

EFFECT OF DIETARY PROTEIN AND ENERGY LEVELS ON THE PERFORMANCES OF STARCROSS LAYERS¹

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Summary

Two similar experiments were designed to evaluate the interaction of dietary CP and ME levels on the production performance parameters at the age between 155 and 300 days in Starcross layers.

In both experiments, the feed intake and mortality decreased but the egg weight, body weight gain and feed conversion efficiency increased as the dietary CP and ME levels increased. The CP intake was highest at the highest CP and lowest ME levels. With the increasing CP and decreasing ME levels, the ME intake decreased significantly (Experiments 1 & 2). The CP × ME interactions were significant only on mean egg weight and egg production in Experiment 2. In both the experiments, the CP levels were positively correlated with CP intake, egg weight, body weight gain and egg production and negative correlation with feed intake, mortality percentage and ME intake. The ME levels showed negative correlation with feed intake, protein intake, mortality percentages and positive correlation with all other parameters in both experiments. The highest values were noted for all the parameters (except mortality percentages) in Experiment 1 than that recorded in Experiment 2.

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

Introduction

The dietary protein and energy levels have independent effect on the performance of the chickens (Seft et al., 1985). Auckland and Fulton (1973) and Pearson and Herron (1982) reported the increased egg production at the increasing dietary energy levels and Ameenuddin et al. (1976) and Cave (1984) reported the increased egg production at the highest protein levels. Sadagopan et al. (1971) and Ameenuddin et al. (1976) reported the beneficial effects of 12 to 20% dietary CP levels on egg production. Contradicting these findings, Smith and Lewis (1964) claimed no advantage at higher levels of CP above 13%. High ME laying rations were reported to be more efficient with respect to egg production compared to low ME diets (Sadagopan et al., 1971).

Scott et al. (1969) reported that the dietary protein requirement of the laying hens decreased throughout the laying cycle. Scott et al. (1976) concluded that the protein requirement of the laying hens remains constant. On the other hand, some other investigators stated that the dietary protein requirements increase throughout the laying cycle (Jennings et al., 1972). However, the dietary ingredients and production systems have profound effects on the performances of chickens. Starcross pullets are reared in Bangladesh very recently. But their dietary crude protein (CP) and metabolizable energy (ME) requirements have not yet been assessed with respect to ingredients availability and existing production systems. Therefore, the present experiment was aimed at the interactions of dietary CP (13, 16, 19 or 22%) and ME (2600, 2800, 3000 or 3100 kcal/kg) levels on the performances of Starcross pullets under Bangladesh Condition.

Materials and Methods

Two similar experiments were conducted with ready-to-lay Starcross pullets over a period of two years. The first experiment was conducted during June to November, 1987 and the second

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Received November 12, 1991

Accepted August 12, 1992

one was conducted during May to October, 1988 to confirm the obtained treatment effects of the first experiment.

In Experiment 1, 155-day old 512 and in Experiment 2, 416 pullets were randomly assigned to either of the 16 diets, computed by the combination of 4 crude protein (CP) and 4 metabolizable energy (ME) levels (13, 16, 19 or 22% and 2600, 2800, 3000 or 3100 kcal/kg). Sixteen different diets used in these experiments were analysed according to conventional method (A.O.A.C., 1980). The amino acids, calcium and phosphorus percentages were estimated using the values (Snyder et al., 1985; Bolton and Blair, 1977) of individual ingredients. The dietary amino acids (critical) increased linearly with the increase of dietary protein level. Thus, the critical amino acid levels were the functions of increasing protein and iso-critical-amino acid diet formulations were not possible. The birds were reared on sand littered floor in an open-sided tin-shed building. Two trough feeders (100.0 × 15.25 × 18 cm) and one earthen drinker (2.5 litres) were provided for the birds in each pen. The pullets were fed *ad libitum* under identical care and managerial practices. The feed intake was recorded weekly. Mortality was recorded daily for adjustment of feed intake and egg production rates. Records on egg production and egg weight were kept daily when the pullets reached approximately 45% production. The first egg weight was recorded at the time when laid for each replication and treatment. The body weight gain was calculated replication wise from the difference of the initial and final body weight. The crude protein intake was calculated by deducting the protein content of the total supplied feed and the metabolizable energy intake was calculated by multiplying the unit metabolizable energy values of each diet by total units of feed consumed. The feed utilization efficiency was calculated as the units of feed consumed for each unit of eggs produced by each of the layers.

A completely randomized experimental design with a 4 × 4 factorial arrangement of treatments was used in both the experiments. Analysis of variance were performed to compare the differently recorded parameters for dietary protein or energy levels and their interactions. 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

Experiment 1

Mean values of performance parameters and their regression on dietary CP and ME levels are summarized in table 2 and 4 respectively. The dietary CP and ME levels had significant effect on all those parameters recorded (except mortality). There were no CP × ME interactions ($p > 0.05$) on any of these parameters (table 2).

The feed intake ($r = -0.66$ for CP levels; $r = -0.71$ for ME levels), feed conversion ratios ($r = -0.56$ for CP levels; $r = -0.64$ for ME levels) and mortality ($r = -0.17$ for CP levels; $r = -0.64$ for ME levels) decreased but the body weight gain ($r = 0.26$ for CP levels; $r = 0.81$ for ME levels), egg weight ($r = 0.82$ for CP levels; $r = 0.50$ for ME levels) and egg production ($r = 0.59$ for CP levels; $r = 0.63$ for ME levels) increased linearly as the dietary CP and ME level increased. The increasing ME level showed more beneficial effect on live weight gain as the dietary CP level increased. Simultaneous increase of dietary CP and ME level was more effective in reducing mortality than increasing either of them alone. Increase in CP and ME in diet increased egg weight and egg production in a similar way.

Table 2 shows that the layers fed on higher CP diets consumed more protein ($r = 0.93$ for CP levels) and less energy ($r = -0.89$ for CP levels) compared to those fed on low CP diets. On the other hand, the CP intake ($r = -0.31$ for ME levels) decreased but the ME intake ($r = 0.32$ for ME levels) increased linearly as the dietary ME level increased.

Experiment 2

Mean values of performance parameters and their regression on dietary CP and ME levels are illustrated in table 3 and 4 respectively. The layers fed on diets with different dietary CP and ME levels revealed significant ($p < 0.01$) differences in mean values of all the parameters measured (except mortality). The mortality maintained the decreasing tendency ($p > 0.05$) as the dietary CP and ME levels increased.

PROTEIN AND ENERGY ON PERFORMANCES OF LAYER

TABLE 1. COMPOSITION OF THE EXPERIMENTAL DIETS (EXPERIMENTS 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	4.00	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	10.00	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
Vitamineral premix	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 composition :																
Drymatter (%)	86.00	88.42	89.71	87.50	90.00	87.50	90.08	89.27	90.74	88.73	90.69	86.95	86.84	85.76	88.00	88.16
Crude protein (%)	13.12	16.16	19.20	21.98	13.18	16.07	19.01	22.11	13.17	16.20	18.93	22.17	13.02	15.96	19.25	21.87
Crude fiber (%)	3.49	5.01	4.76	4.42	3.53	4.30	4.48	5.00	3.68	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
Nitrogen free extract (%)	46.57	44.52	44.02	43.32	53.61	49.83	52.20	47.55	62.49	57.25	56.65	48.86	60.74	56.66	53.66	49.65
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
Calcium (%) [*]	1.38	1.66	1.89	2.15	1.38	1.64	1.89	1.67	1.38	1.67	2.19	2.75	1.39	1.83	2.22	2.68
Phosphorus (g/kg) [*]	1.07	1.14	1.11	1.09	0.90	0.89	0.86	1.00	0.58	0.67	0.87	1.12	0.48	0.69	0.87	1.09
Metabolizable energy (kcal/kg) [*]	2600	2600	2600	2600	2800	2800	2800	2800	3000	3000	3000	3000	3100	3100	3100	3100
Amino acid (%) :																
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	1.68	0.51	0.90	1.23	1.65
Cystine	0.35	0.39	0.40	0.41	0.32	0.34	0.33	0.40	0.26	0.28	0.36	0.44	0.23	0.30	0.36	0.43
Cost (taka/kg)	2.35	2.88	3.81	4.63	3.24	4.10	5.03	5.88	4.88	5.54	6.62	7.69	5.45	6.20	6.84	7.58

1 kg of vitamineral premix (Embavit W & L) contained: Vitamin A, 480000 IU; Vitamin D, 1000000 IU; Vitamin B₁, 8000 IU; Vitamin K₃, 1.60 g; Vitamin B₂, 0.60 g; Vitamin B₆, 2.00 g; Vitamin B₁₂, 1.60 g; Nicotinic acid, 12.00 g; Pantothenic acid, 4.00 g; Vitamin B₅, 4.00 mg; Folic acid, 0.20 g; Cobalt, 0.12 g; Copper, 6.4 g; Iron, 9.6 g; Iodine, 0.24 g; Manganese, 19.20 g; Zinc, 1.60 g; Selenium, 0.048 g; DL-methionine, 20.00 g; Choline chloride, 100.00 g; BHT, 20.00 g; Cereal base, 100% (2.5 kg).

^{*} - estimated.

TABLE 2. EFFECT OF DIETARY PROTEIN AND ENERGY LEVELS ON THE PERFORMANCE OF STARCROSS LAYERS (EXPERIMENT 1)

Parameters	Crude protein (%)	Metabolizable energy (kcal/kg)				Mean	SED and significance level [†]		
		2600	2800	3000	3100		CP	ME	CP×ME
Feed intake (g/bird/d)	13	120.02	115.56	109.79	104.84	112.55	0.831	0.831	1.663
	16	116.27	110.98	105.23	102.92	108.85	**	**	NS
	19	113.18	108.98	102.03	97.10	105.32			
	22	104.84	101.09	96.57	96.02	99.63			
	Mean	113.57	109.15	103.40	100.22	106.58			
Protein intake (g/bird/d)	13	15.56	15.00	14.25	13.61	14.60	0.149	0.149	0.298
	16	18.57	17.68	16.86	16.49	17.40	**	**	NS
	19	21.56	20.66	19.32	18.50	20.01			
	22	23.04	22.66	21.64	20.44	21.94			
	Mean	19.68	19.00	18.01	17.26	18.48			
Energy intake (kcal ME/bird/d)	13	312.06	323.58	329.38	325.01	322.50	2.413	2.413	4.825
	16	302.31	310.74	315.68	329.06	311.94	**	**	NS
	19	294.26	305.14	306.10	301.02	301.63			
	22	272.58	283.05	289.71	297.66	285.75			
	Mean	295.30	305.62	310.21	310.66	305.45			
Feed conversion ratio (feed/egg)	13	7.71	4.09	5.27	4.04	5.27	0.430	0.430	0.860
	16	6.36	3.75	2.96	2.61	3.92	**	**	NS
	19	5.51	4.41	2.73	2.15	3.70			
	22	3.41	2.62	1.87	1.87	2.44			
	Mean	5.74	3.71	3.20	2.66	3.83			
Body weight gain (g/bird)	13	57.64	68.17	76.42	92.25	73.62	1.606	1.606	3.212
	16	64.96	70.02	78.46	94.69	77.03	**	**	NS
	19	72.93	82.72	84.84	100.60	85.27			
	22	81.90	82.29	86.25	102.11	88.13			
	Mean	69.35	75.80	81.49	97.41	81.01			
Mortality (%)	13	16.51	17.17	6.51	14.58	13.69	2.726	2.726	5.452
	16	10.81	12.98	11.26	13.59	12.16	NS	NS	NS
	19	16.25	9.58	14.21	6.06	11.52			
	22	11.68	11.45	16.04	5.13	11.07			
	Mean	13.81	12.79	12.00	9.84	12.11			
Egg weight (g)	13	53.01	54.45	55.46	55.57	54.62	0.318	0.318	0.637
	16	54.96	55.86	56.07	57.06	55.98	**	**	NS
	19	56.78	57.03	58.44	58.54	57.69			
	22	57.30	58.10	58.92	59.94	58.56			
	Mean	55.51	56.36	57.22	57.78	56.71			
Total eggs/bird (in 75 days)	13	23.19	38.88	28.26	35.54	31.46	3.092	3.092	6.184
	16	25.46	42.19	47.67	52.14	41.86	**	**	NS
	19	27.26	31.97	50.56	57.99	41.94			
	22	40.60	49.94	65.94	62.07	54.63			
	Mean	29.12	40.74	48.10	51.93	42.47			

[†] All SEDs are against 16 d.f.; NS: $p > 0.05$; *: $p < 0.05$; **: $p < 0.01$.

PROTEIN AND ENERGY ON PERFORMANCES OF LAYER

TABLE 3. EFFECT OF DIETARY PROTEIN AND ENERGY LEVELS ON THE PERFORMANCES OF STARCROSS LAYERS (EXPERIMENT 2)

Parameters	Crude protein (%)	Metabolizable energy (kcal/kg)				Mean	SED and significance level*		
		2600	2800	3000	3100		CP	ME	CP×ME
Feed intake (g/bird/day)	13	109.55	102.52	98.67	95.35	101.52	0.718	0.718	1.436
	16	101.65	97.97	93.83	91.53	96.24	**	**	NS
	19	97.71	95.25	89.90	87.67	92.64			
	22	92.52	91.96	88.44	85.94	89.71			
	Mean	100.35	96.93	92.71	90.12	95.02			
Protein intake (g/bird/d)	13	14.41	13.34	12.94	12.39	13.27	0.110	0.110	0.220
	16	16.40	15.72	15.30	14.64	15.51	**	**	NS
	19	18.74	18.16	17.21	16.96	17.76			
	22	20.48	20.13	19.79	18.86	19.81			
	Mean	17.50	16.83	16.31	15.71	16.58			
Energy intake (kcal/bird/d)	13	284.83	287.07	296.03	295.61	290.88	1.990	1.990	3.990
	16	264.29	274.31	281.51	283.75	275.96	**	**	NS
	19	254.04	266.83	269.71	271.79	265.59			
	22	240.57	257.49	265.32	266.43	257.45			
	Mean	260.93	271.42	278.14	279.39	272.47			
Feed conversion ratio (feed/egg)	13	10.59	6.72	6.80	5.70	7.45	0.426	0.426	0.852
	16	7.46	5.91	5.29	4.27	5.73	**	**	NS
	19	6.03	5.53	3.56	2.83	4.48			
	22	3.84	3.94	2.99	2.72	3.37			
	Mean	6.98	5.52	4.66	3.88	5.26			
Body weight gain (g/bird)	13	47.69	51.92	70.04	96.87	66.63	4.334	4.334	8.668
	16	53.87	55.73	73.85	100.83	71.07	*	**	NS
	19	57.94	60.99	76.49	105.82	75.31			
	22	65.11	72.44	81.27	105.73	81.13			
	Mean	56.15	60.27	75.41	102.31	73.53			
Mortality (%)	13	23.33	16.04	22.12	21.74	20.80	2.122	2.122	2.244
	16	19.04	19.37	15.47	20.29	18.54	NS	NS	NS
	19	18.19	20.00	17.41	12.91	17.13			
	22	20.71	22.50	15.07	10.26	17.13			
	Mean	20.31	19.47	17.51	16.30	18.39			
Egg weight (g)	13	47.92	51.27	51.51	51.80	50.62	0.248	0.248	0.497
	16	50.59	52.46	51.81	53.01	51.96	**	**	**
	19	51.11	51.77	52.12	54.42	52.35			
	22	51.75	52.95	53.79	56.35	53.71			
	Mean	50.34	52.11	52.30	53.89	52.16			
Total eggs/bird (in 60 days)	13	13.10	17.96	17.17	19.57	16.95	1.159	1.159	2.318
	16	16.22	19.05	20.73	24.35	20.08	**	**	*
	19	19.21	20.01	20.63	34.13	23.49			
	22	27.91	26.41	33.15	34.21	30.42			
	Mean	19.11	20.85	22.92	28.06	22.73			

* All SEDs are against 16 d.f.; NS: p > 0.05; *: p < 0.05; **: p < 0.01.

TABLE 4. REGRESSIONS OF LAYING PERFORMANCES (Y) ON THE DIETARY PROTEIN AND ENERGY LEVELS (X)

Parameters (Y)	Experiment 1		Experiment 2			
	a	b	F	a	b	r
X = Crude Protein (CP) in diets (%)						
Feed intake (g/bird/d)	132.29	-1.48	-0.66**	117.80	-1.30	-0.71**
Protein intake (g/bird/d)	4.27	0.81	0.93**	3.82	0.72	0.96**
Energy intake (kcal ME/bird/d)	379.29	-4.29	-0.89**	337.01	-3.68	-0.82**
Feed efficiency (feed/egg)	8.92	-0.29	-0.56**	13.12	-0.14	-0.72**
Body weight gain (g/bird)	45.67	1.59	0.26NS	0.83	4.48	0.97**
Mortality (%)	17.06	-0.28	-0.17NS	25.55	0.41	-0.29NS
Egg weight (g)	48.82	0.45	0.82**	46.34	0.34	0.59**
Total eggs/bird	1.88	2.32	0.56**	-2.82	1.46	0.74**
X = Metabolizable energy (ME) in diets (kcal/kg)						
Feed intake (g/bird/d)	186.58	-0.02	-0.71**	153.54	-0.02	-0.64**
Protein intake (g/bird/d)	32.01	-4.71	-0.31NS	26.42	-3.42	-0.25NS
Energy intake (kcal ME/bird/d)	226.35	0.02	0.32NS	164.92	0.03	0.48**
Feed efficiency (feed/egg)	20.57	-0.005	-0.64**	22.37	-0.003	-0.54**
Body weight gain (g/bird)	-196.80	0.08	0.81**	-62.18	0.04	0.77**
Mortality (%)	32.47	-7.08	-0.25NS	41.61	0.008	-0.33NS
Egg weight (g)	42.78	4.99	0.50**	34.40	6.17	0.65**
Total eggs/bird	-86.80	0.04	0.63**	-23.27	0.01	0.46**

NS; p > 0.05; * p < 0.05; ** p < 0.01

The feed intake ($r = 0.71$ for CP levels; $r = -0.64$ for ME levels), feed conversion ratios ($r = 0.72$ for CP levels; $r = -0.54$ for ME levels) and mortality ($r = -0.29$ for CP levels; $r = -0.33$ for ME levels) decreased whereas the body weight gain ($r = 0.59$ for CP levels; $r = 0.65$ for ME levels) and egg production ($r = 0.74$ for CP levels; $r = 0.46$ for ME levels) increased linearly as the dietary CP and ME levels increased. The increasing ME levels reflected more advantages on body weight gain as the dietary CP level increased. However, the simultaneous increase of dietary CP and ME was more effective in reducing mortality than increasing either of them alone. The layers receiving higher CP diets consumed more protein ($r = 0.96$ for CP levels) compared to those receiving the lower CP diets. On the other hand, the CP intake declined ($r = -0.25$ for ME levels) but the ME intake improved ($r = 0.48$ for ME levels) as the dietary ME levels increased.

The increased diet density obtained by increased CP and ME combination drastically reduced feed intake. At all CP levels the increasing ME levels significantly increased the egg weight and egg production.

Discussion

In both experiments, data revealed the linear decrease in feed consumption and increase in body weight gain as the dietary CP and ME level increased. Similar findings were reported by Doran et al. (1980). In support of the present findings, Nagabhushanam et al. (1979) reported that, most probably due to increased nutrients (protein, energy, mineral, amino acids, fats etc.) intakes, the hens receiving high CP-ME diets gained more weight compared to those receiving low CP-ME diets. However, in present study (Experiments 1 & 2) the increased CP intake at increased CP levels is supported by Leeson and Summers (1989) and the increased ME intake with increasing ME levels is in line with the results of Pesti et al. (1986) and Gous et al. (1987).

The lack of effect of dietary CP and ME levels on mortality percentages is supported by McNaughton et al. (1977). The higher mortality in both experiments might possible be due to the interaction of nutrient deficiency and canni-

balism which inturn reduced egg production severely.

The higher mortality might be attributed to the lower critical amino acid levels of the low CP low ME diets the effect of which was also reflected on egg production. The egg production counting started from levels is of first egg obtained in any pen of all the treatments. The egg production delayed with the decrease of dietary CP and/or critical amino acids. That is why the birds on lower CP diet did not reach peak production in 75 days and the overall egg production presented in tables 3 & 4 appears to be poorer.

The poorest feed conversion efficiency at the lowest CP and/or ME levels found in both experiments agrees with the observations of Baghel and Pradhan (1989). Most probably, the high CP-ME diets contained and supplied the higher amount of other nutrients (mineral, amino acid, fat etc.) despite of low feed intake leading to higher body weight gain and improved feed conversion efficiency with respect to egg production and egg weight (Baghel and Pradhan, 1989).

Data in both experiments infer that the mean egg weight might be improved with the increase of dietary CP and/or ME level. Similarly, decreases in egg weight due to decreasing CP or ME in diets were reported by Oluyemi and Harms (1978) and Khan and Baghel (1983). These authors also concluded that the egg weight could be increased or decreased by changing the dietary ME concentration. Showing contradiction to the current study, other researchers (Pearson and Herron, 1982), however, reported that the egg weight decreased with the high CP-low ME diets. Moreover, other findings (Sadagopan et al., 1971; Saxena et al., 1986) revealed that neither the dietary CP nor ME concentration significantly ($p < 0.05$) affected the egg weight. The results (Experiments 1 & 2) or increased egg weight due to increased CP and ME levels might be associated with higher CP and ME intakes as supported by previous findings (Doran et al., 1980; Pearson and Herron, 1982; Spratt and Leeson, 1987).

Findings of both experiments exhibited better egg production at the increasing dietary CP-ME combinations than at the decreasing CP-ME combinations. These results are in concurrence to the reports by other researchers (Reddy et

al., 1980, Keshvarz, 1984; Ameenuddin et al., 1976; Cave, 1984). Most of these researchers evaluated 12 to 22% CP in the diets. But other researchers concluded that the increasing dietary CP levels up to 18% in the laying period increased egg production, increasing beyond that upto 22% had no beneficial effect (Singh et al., 1980; Onwudike, 1983; Jalaludeen and Ramkrishnan, 1989). In contravene to the present findings, numerous workers failed to show significant differences in egg production due to feeding birds within a limited range of CP in the growing period (Leeson and Summers, 1982; Keshavarz, 1984; Saxena et al., 1986; Reddy et al., 1989).

In contrast to the present results, some other investigators have shown the absence of influence of dietary ME concentrations (2600 to 3200 kcal/kg) on the rates of egg production (Sadagopan et al., 1971; Cunningham and Morrison, 1977; Jalaludeen and Ramkrishnan, 1989). However, the increased egg production at increased ME levels due to higher ME intake observed in the present study is in line with the findings of Pearson and Herron (1982). Reversibly, Gleaves et al. (1977) and Raddy et al. (1979) reported the decreased rate of egg production at the increasing ME levels.

Being in agreement with the conclusion of Keshavarz (1984), possibly lower intakes of lysine and other amino acids might have been the reasons of the inferior performance of the birds fed low CP compared to higher ones. He also concluded that the addition of CP after 16% (upto 18%) may not be beneficial in terms of egg production. In addition, some other authors (Ameenuddin et al., 1976 and Douglas et al., 1985), therefore, indicated that improvement in egg production on high CP diet than low CP ones might be mainly due to better amino acid make up.

However, the higher CP intake at the higher CP-ME concentration during the prelaying period in both experiments would possibly allow sufficient CP or ME to be stored in the liver to sustain the higher egg output in the laying period (Bowmaker and Gous, 1989). Moreover, the reduced egg production might also be associated with the decreased dietary calcium. Luck and Scanes (1979) reported reduction in ovulation and plasma luteinizing hormone (LH) in hens fed

calcium deficient ration. Because estrogen secretion is dependent upon ovulatory activity and production state in the bird (Bacon et al., 1980). It is clear that the dietary calcium content may affect the plasma levels of the hormone.

Higher feed intake, CP intake, ME intake, feed conversion efficiency, egg production, egg weight and lower mortality in Experiment 1 than in Experiment 2 may be attributed to the heavier live weight of the pullets in Experiment 1 at the onset of production. However, the overall resulting trends for most of the parameters found in Experiment 2 are supported by the results of Experiment 1.

Considering all the parameters of both the two experiments, it could be concluded that the recommended dietary CP and ME levels lie between 19 to 22% and 3000 to 3100 kcal/kg respectively for Starcross layers.

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