

# EFFECT OF DIFFERENT DIETARY PROTEIN AND ENERGY LEVELS ON THE PERFORMANCES OF STARCROSS PULLETS

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## Summary

In two experiments 640 starcross replacement pullets between 25 and 154 days of age were fed *ad libitum* on either of 16 diets formed by the combination of 4CP × 4ME levels to study the interaction of CP and ME on growth performances.

In both experiments, feed intake decreased, but protein intake, energy intake, live weight gain and feed conversion efficiency increased and sexual maturity hastened with the increase of dietary protein and/or energy level. The protein conversion efficiency decreased with the increase of dietary protein level. The energy conversion efficiency, however, did not show any relationship with dietary energy level. There was a greater improvement of growth performance due to simultaneous increase of dietary protein and energy level than that of increasing protein or energy alone.

(Key Words :Protein, Energy, Performance, Starcross, Pullets)

## Introduction

Dietary requirements of protein and energy for the growing pullets according to genetic background, environment and production system are variable in advanced countries. Some research investigators (Cunningham and Morrison, 1977; McNaughton et al., 1977), concluded that the body weight at 20 week age was not affected either by dietary protein or energy concentrations. Jalaludeen and Ramkrishnan(1989) have shown that the dietary protein (14, 16, 18 or 20%) and metabolisable energy (2400, 2500, 2600 or 2700 kcal/kg) levels had no effect on body weight gain where the 14% protein and 2400 kcal/kg diet were sufficient to maintain the mature body weight. On the other hand, several workers (Waldroup and Harms, 1962; Auckland and Fulton, 1973; Goan et al., 1973; Quarles et al., 1981; Christmas et al., 1982; Douglas and Harms, 1982) employed the protein levels with a range from 9 to 21.5% and observed that the increasing dietary protein levels increased the body weight gain of the growing pullets. Due to difference in environment, production system and feed

ingredients, we are not in a position to follow those recommendations. Recommendations regarding the dietary concentrations of protein and/or energy for pullets in Bangladesh with reference to ingredients availability, environmental variability in different seasons and rearing system still needed to be investigated. The present study was, therefore, aimed at observing the effects of 4 protein × 4 energy levels on feed consumption, live weight gain, protein intake, energy intake, feed conversion efficiency, protein conversion efficiency, energy conversion efficiency and sexual maturity of Starcross replacement pullets.

## Materials and Methods

### Birds

Two experiments were conducted with Starcross replacement pullets. In each experiment, 700 day-old chicks were brooded up to 24-days of age and were fed *ad libitum* on a starter mash containing 22% crude protein (CP) and 3000 kcal of metabolisable energy (ME)/kg. In each experiment, at 25 days of age, 640 chicks were randomly allocated on either of 16 diets; computed by the combination of 4 CP (13, 16, 19 or 22 %) levels × 4 ME (2600, 2800, 3000 or 3200 kcal/kg levels (table 1). There were two replications having 20 birds in each for all allocated treatments.

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### Rations

Sixteen different dietary rations used in these experiments were computed (table 1) by the combined concentrations of 4 different protein levels (13, 16, 19 or 22%) and 4 different metabolizable energy levels (2600, 2800, 3000 or 3100 kcal/kg). The individual ingredients and rations were analysed (AOAC, 1980) for proximate components. The gross energy (GE) values were also determined by using an Adiabatic Bomb Calorimeter. The amino acid percentages were estimated using the values (Snyder et al., 1958; Bolton and Blair, 1977) and the calcium and phosphorus contents were estimated by using the values (NRC, 1977; Bolton and Blair, 1977) of individual ingredients.

### Housing

The birds were housed in open-sided tin shed building with a floor space of 3150 sq cm/bird. The birds were exposed only to natural day light in their sand littered pens and no artificial lighting was provided. Fresh sundried sand was added time to time to avoid litter dampness. Room temperature ( $^{\circ}\text{C}$ ) and relative humidity (%) were recorded four times a day with a Wet and Dry bulb hygrometer. The average temperature and relative humidity were  $26.97(\pm 0.57)^{\circ}\text{C}$  and  $69.95(\pm 1.41)\%$  and  $21.45(\pm 0.25)^{\circ}\text{C}$  and  $72.52(\pm 0.64)\%$  for first and second experiment respectively. The respective air speed (m/sec.) were  $202.00(\pm 0.70)$  and  $137.33(\pm 0.50)$  respectively. Two trough feeders (100.00 cm  $\times$  15.25 cm  $\times$  18.00 cm) and one earthen drinker (2.5 litres) were provided for the birds in each pen.

### Feeding and watering

Feed intake (g/bird/d) and water intake (ml/bird/d) were recorded replicationwise for each treatment. Feed conversion ratio and protein and energy conversion ratios were calculated as the units of feed, protein and energy were consumed for each unit of live weight gain. The live weight gain was calculated as the difference between the initial and final weight.

### Sexual maturity

On the basis of first egg laid, the age at sexual maturity was noted down in days for each pen (Poggenpoel, 1986).

### Statistical Analysis

Both the two experiments were for  $4 \times 4$  (protein  $\times$  energy) factorial in a Completely Randomized Design. Analysis of variance partitioned variances of all recorded parameters into protein, energy levels and their interactions for comparison. The parameters were also regressed on either protein or energy levels to have the change in different parameters against unit change of protein or energy levels and then compared.

### Results and Discussions

The effects of dietary protein and/or energy levels on growth performance are presented in tables 2 and 3. The regressions of growth performance parameters on protein or energy levels in the diets are shown in table 4.

In both experiments, feed intake decreased but live weight gain and feed conversion efficiency increased and sexual maturity hastened ( $p < 0.01$ ) in a linear fashion with the increase of dietary protein and/or energy levels.

The simultaneous increase of protein and energy levels had a greater effect on growth than that of increasing protein or energy alone. The protein and energy intake increased ( $p < 0.01$ ) linearly with the increase of dietary protein and energy levels respectively. The increased protein or energy intake with increase of their dietary levels is supported by Leeson and Summers (1989). In both experiments, the protein conversion efficiency decreased ( $p < 0.01$ ) linearly with the increase of dietary protein levels. In Experiment 1, energy conversion efficiency improved up to 3000 kcal ME/kg feed and then declined at 3100. But in experiment 2, energy conversion efficiency was almost similar with 2600, 2800 and 3100 kcal ME levels but decreased with 3000 kcal ME. The effects of protein or energy on live weight gain and feed intake obtained is supported by Sengar (1987). Increase of dietary crude protein or metabolisable energy had a beneficial effect on crude protein or metabolisable energy utilisation and viceversa.

In both experiments, the increased live weight gain and hastened sexual maturity at higher protein levels are in agreement with Auckland and Fulton (1973), Goan et al., (1973), Gous et al., (1973), Stockland and Blaylock (1974), Christmas et al., (1974), Balnave (1974, 1976) and

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TABLE 1. COMPOSITION OF THE EXPERIMENTAL RATIONS (EXPERIMENT 1 & 2).

Ingredients (%)	Treatments															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Wheat crushed	4.00	5.00	17.00	29.00	29.00	40.00	53.00	53.00	75.00	75.00	75.00	70.00	90.00	84.00	78.00	71.00
Wheat bran	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	4.00	1.00	1.00	1.00	1.00	1.00	1.00
Rice polish	85.00	70.00	46.00	21.00	60.00	36.00	10.00	1.00	14.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Fish meal	1.00	1.00	1.00	1.00	1.00	1.00	1.00	6.00	1.00	3.00	13.00	23.00	2.00	9.00	15.00	22.00
Sesame oil cake	5.00	19.00	31.00	44.00	5.00	18.00	31.00	35.00	5.00	13.00	6.00	1.00	2.00	1.00	1.00	1.00
Bone meal (Steamed)	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Oyster shell	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Salt	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Vitamineral premix <sup>1</sup>	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Nutrient content:																
Dry matter (%)	86.91	88.42	89.71	87.50	90.03	87.50	90.08	89.27	90.74	88.73	90.69	86.95	86.84	85.76	88.00	88.16
Grode protein (%)	13.12	16.16	19.19	21.98	13.18	16.07	19.01	22.11	13.17	15.20	18.93	22.17	13.07	15.96	19.25	21.87
Grode fiber (%)	3.49	5.01	4.76	4.42	3.53	4.30	4.48	5.00	3.58	4.37	3.55	2.76	3.62	3.21	3.08	2.74
Ether extract (%)	13.02	12.07	9.84	7.56	9.87	7.71	5.30	4.89	4.06	3.21	3.59	4.18	2.31	2.81	3.44	4.09
Ash (%)	10.71	10.66	10.88	10.22	9.81	9.59	9.09	9.72	7.34	7.70	7.97	8.98	7.15	7.12	8.57	9.81
Nitrogen free extract (%)	46.57	44.52	44.02	43.12	53.61	49.83	52.20	47.55	62.49	57.25	56.65	48.86	60.74	56.66	53.66	49.65
Estimated:																
Metabolizable energy (kcal/kg)	2600	2600	2600	2600	2800	2800	2800	2800	3000	3000	3000	3000	3100	3100	3100	3100
Methionine	0.29	0.46	0.59	0.62	0.72	0.42	0.56	0.70	0.25	0.37	0.46	0.58	0.22	0.33	0.44	0.56
Lysine	0.71	0.65	0.71	0.73	0.64	0.55	0.58	0.83	0.92	0.57	1.17	1.63	0.51	0.90	1.23	1.65
Cystine	0.35	0.39	0.40	0.41	0.32	0.34	0.35	0.40	0.26	0.28	0.36	0.44	0.23	0.30	0.36	0.43

<sup>1</sup> 1 kg of vitamin-mineral premix contained: Vitamin-A-480000 IU; Vitamin D 1000000 IU; Vitamin E-8000 IU; Vitamin-K 1.60 g; Vitamin-B<sub>1</sub>-0.60 g; Vitamin-B<sub>2</sub>-2.00 g; Vitamin-B<sub>6</sub>-1.60g; Nicotinic Acid-12.00 g; Pantothenic acid-4.00 g; Vitamin-B<sub>12</sub>-4.00 mg; Folic acid-0.20 g; Cobalt-0.12 g; Copper 6.4 g; Iron-9.6; Iodine-0.24 g; Manganese-19.20 g; Zinc-1.50 g; Selenium-0.048 g; DL-methionine-20.00 g; Choline-chloride-100.00 g; BHT-20.00 g; Cereal base-100% (2.5kg).

TABLE 2. LIVE WEIGHT GAIN, FEED INTAKE, FEED CONVERSION RATIO, PROTEIN INTAKE, ENERGY INTAKE, PROTEIN CONVERSION RATIO, ENERGY CONVERSION RATIO AND AGE AT SEXUAL MATURITY OF THE BIRDS FED ON EITHER OF 4 LEVELS OF PROTEIN (CP) AND/OR 4 LEVELS OF ENERGY (ME) BETWEEN 25 AND 154 DAYS OF AGE (EXPERIMENT 1)

Parameters	Percent crude protein (CP) in diet	kcal Metabolizable Energy (ME)/kg diet				Mean	SED and significance level		
		2600	2800	3000	3100		CP	ME	CP×ME
Feed intake (g/bird/d)	13	82.50	80.38	79.01	77.20	79.77	0.541	0.541	1.083
	16	75.87	74.04	73.53	72.61	74.01	**	**	**
	19	71.40	70.48	69.27	61.66	68.20			
	22	70.54	68.00	66.67	59.68	66.22			
	Mean	75.07	73.22	72.12	67.78	72.05			
Live weight gain (g/bird/d)	13	9.23	10.06	8.41	7.87	8.89	0.164	0.164	0.329
	16	9.98	10.52	10.84	11.42	10.69	**	**	**
	19	10.68	10.93	10.99	11.67	11.06			
	22	11.16	11.42	12.79	13.21	12.12			
	Mean	10.26	10.73	10.75	11.04	10.69			
Feed conversion ratio (feed intake/live weight gain)	13	8.95	7.99	9.39	9.79	9.03	0.142	0.147	0.294
	16	7.61	7.03	6.48	6.35	6.86	**	**	**
	19	6.68	6.45	6.29	5.28	6.17			
	22	6.31	5.95	5.21	4.51	5.49			
	Mean	7.38	6.85	6.84	6.48	6.88			
Protein intake (g/bird/d)	13	10.72	10.44	10.27	10.03	10.36	0.093	0.093	0.187
	16	12.13	11.84	11.76	11.61	11.83	**	**	**
	19	13.56	13.39	13.16	11.71	12.95			
	22	15.51	14.96	14.66	13.12	14.56			
	Mean	12.98	12.65	12.46	11.61	12.42			
Energy intake (kcal ME/bird/d)	13	214.52	225.06	237.04	239.33	228.98	1.575	1.575	3.151
	16	197.26	207.33	220.61	225.10	212.57	**	**	**
	19	185.66	197.35	207.82	191.17	195.50			
	22	183.40	190.40	200.01	185.01	189.70			
	Mean	195.21	205.03	266.37	210.15	206.68			
Protein conversion ratio (protein intake/live weight gain)	13	1.16	1.03	1.22	1.27	1.17	0.007	0.007	0.047
	16	1.22	1.12	1.03	1.01	1.09	**	**	**
	19	1.26	1.22	1.19	1.00	1.16			
	22	1.39	1.30	1.14	0.99	1.20			
	Mean	1.25	1.16	1.14	1.06	1.15			
Energy conversion ratio (kcal ME intake/live weight gain)	13	23.27	22.38	28.17	30.37	26.04	0.405	0.405	1.811
	16	19.79	19.70	19.46	19.70	19.66	**	**	**
	19	17.37	18.08	18.89	16.37	17.67			
	22	16.42	16.67	15.63	14.00	15.68			
	Mean	19.21	19.20	20.53	20.11	19.76			
Sexual maturity (days)	13	186.00	185.50	175.00	166.00	178.12	1.665	1.665	3.330
	16	182.00	168.50	161.00	160.50	168.00	**	**	NS
	19	181.00	170.50	158.00	152.00	165.37			
	22	171.50	158.00	154.50	151.50	158.87			
	Mean	180.12	170.62	162.12	157.50	167.59			

† All SEDs are against 16 df. \*\* (p < 0.01); NS (p > 0.05).

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TABLE 3. LIVE WEIGHT GAIN, FEED INTAKE, FEED CONVERSION RATIO, PROTEIN INTAKE, ENERGY INTAKE, PROTEIN CONVERSION RATIO, ENERGY CONVERSION RATIO AND AGE AT SEXUAL MATURITY OF THE BIRDS FED ON EITHER OF 4 LEVELS OF PROTEIN (CP) AND/OR 4 LEVELS OF ENERGY (ME) BETWEEN 25 AND 154 DAYS OF AGE (EXPERIMENT 2)

Parameters	Percent crude protein (CP) in diet	kcal Metabolizable Energy (ME)/kg diet				Mean	SED and significance level		
		2600	2800	3000	3100		CP	ME	CP×ME
Feed intake (g/bird/d)	13	75.61	74.59	72.19	68.56	72.73	0.356	0.356	0.712
	16	71.99	70.58	68.61	68.37	69.88	**	**	**
	19	71.37	68.61	67.47	66.42	68.45			
	22	67.72	67.01	66.19	65.75	66.66			
	Mean	71.67	70.19	68.60	67.27	69.43			
Live weight gain (g/bird/d)	13	7.59	9.09	9.29	9.34	8.85	0.076	0.076	0.153
	16	7.76	9.26	9.39	9.78	9.04	**	**	**
	19	8.71	9.43	9.53	9.99	9.41			
	22	9.17	9.52	9.84	10.31	9.71			
	Mean	8.33	9.32	9.51	9.85	9.25			
Feed conversion ratio (feed intake/live weight gain)	13	9.83	8.40	7.77	7.36	8.34	0.090	0.090	0.182
	16	9.27	7.61	7.30	6.98	7.79	**	**	**
	19	8.18	7.26	7.07	6.64	7.28			
	22	7.37	7.03	6.72	6.37	6.87			
	Mean	8.66	7.57	7.21	6.83	7.57			
Protein intake (g/bird/d)	13	9.82	9.69	9.38	8.94	9.45	0.056	0.056	0.113
	16	11.51	11.29	10.97	10.93	11.17	**	**	*
	19	13.56	13.03	12.81	12.61	13.00			
	22	14.89	14.74	14.56	14.46	14.66			
	Mean	12.44	12.18	11.93	11.73	12.07			
Energy intake (kcal ME/bird/d)	13	196.59	208.86	216.59	213.25	208.82	0.960	0.960	1.921
	16	187.19	197.64	205.84	211.95	200.65	**	**	**
	19	187.58	192.12	202.31	205.90	196.97			
	22	176.07	187.63	198.59	203.83	191.53			
	Mean	186.85	196.56	205.83	208.73	199.49			
Protein conversion ratio (protein intake/live weight gain)	13	1.27	1.06	1.01	0.95	1.07	0.014	0.014	0.029
	16	1.48	1.21	1.16	1.11	1.24	**	**	*
	19	1.55	1.38	1.34	1.26	1.38			
	22	1.62	1.54	1.47	1.40	1.50			
	Mean	1.48	1.29	1.24	1.18	1.29			
Energy conversion ratio (kcal ME intake/live weight gain)	13	25.56	22.97	23.31	28.83	25.16	0.245	0.245	0.491
	16	24.12	21.32	21.91	21.65	22.25	**	**	*
	19	21.29	20.35	21.21	20.60	20.86			
	22	19.18	19.69	20.17	19.75	19.69			
	Mean	22.53	21.08	20.65	22.70	21.99			
Sexual maturity (days)	13	174.00	162.50	147.00	146.00	157.37	1.667	1.667	3.335
	16	159.00	159.50	146.00	145.50	152.50	**	**	*
	19	160.50	155.50	143.00	142.50	150.37			
	22	145.50	145.00	142.00	136.50	142.25			
	Mean	159.75	155.62	144.50	142.62	151.62			

All SEDs are against 16 df; \* (p < 0.05); \*\* (p < 0.01);

TABLE 4. REGRESSIONS OF GROWTH PERFORMANCE PARAMETERS (Y) ON PROTEIN (CP) OR ENERGY (ME) LEVELS (X) IN THE DIETS

Growth performance parameters(Y)	Experiment 1			Experiment 2		
	a	b	r	a	b	r
X = Crude Protein (%) in the diets						
Feed intake (g/bird/d)	99.61	-1.548**	-0.846**	80.900	-0.650**	-0.750**
Live weight gain (g/bird/d)	4.792	0.338**	0.824**	7.537	0.098**	0.416*
Feed conversion ratio (feed intake/wt. gain)	13.484	-0.376**	-0.857**	10.332	-0.158**	-0.583**
Protein intake (g/bird/d)	4.436	0.457**	0.927**	1.908	0.581**	0.988**
Energy intake (kcal ME/bird/d)	285.393	-4.496**	-0.838**	232.075	-1.868**	-0.565**
Protein conversion ratio (protein intake/wt. gain)	1.057	0.006**	0.168 ns	0.465	0.047**	0.805**
Energy conversion ratio (kcal ME intake/wt. gain)	39.073	-1.102**	-0.854**	29.379	-0.443**	-0.846**
Sexual maturity (days)	202.812	-2.012**	-0.579**	178.333	-1.583**	-0.533**
X = Metabolizable Energy (kcal/kg) in the diets						
Feed intake (g/bird/d)	108.527	-0.012**	-0.390*	94.050	-0.085**	-0.560**
Live weight gain (g/bird/d)	6.771	0.003**	0.191 ns	1.166	0.002**	0.780**
Feed conversion ratio (feed intake/wt. gain)	11.406	-1.568**	-0.204 ns	17.447	-0.003**	-0.725**
Protein intake (g/bird/d)	19.204	-0.002**	-0.273 ns	16.078	-0.001**	0.135 <sup>ns</sup>
Energy intake (kcal ME/bird/d)	103.983	0.035**	0.381*	68.725	0.045**	0.707**
Protein conversion ratio (Protein intake/wt. gain)	2.133	0.0003**	-0.535**	2.931	-0.0006**	-0.544**
Energy conversion ratio (kcal ME intake/wt. gain)	12.599	0.0024**	0.110 ns	27.508	-0.0020**	-0.230 <sup>ns</sup>
Sexual maturity (days)	296.61	-0.044**	-0.741**	256.853	-0.036**	-0.712**

\* \* (p &lt; 0.05); \*\* (p &lt; 0.01); NS (p &gt; 0.05).

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Kim and McGinnis (1976). In both experiments, the decrease of feed intake ( $p < 0.01$ ) with the increase of dietary protein and/or energy levels is in agreement with Cunningham and Morrison (1977) and Singh et al., (1980).

It is evident from the regressions of growth performances (table 4), that increased protein levels decreased ( $p < 0.01$ ) feed intake more at higher temperature ( $26.97 \pm 0.57^\circ\text{C}$ ) in experiment 1 than that at lower temperature ( $21.45 \pm 0.25^\circ\text{C}$ ) in experiment 2. However, ingested feed was more efficiently utilised for live weight gain in experiment 1 than in experiment 2. The detrimental effect of increased dietary protein on feed utilisation at elevated temperatures is supported by Dale (1985). The findings revealed that at optimum temperature, the birds may perform better on diets with increased protein and energy levels than that on diets with increased protein or energy alone. But at higher temperature the feed intake may be decreased linearly at a greater rate if the dietary protein level is increased.

The greater growth promotion with simultaneous increase of protein and energy than increasing protein or energy in the diets alone obtained in the present study is consistent with Charles (1986).

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