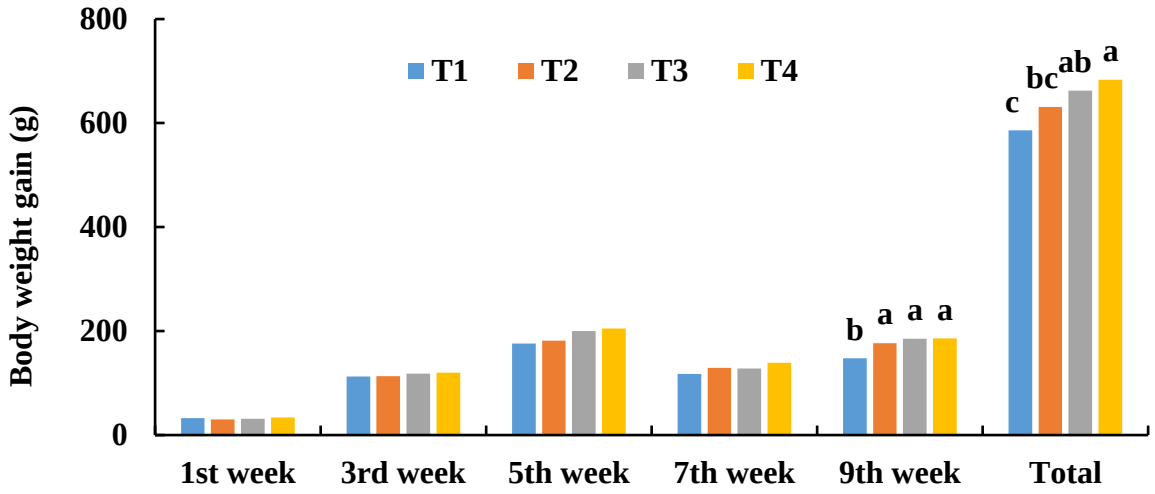

Figure 1: Weekly body weight gain (g) of Sonali chicken in different dietary treatments. Bars within a time class not sharing a common letter are significantly different (P<0.05). T1= ME, 2900 kcal/kg & CP, 20% (starter); ME, 3000 kcal/kg & CP, 19% (grower); T2= ME, 2900 kcal/kg & CP, 21% (starter); ME, 3000 kcal/kg & CP, 20% (grower); T3= ME, 2950 kcal/kg & CP, 20% (starter); ME, 3050 kcal/kg & CP, 19% (grower); T4= ME, 2950 kcal/kg & CP, 21% (starter); ME, 3050 kcal/kg & CP, 20% (grower).

The data show that there was no significant difference (P>0.05) in day-old chicks weight and first week body weight among dietary groups. Significant differences (P<0.05) were found in the 3rd week, 5th week, 7th week and 9th week body weight among the dietary groups. Body weight gain differed significantly in the 9th week and total body weight gain. Higher body

weight and body weight gain were in the T4 group followed by the T3, T2 and T1 groups. In the present study, the body weight indicated that the starter diet with 21% CP and 2950 kcal/kg ME and the grower diet with 20% CP and 3050 kcal/kg ME gained maximum growth. Additionally, it was shown that inadequate body weight performance was associated with lower levels of protein (20%) and energy (2900 kcal/kg). The findings corroborate those of Aftab (2009), Maliwan et al. (2018), and Roy 4 et al. (2010), who found that increased body weight is reached at elevated ME and CP levels. Similar findings were made by Haunshi et al. (2012), who calculated that an Aseel chicken fed a diet containing 2,400 kcal/kg ME had significantly less body weight gain than a diet containing 2600 kcal/kg ME, but that diet had higher body weight gain. As reported by Yunana *et al*. (2019), a diet with high energy and high protein performed better during the finisher phase with significantly higher final body weight and body weight gain. By contrast, Rodriguez *et al.* (2016), Buteri *et al.* (2009) and Ozek *et al.* (2003) reported that body weight gain was not influenced by energy level. The results of the present study contradicted Yunana *et al.* (2019) who suggested that low energy and low protein diets could be fed to broilers chicken as long as proper management practices are put in place. One important element influencing the feed efficiency, growth performance, and carcass composition of chicken is the macronutrient content of their diet, both ME and CP.

Feed intake

Data revealed in Table 5 that there was no significant effect (P>0.05) on the 1st week, 3rd week, 7th week, and 9th week among the dietary groups**.** However, feed intake in the 5th week and total feed intake showed significant variation (P<0.05) among dietary groups.

Table 5. Weekly feed intake (g/bird) of Sonali chicken in different dietary treatments

Parameter	Treatments*				P-Value	LS
	T1	T2	T3	T4		
1st week	31.00±1.64	30.00±1.06	32.00±0.82	32.00±0.65	0.54	NS
3rd week	217.40±6.71	206.00±3.94	217.00±1.02	223.00±0.80	0.05	NS
5th week	370.02^{b}±10.80	357. 70^{b}±13.21	405.47^{a}±3.98	409.00^{a}±3.56	0.01	*
7th week	437.50±34.49	456.87±41.09	455.22±5.11	470.82±12.38	0.86	NS
9th week	425.00±25.33	465.32±3.08	472.25±15.38	467.50±13.14	0.20	NS
Total	1480.93^{c}±16.68	1515.90^{bc}±40.25	1581.95^{ab}±13.42	1602.33^{a}±8.76	0.02	*

^{a,b,c}= Means with different superscript in the same row differ significantly. Data presented as mean±SE. *= (P<0.05), NS= Non-significant (P>0.05), LS= Level of significance. $T1= ME, 2900 kcal/kg & CP, 20% (starter); ME, 3000 kcal/kg & CP, 19% (grower); T2= ME, 2900 kcal/kg & CP, 21% (starter); ME, 3000 kcal/kg & CP, 20% (grower); T3= ME, 2950 kcal/kg & CP, 20% (starter); ME, 3050 kcal/kg & CP, 19% (grower); T4= ME, 2950 kcal/kg & CP, 21% (starter); ME, 3050 kcal/kg & CP, 20% (grower).

Considering the total feed intake, T4 group showed higher feed intake (1602.33g) followed by T3 (1581.95g), T2 (1515.90g) and T1 (1480.93g) groups respectively. In the current study, as the raising period progressed, the feed intake of four treatment groups was progressively raised. The study showed that the lower feed intake found on 2900 kcal/kg ME with 20% CP (starter diet) and 3000 kcal/kg ME with 19% CP (grower diet) and higher feed intake on 2950kcal/kg ME with 21% CP (starter diet) and 3050 kcal/kg ME with 20% CP (grower diet). This finding is nearly consistent with the previous observation Hanushi *et al.* (2012) who reported that Aseel chicken fed diet with 2800 kcal/kg ME had significantly higher feed intake than those fed diet with either 2400 or 2600 kcal/kg ME. On the other hand, the findings of this study contradicted some of the previous observations (Sarker *et al*., 2008; Ozek *et al.,* 2003; Habib *et al.,* 2019), which found higher feed intake on lower energy. These results contradict the report of Maliwan *et al.* (2018) who reported that feed intake decreased with increasing energy concentration thereby significantly improving the feed conversion ratio. Similar observations were found by Ozek *et al.* (2003) who estimated that the daily mean feed intake for the 0-8, 9-16 and 0-16-weeks periods decreased when the ME concentration of the starter and grower diets increased which contradicted our findings.

Feed conversion ratio

Results from Table 6 and Figure 2 indicate that there were no significant variations (P>0.05) among different dietary groups from 1st week to 8th week of age.

Table 6. Weekly feed conversion ratio (feed/weight gain) of Sonali chicken in different dietary treatments

Parameter	Treatments[$]				P-Value	LS
	T1	T2	T3	T4		
1st week	0.96±0.03	0.99±0.02	1.03±0.01	0.96±0.06	0.59	NS
3rd week	1.92±0.07	1.82±0.02	1.83±0.03	1.86±0.05	0.50	NS
5th week	2.11±0.05	1.99±0.10	2.02±0.03	2.01±0.12	0.78	NS
7th week	3.73±0.09	3.57±0.14	3.56±0.07	3.40±0.11	0.27	NS
9th week	2.88[a]±0.02	2.63[b]±0.03	2.55[b]±0.07	2.53[b]±0.07	0.01	*

[a,b,c]= Means with different superscript in the same row differ significantly. Data presented as mean±SE. **= (P<0.01), NS= Non-significant (P>0.05), LS= Level of significance. [$]T1= ME, 2900 kcal/kg & CP, 20% (starter); ME, 3000 kcal/kg & CP, 19% (grower); T2= ME, 2900 kcal/kg & CP, 21% (starter); ME, 3000 kcal/kg & CP, 20% (grower); T3= ME, 2950 kcal/kg & CP, 20% (starter); ME, 3050 kcal/kg & CP, 19% (grower); T4= ME, 2950 kcal/kg & CP, 21% (starter); ME, 3050 kcal/kg & CP, 20% (grower).

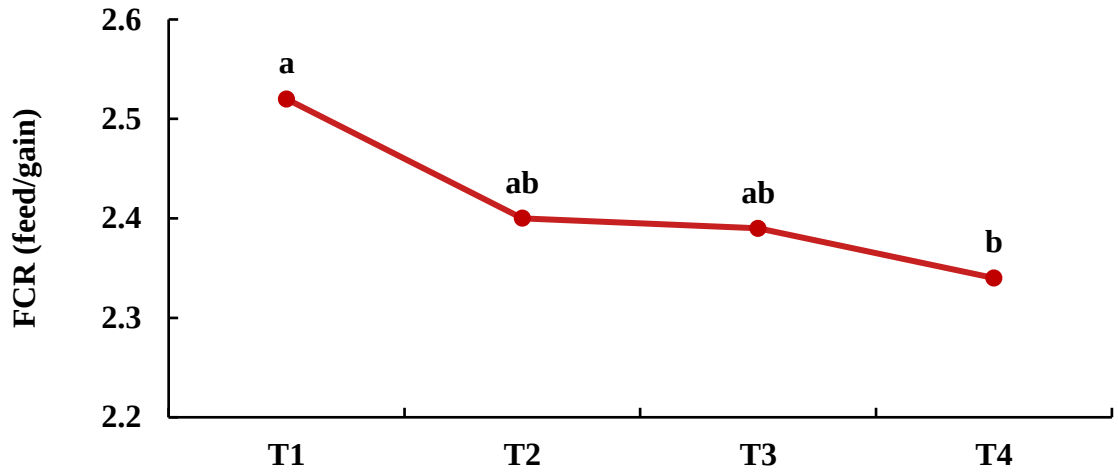

Figure 2: Cumulative feed conversion ratio (feed/gain) of Sonali chicken in different dietary treatments. Within the FCR, different letters indicate significant differences (P<0.05). T1= ME, 2900 kcal/kg & CP, 20% (starter); ME, 3000 kcal/kg & CP, 19% (grower); T2= ME, 2900 kcal/kg & CP, 21% (starter); ME, 3000 kcal/kg & CP, 20% (grower); T3= ME, 2950 kcal/kg & CP, 20% (starter); ME, 3050 kcal/kg & CP, 19% (grower); T4= ME, 2950 kcal/kg & CP, 21% (starter); ME, 3050 kcal/kg & CP, 20% (grower).

At the 9th week of age, the T1 (2.88) group showed significantly (P<0.05) poor FCR compared to the T2 (2.63), T3 (2.55) and T4 (2.53) group. When we considered total FCR, the T4 group (2.34) showed statistically (P<0.05) better compared to the T1 (2.52) group. The present study showed that ME and CP played a significant role in improving the FCR of Sonali chicken. Better FCR (2.40) was found on the starter diet with 21% CP and 2950 kcal/kg ME and the grower diet with 20% CP and 3050 kcal/kg ME. The higher body weight gained was due to high energy and high protein ratio that helped to improve feed efficiency. This finding is consistent with previous observations (Aftab 2009; Hanushi *et al.,* 2012) who stated that to obtain better FCR, feeding Aseel birds with a diet having 2800 kcal/kg ME and 16% CP would be ideal. Rodriguez *et al.* (2016) reported that feed conversion efficiency was improved in the diets with 3040 kcal/kg and 3120 kcal/kg which is almost similar to the earlier reports of Miah *et al*. (2020). These results are different from the finding of Maliwan *et al.* (2018) who reported that feed intake decreased with increasing ME, thereby significantly improving the FCR. The results of the present study contradicted some of the previous observations (Habib *et al.,* 2019 and Sarker *et al.,* 2008), indicating better FCR obtained at low energy. The average FCR of Sonali chickens up to their market ages in the present study is lower than the research result of Sarker *et al.* (2008) and Habib *et al. (*2019) who reported 2.98 and 2.77 FCR respectively at the market age. The minimum FCR and maximum PER values were found when the diet contained 3000 kcal ME/kg from hatch to 21 days of age and 3175 kcal ME/kg from 22 to 42 days of age, respectively, using diets containing 7.5 and 6.6 g of protein/100 kcal ME, respectively (Maliwan *et al.*, 2018). Broken-line analysis was used to

estimate the ME content of feed in order to obtain these values. Ozek *et al.* (2003) and Yunana *et al. (*2019) expressed a similar statement that FCR was good at low energy (2700 kcal/kg ME) and low protein (22%) diet.

Dressing parameters of *Sonali*

Results from Table 7 indicate that there were no significant differences (P>0.05) in skin, head, leg, liver, heart, gizzard, breast meat, drumstick meat, wing meat, drumstick bone and thigh bone weight in relation to body weight among different dietary groups. Numerically, the dressing percentage (DP) was higher in the T4 group (61.18%) but lowest in the T1 group (57.55%). Abdominal fat percentage was lower (P<0.05) in the T1 group (0.13%) whereas higher value in the T4 group (0.62%).

Table 7. Dressing parameters of Sonali chicken in different dietary treatments (% relation to body weight)

Parameter	Treatments[$]				P-Value	LS
	T1	T2	T3	T4		
Dressing yield	57.55±1.78	58.68±1.28	58.31±1.12	61.18±1.34	0.33	NS
Skin	6.73±0.52	5.47±0.81	6.00±0.14	6.64±0.29	0.31	NS
Head	4.46±0.14	4.55±0.16	4.52±0.22	4.27±0.21	0. 73	NS
Neck	3.40±0.52	3.34±0.27	3.83±0.28	3.18±0.30	0.63	NS
Leg	4.72±0.26	4.91±0.10	4.74±0.23	4.27±0.29	0.31	NS
Liver	3.30±0.22	3.03±0.17	2.95±0.10	3.41±0.26	0.37	NS
Heart	0.86±0.03	0.85±0.03	0.85±0.08	0.79±0.03	0. 79	NS
Abdominal fat	0.13^{b}±0.13	0.20^{b}±0.20	0.15^{b}±0.15	0.62^{a}±0.36	0.04	*
Gizzard	3.19±0.13	2.65±0.15	2.92±0.21	2.67±0.19	0.15	NS
Breast meat	10.12±1.31	9.21±0.62	8.33±0.65	9.68±0.29	0.47	NS
Thigh meat	10.09±0.26	9.22±0.19	9.92±0.58	10.36±0.17	0.17	NS
Drumstick meat	9.46±0.43	8.12±0.63	9.47±0.33	8.66±0.38	0.16	NS
Wing meat	9.13±0.29	9.95±0.32	9.42±0.54	9.31±0.12	0.42	NS
Thigh bone	3.34±0.26	2.40±0.25	2.94±0.31	2.52±0.20	0.09	NS
Drumstick bone	3.99±0.17	3.34±0.32	4.20±0.09	3.45±0.05	0.06	NS

[a,b]= Means with different superscript in the same row differ significantly. Data presented as mean±SE. *= (P<0.05), NS= Non-significant (P>0.05), LS= Level of significance. [$]T1= ME, 2900 kcal/kg & CP, 20% (starter); ME, 3000 kcal/kg & CP, 19% (grower); T2= ME, 2900 kcal/kg & CP, 21% (starter); ME, 3000 kcal/kg & CP, 20% (grower); T3= ME, 2950 kcal/kg & CP, 20% (starter); ME, 3050 kcal/kg & CP, 19% (grower); T4= ME, 2950 kcal/kg & CP, 21% (starter); ME, 3050 kcal/kg & CP, 20% (grower).

The results of this research are similar to the results of Habib *et al*. (2019). According to our findings, carcass weight increased with increasing energy and protein ratio, which is similar to the findings of Ozek et al. (2003), who discovered that male partridge carcass weights increased with increased diet ME content. On the contrary, Rodriguez *et al.* (2016) found that there was no influence of treatment on total carcass weight. The present study showed a higher DP value in high energy and high protein diets while a similar statement was stated by Karomy *et al. (*2019), who observed a significant increase in average dressing percentage value with rising ME.

Table 8. Cost-benefit analysis for different dietary treatments (compared to treatment-1)

Treatment	Feed cost difference (taka)	Selling price difference (taka)	Profit difference (taka)
T1	0.00	0.00	0.00
T2	5.04	10.35	5.31
T3	7.58	17.53	9.95
T4	11.75	22.42	10.67

The present study showed higher abdominal fat% at high energy (2950 kcal/kg ME for starter and 3050 kcal/kg ME for grower) and high protein (21% CP for starter and 20% CP for grower) diet and lower at low energy (2900 kcal/kg ME for starter and 3000 kcal/kg ME for grower) and low protein (20% CP for starter and 19% CP for grower) diet group which is

consistent with the observation of Kassim and Suwanpradit (1996). They found that, in broiler chickens aged 21 to 42 days, cutting their energy intake from 3200 to 3000 kcal/kg dramatically decreased the percentage of abdominal fat and overall body fat deposition. This reduction occurred without negatively affecting the average daily gain, feed intake, or dressing percentage, and instead increased the percentage of fat at high energy diets. Similar findings were reported by Fan et al. (2008), who observed that while the percentages of breast and leg muscles remained unchanged, the abdominal fat weight in relation to live body weight was significantly reduced by reducing the dietary energy level in ducks from 14 to 42 days of age from 2900 to 2700 kcal/kg. Additionally, Xie et al. (2010) demonstrated that feeding ducklings a diet containing 2747 kcal/kg from hatching to 21 days of age resulted in a significant reduction in the percentage of live weight that was made up of abdominal fat, but not in the percentage of meat that was made up of the breast or legs. This was in contrast to feeding the ducklings a diet containing 3045 kcal/kg.

Fatty acid synthase (FAS) is an essential enzyme in the de novo lipogenesis pathway in chicken livers, and the activity of FAS in the liver controls the ability of chickens to generate fatty acid deposits in the body. In order to decrease body fat deposition, it is therefore advised to formulate poultry diets to fulfill their energy requirements based on standards for particular strains, whereas increasing dietary energy content to promote feed conversion results in an increase in body fat deposition (Back *et al.,* 1986). Azharul *et al*. (2005) observed that a higher percentage of dressing weight, thigh weight and total meat weight was found at low energy diet for the corresponding values at 8 weeks of age which contradicted our result. However, energy and protein both have a significant impact on the way chickens grow, how well they are fed, and how their carcasses are composed (Cheeke, 2005).

Cost-benefit analysis

Results indicated that increasing energy and protein from 2900 to 2950 kcal/kg and 20 to 21% in starter diet, and 3000 to 3050 kcal/kg and 19 to 20% in grower diet, the feed cost increased upto 11.75 tk/bird. Although feed cost was higher, we observed higher selling price (22.42 tk/bird) as well as higher profit (10.67 tk/bird) in high nutrient group. It may be that high nutrient density diet has the positive effect on growth performances of sonali chicken, resulted the higher profit in these groups. Here, we took into account that every treatment group had the identical expenditures, with the exception of feed. The feed cost difference increased by up to 15% when energy and protein were raised from 2900 to 2950 kcal/kg and 20 to 21% in the starter diet and 3000 to 3050 kcal/kg and 19 to 20% in the grower diet. We saw greater selling prices and profit differences per bird in the high nutrition group despite the higher feed costs. It is probable that a high nutrient density diet enhances the growth performance of sonali chickens, resulting in larger profits in these groups.

Conclusion

The study's findings show that a diet high in energy (2950 kcal/kg ME for starters and 3050 kcal/kg ME for growers) and protein (21% CP for starters and 20% CP for growers) increases body weight and weight gain while providing a higher FCR. Additionally, the diet improves dressing yield and abdominal fat than other diets. Furthermore, despite the higher feed costs, the high nutrition group had higher selling price and profit margins per bird than the low nutrition diet. As a result, it is proposed that including energy (2950 kcal/kg ME for starter and 3050 kcal/kg ME for grower) and protein (21% CP for starter and 20% CP for grower) in the diet could provide a potential energy and protein level that will enhance Sonali chicken performance.

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Conflict of Interests

The authors disclose no conflicts of interest in publishing this research.

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