EFFECT OF DIETARY PROTEIN AND ENERGY LEVELS ON GROWTH AND CARCASS YIELD PERFORMANCES OF SPENT STARCROSS HENS

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Summary

The effect of 16 different dietary rations, computed by the combinations of 13, 16, 19 or 22% CP and 2600, 2800, 3000 or 3100 kcal ME/kg, on growth performances and carcass yield of Starcross layers were assessed in two similar experiments.

In both experiments, the body weight, eviscerated carcass yield, edible carcass yield, length of digestive tract and shank length increased but the feed intake decreased linearly with the increase of dietary CP and ME levels. The liver and gizzard weights as percentages of live weight tended to be increased with the increase of dietary CP and ME levels. The carcass dry matter, crude protein, fat, ash and energy content were not influenced by the dietary CP and ME levels.

Dietary CP levels had positive correlations with all the parameters (except feed and energy intake and carcass dry matter). However, the dietary ME levels were positively correlated with all the parameters (except feed and energy intake; carcass dry matter and ash) in both experiments. The higher values were noted for all the parameters (except gizzard and carcass fat percentages) studied in Experiment 1 compared to those observed in Experiment 2.

(**Key Words**: Protein, Energy, Carcass, Performance)

Introduction

The eviscerating and dressing losses were greater with the smaller birds which in turn decreased the percentages of the eviscerated and edible carcass weight (Card and Nesheim, 1978). Summers et al. (1965) and Kubena et al. (1972) reported that the eviscerated and edible carcass weight percentages increased due to the increased deposition of subcutaneous and intramuscular fat in the birds fed on high energy diets. However, limited informations are available on the carcass yields of spent hens slaughtered at the termination of lay. Having this idea in view, the present study was undertaken to assess the effects of different distray protein and energy levels on the growth and carcass yield performances of spent Starcross hens.

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Materials and Methods

Two similar experiments were conducted with Starcross replacement pullets.

In each experiment, at 25 days of age, 640 chicks were randomly allocated on either of 16 diets (table 1) computed by the combination of 4 crude portein (CP) levels (13, 16, 19 or 22%) and 4 metabolizable energy (ME) levels (2600, 2800, 3000 or 3100 kcal/kg). There were two replications in each for all allocated treatment of both experiments. The individual ingredients and computed rations were analysed (A.O.A.C., 1980) for proximate components. The amino acid percentages were estimated using the values of Snyder et al., (1958) and Bolton and Blair, (1977) and the calcium and phosporus contents were estimated by using the values of NRC, (1977) and Bolton and Blair (1977) of individual ingredient.

The birds were reared in opensided tinshed building in individual cages made of iron wire having a dimension of 37.5 × 47.5 × 37.5 cm attached side by side in rows. Each row of 10 cages situated face to face. The cages were hung 60 cm above the floor. A common water trough

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	1.30	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[1]	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	90.00	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	19.19	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
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	43.32	53.61	49.83	52.20	47.55	62.49	57.25	56.65	48.86	60.74	56.66	53.56	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	1.68	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

[1] 1 kg of vitamineral premix contained: Vitamin-A-480000 IU; Vitamin-D-1000000 IU; Vitamin-E-8000 IU; Vitamin-K, 1.60 g; Vitamin-B_1-0.60 g; Vitamin-B_2-2.00 g; Vitamin-B_6-1.60g; Nicotinic Acid-12.00 g; Pantothenic acid-4.00 g; Vitamin-B_{12}-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-1.60 g; Selenium-0.048 g; DL-methionine-20.00 g; Choline-chloride-100.00 g; BHT-20.00 g; Cereal base-100% (2.5kg).

was attached to backside in each cage, but separate feed troughs were attached infront. Feed and clean fresh water were offered to the birds *ad libitum*. Feed intake and body weights (initial and final), CP and ME intakes; and feed conversion efficiency were recorded for each treatment.

At the age between 280 and 287 days, where the egg production recording was over, the brids were kept under fasting for 20 hours. Then the birds were reweighed, slaughtered, eviscerated and dissected (Jones, 1984). The lengths of the shanks and digestive tracts and weights of the liver, gizzard and edible carcasses were recorded individually for each replication. The proximate components (A.O.A.C., 1980) and the gross energy (determined by Bomb Calorimeter) contents of the carcasses were recorded replicationwise.

In both experiments, the data were set for a 4 × 4 (CP × ME) factorial in a Completely Randomized Design. Analysis of variance compared the different recorded parameters for CP or ME levels and their interactions. The parameters were also regressed on either CP or ME levels to have the changes in different parameters against the unit change of CP or ME levels and then compared.

Results

Experiment 1.

Results of growth performances and carcass quality parameters of spent Starcross hens are presented in tables 2 & 3. Feed intake and feed conversion ratios decreased whereas the final body weight, length of digestive tracts, eviscerated carcass weight and edible carcass weight increased linearly as the dierary CP and or ME levels increased.

Spent hens receiving higher CP diets consumed significantly ($p < 0.05$) more CP and less ME than those receiving the lower CP diets. However, the CP intake decreased and the ME intake increased with the increasing dietary ME levels.

Shank length increased slightly ($p > 0.05$) with the increasing dietary CP levels, while increased significantly ($p < 0.01$) as the dietary ME levels increased. The liver and gizzard weights tended to be increased ($p > 0.05$) with the increasing dietary CP and/or ME levels (table 2).

Carcass drymatter tended to be decreased whereas the crude protein content failed to have regular trend at the increasing dietary CP and ME levels. The protein content increased upto 19% dietary CP and 3000 kcal ME levels and then declined at the highest CP ME level. The carcass fat increased slightly ($p > 0.05$) as the dietary CP and ME levels increased. However, the carcass ash percentages as shown in table 2, increased ($p > 0.05$) with the increasing CP and decreasing ME levels in the diets. Moreover, the carcass energy content tended to be improved as the dietary CP and ME levels increased.

Experiment 2.

Results of growth performances and carcass quality parameters of spent Starcross hens are presented in tables 2 and 3. As a consequence of feeding higher CP-ME diets, significantly ($p < 0.01$) lower feed intake and higher final body weight, feed conversion, eviscerated carcass weight and length of digestive tract were observed.

Having significant differences ($p < 0.05$), at all CP levels, the increased ME levels decreased the feed intake. However, the final body weight increased at all CP levels (except 13%) with the increase of dietary ME levels.

Crude protein intake increased significantly ($p < 0.01$) due to increasing dietary CP levels but decreased at increasing dietary ME levels. On the other hand, reverse trends were found in ME intake due to increasing dietary CP and ME levels. Shank length and edible carcass weight increased slightly as the dietary CP levels increased. But there was significant ($p < 0.01$) improvement in shank length and edible carcass weight due to higher ME levels in the diets compared to lower ones.

Carcass drymatter percentages tended to be decreased but the energy content (gross energy) increased slightly as the dietary CP and ME levels increased. Carcass crude protein content tended to be increased up to at 19% CP and 3000 kcal ME/kg levels and then declined at the highest CP ME levels. Carcass fat showed irregular trend at the increasing dietary CP levels but improved slightly as the dietary ME levels increased. However, the carcass energy tended to be increased at the increasing dietary CP levels and decreasing dietary ME levels.

TABLE 2. GROWTH AND CARCASS YIELD PERFORMANCES OF SPENT STARCROSS HENS AS INFLUENCED BY DIETARY CRUDE PROTEIN (CP) AND METABOLIZABLE ENERGY (ME) LEVELS (EXPERIMENT 1 & 2)

Experiment 1.

Parameters	Crude protein in diets (%)	Metabolizable energy (kcal/kg) in diets 2600	2800	3000	3100	Mean	SED and significance level CP	ME
Feed intake (g/bird/d)	13	103.47	100.04	96.21	92.64	98.09	0.526	0.526
	16	98.45	94.68	90.61	89.55	93.32	**	**
	19	94.75	91.99	87.58	81.47	88.94		
	22	89.70	86.49	84.49	78.31	84.74		
	Mean	96.59	93.30	89.72	85.49	91.27		
Protein intake (g/bird/d)	13	13.45	13.00	12.50	12.04	12.74	0.102	0.102
	16	15.75	15.14	14.49	14.32	14.92	**	**
	19	18.00	17.47	16.64	15.47	16.89		
	22	19.73	19.02	18.58	17.22	18.63		
	Mean	16.73	16.15	15.55	14.76	15.79		
Energy intake (kcal ME/bird/d)	13	269.02	280.11	288.64	287.21	281.24	1.515	1.515
	16	255.96	265.12	271.85	277.61	267.63	**	**
	19	246.35	257.58	262.74	252.56	254.80		
	22	233.24	242.18	253.49	242.77	242.92		
	Mean	251.14	261.24	269.18	265.03	261.64		
Initial body weight (g)	13	315.00	320.00	312.50	310.00	314.37	NS	NS
	16	317.50	310.00	310.00	310.00	311.87		
	19	312.50	315.00	317.50	315.00	315.00		
	22	307.50	317.50	305.00	307.50	309.37		
	Mean	313.12	315.62	311.25	310.62	312.65		
Final body weight (g)	13	1562.50	1620.00	1607.50	1565.00	1588.75	15.226	15.226
	16	1637.50	1680.00	1757.50	1832.50	1726.87	**	**
	19	1722.50	1780.00	1845.00	2030.00	1844.37		
	22	1745.00	1847.50	1925.00	2065.00	1895.62		
	Mean	1666.87	1731.87	1783.75	1873.12	1763.90		
Feed efficiency (feed/gain)	13	22.81	21.17	20.42	20.30	21.17	0.190	0.190
	16	20.51	19.00	17.21	16.17	18.22	**	**
	19	18.84	17.26	15.26	13.07	16.01		
	22	17.16	15.54	14.34	12.26	14.82		
	Mean	19.74	18.24	16.80	15.45	17.55		

(continued)

Parameters	Crude protein in diets (%)	Metabolizable energy (kcal/kg) in diets				Mean	SED and significance level	
		2600	2800	3000	3100		CP	ME
Shank length (cm)	13	9.45	9.65	9.85	10.05	9.75	0.096	0.096
	16	9.50	9.75	9.80	10.15	9.80	NS	**
	19	9.65	9.65	9.70	10.40	9.85		
	22	9.60	9.80	9.90	10.30	9.90		
	Mean	9.55	9.71	9.81	10.22	9.82		
Length of digestive tract (cm)	13	139.19	140.16	140.41	141.32	140.27	0.225	0.225
	16	139.75	140.17	141.26	141.98	140.79	**	**
	19	141.27	141.09	142.59	143.43	142.09		
	22	142.31	142.57	143.43	143.56	142.96		
	Mean	140.63	140.99	141.92	142.57	142.52		
Liver weight (%)	13	2.32	2.33	2.33	2.34	2.32	0.015	0.015
	16	2.32	2.33	2.33	2.33	2.32	NS	NS
	19	2.33	2.32	2.32	2.34	2.32		
	22	2.33	2.32	2.34	2.34	2.33		
	Mean	2.32	2.32	2.33	2.33	2.32		
Gizzard weight (%)	13	2.75	2.75	2.73	2.77	2.75	0.018	0.018
	16	2.75	2.77	2.77	2.78	2.76	NS	NS
	19	2.78	2.77	2.78	2.77	2.77		
	22	2.79	2.78	2.80	2.78	2.77		
	Mean	2.78	2.77	2.78	2.77	2.77		
Eviscerated carcass weight (%)	13	60.16	60.34	60.34	60.54	60.34	0.152	0.152
	16	59.99	60.41	60.70	61.38	60.62	*	**
	19	60.23	60.38	60.43	61.94	60.74		
	22	60.31	60.34	60.90	62.10	60.91		
	Mean	60.17	60.36	60.59	61.49	60.65		
Edible carcass weight (%)	13	66.08	65.58	66.25	65.96	65.96	0.381	0.381
	16	66.25	66.21	66.55	66.85	66.46	*	*
	19	66.47	66.57	67.20	68.34	67.14		
	22	66.18	66.70	67.65	68.63	67.29		
	Mean	66.24	66.26	66.91	67.44	66.71		
Carcass dry matter (%)	13	35.10	35.03	34.95	35.23	35.07	0.191	0.191
	16	35.13	35.09	35.04	34.47	34.93	NS	NS
	19	35.00	34.87	34.95	34.63	34.86		
	22	34.95	34.96	34.44	34.58	34.73		
	Mean	35.04	34.98	34.84	34.72	34.89		

(continued)

Parameters	Crude protein in diets (%)	Metabolizable energy (kcal/kg) in diets 2600	2800	3000	3100	Mean	SED and significance level CP	ME
Crude protein in carcass (%) (DM basis)	13	54.01	54.03	54.91	54.89	54.46	0.387	0.387
	16	54.91	54.62	54.79	54.54	54.71	NS	NS
	19	54.73	55.34	54.66	54.21	54.98		
	22	54.45	55.28	54.94	54.18	54.71		
	Mean	54.52	54.81	54.82	54.70	54.71		
Fat in carcass (%) (DM basis)	13	36.36	36.13	36.35	36.43	36.31	0.242	0.242
	16	35.93	35.95	36.27	36.29	36.11	NS	NS
	19	36.04	36.09	36.35	36.46	36.23		
	22	36.09	36.68	36.73	36.92	36.60		
	Mean	36.10	36.21	36.42	36.52	36.31		
Ash in carcass (%)	13	8.19	8.09	7.70	7.68	7.91	0.099	0.099
	16	8.14	8.11	7.96	8.06	8.06	NS	NS
	19	8.25	7.79	8.14	8.11	8.07		
	22	8.27	8.24	8.18	8.10	8.19		
	Mean	8.21	8.05	7.99	7.98	8.05		
Energy content (kcal/100 gm fresh meat)	13	169.61	170.80	172.38	172.42	171.30	0.954	0.954
	16	172.26	172.04	172.26	172.95	172.37	NS	NS
	19	172.22	172.07	173.52	172.77	172.64		
	22	172.95	172.65	173.70	173.52	173.13		
	Mean	171.76	171.89	172.89	172.91	172.36		

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

Experiment 2.

Parameters	Crude protein in diets (%)	Metabolizable energy (kcal/kg) in diets 2600	2800	3000	3100	Mean	SED and significance level CP	ME
Feed intake (g/bird/d)	13	94.58	90.20	87.99	83.63	89.10	0.547	0.547
	16	88.57	85.89	82.71	83.31	85.12	**	**
	19	86.09	83.52	79.99	78.29	81.97		
	22	81.58	81.03	79.12	77.03	79.69		
	Mean	87.70	85.16	82.45	80.56	83.97		
Protein intake (g/bird/d)	13	12.29	11.72	11.43	10.87	11.57	0.086	0.086
	16	14.17	13.74	13.23	13.01	13.53	**	**
	19	16.35	15.86	15.19	14.87	15.56		
	22	17.94	17.40	16.96	17.52	17.52		
	Mean	15.18	14.78	14.31	13.92	14.54		
Energy intake (kcal ME/bird/d)	13	245.90	252.57	263.98	259.27	255.43	1.505	1.505
	16	230.28	240.49	248.13	252.07	242.74	**	**
	19	223.49	233.86	239.97	242.72	235.01		
	22	212.11	226.88	237.38	238.81	228.79		
	Mean	227.94	238.45	247.36	248.21	240.49		

(continued)

Parameters	Crude protein in diets (%)	Metabolizable energy (kcal/kg) in diets 2600	2800	3000	3100	Mean	SED and significance level CP	ME
Initial body weight (g)	13	297.50	305.00	302.50	297.50	300.62	NS	NS
	16	302.50	302.50	307.50	302.50	303.75		
	19	302.50	297.50	312.50	305.00	304.37		
	22	307.50	305.00	295.00	302.50	302.50		
	Mean	302.50	302.50	304.37	301.87	302.81		
Find body weight (g)	13	1470.00	1527.50	1520.00	1535.00	1513.12	15.423	15.423
	16	1510.00	1592.50	1682.50	1705.00	1622.50	**	**
	19	1577.50	1647.50	1792.50	1812.50	1707.50		
	22	1637.50	1705.00	1797.50	1872.50	1753.12		
	Mean	1548.75	1618.12	1698.12	1731.25	1649.06		
Feed efficiency (feed/gain)	13	22.18	20.29	19.60	18.59	20.16	0.262	0.262
	16	20.17	18.30	16.54	15.95	17.74	**	**
	19	18.58	17.01	14.86	14.28	16.18		
	22	16.88	15.91	14.48	13.49	15.19		
	Mean	19.45	17.87	16.37	15.57	17.31		
Shank length (cm)	13	9.22	9.32	9.45	9.60	9.39	0.051	0.051
	16	9.25	9.42	9.50	9.57	9.43	NS	**
	19	9.32	9.44	9.55	9.70	9.50		
	22	9.32	9.50	9.52	9.77	9.52		
	Mean	9.27	9.42	9.50	9.65	9.46		
Liver weight (%)	13	2.25	2.27	2.26	2.28	2.26	0.009	0.009
	16	2.26	2.27	2.27	2.28	2.27	NS	NS
	19	2.27	2.29	2.29	2.29	2.28		
	22	2.27	2.28	2.29	2.30	2.28		
	Mean	2.26	2.27	2.27	2.28	2.27		
Gizzard weight (%)	13	2.78	2.77	2.79	2.80	2.78	0.018	0.018
	16	2.80	2.79	2.79	2.81	2.79	NS	NS
	19	2.81	2.82	2.81	2.82	2.81		
	22	2.82	2.82	2.83	2.83	2.82		
	Mean	2.80	2.80	2.80	2.81	2.80		
Eviscerated carcass weight (%)	13	58.49	58.58	59.76	60.88	59.42	0.488	0.488
	16	58.77	59.50	60.77	62.16	60.30	*	**
	19	59.58	60.38	61.50	62.47	60.98		
	22	60.14	59.38	61.87	63.69	61.27		
	Mean	59.24	59.46	60.97	60.30	60.49		

(continued)

Parameters	Crude protein in diets (%)	Metabolizable energy (kcal/kg) in diets 2600	2800	3000	3100	Mean	SED and significance level CP	ME
Edible carcass weight (%)	13	64.45	64.96	66.00	66.30	65.42	0.448	0.448
	16	65.06	65.77	66.42	67.29	66.13	NS	*
	19	65.29	66.15	67.08	67.45	66.49		
	22	65.49	66.56	67.30	67.68	66.75		
	Mean	65.07	65.86	66.70	67.18	66.20		
Length of digestive tract (cm)	13	134.25	135.42	138.07	138.67	136.60	0.760	0.760
	16	135.22	136.75	139.02	140.40	137.85	**	**
	19	135.55	136.85	141.75	143.50	139.41		
	22	137.12	137.52	140.77	144.07	139.87		
	Mean	135.53	136.63	139.90	141.66	138.43		
Carcass dry matter (%)	13	36.00	34.89	35.31	34.98	35.29	0.321	0.321
	16	35.52	34.98	35.21	34.45	35.04	NS	NS
	19	34.75	35.22	34.41	35.20	34.89		
	22	35.32	34.32	34.12	34.19	34.48		
	Mean	35.39	34.85	34.76	34.70	34.92		
Crude protein in carcass (%) (DM basis)	13	54.48	54.15	54.09	54.92	54.41	0.297	0.297
	16	54.81	54.78	54.53	54.97	54.77	NS	NS
	19	55.09	55.18	55.42	55.08	55.19		
	22	54.46	54.78	55.49	54.18	54.72		
	Mean	54.71	54.72	54.88	54.78	54.77		
Fat in carcass (%) (DM basis)	13	36.24	36.17	36.43	36.46	36.32	0.386	0.386
	16	35.41	35.58	35.68	35.77	35.61	NS	NS
	19	35.96	35.92	35.90	35.94	35.93		
	22	36.43	36.46	36.32	36.49	36.42		
	Mean	36.01	36.03	36.08	36.16	36.07		
Ash in carcass (%)	13	8.74	8.54	8.18	7.92	8.34	0.188	0.188
	16	8.68	8.62	8.47	8.25	8.50	NS	NS
	19	8.84	8.88	8.76	8.51	8.74		
	22	8.91	8.84	8.80	8.69	8.81		
	Mean	8.79	8.72	8.55	8.34	8.60		
Energy content (kcal/100 g fresh meat)	13	171.89	172.04	172.23	172.98	172.28	1.190	1.190
	16	172.46	173.40	173.00	172.71	172.89	NS	NS
	19	173.05	174.19	174.44	174.95	174.15		
	22	174.18	174.62	174.96	174.13	174.47		
	Mean	172.89	173.56	173.65	173.69	173.44		

[1] NS $p > 0.05$; * $p < 0.05$; ** $p < 0.01$.

TABLE 3. REGRESSIONS OF GROWTH AND CARCASS YIELD PERFORMANCE PARAMETERS (Y) OF SPENT STARCROSS HENS ON DIETARY CRUDE PROTEIN (CP) OR METABOLIZABLE ENERGY (ME) LEVELS (X) (EXPERIMENT 1 & 2)

Parameters	Experiment 1			Experiment 2		
	a	b	r	a	b	r
X = Crude Protein (CP) in diets (%)						
Feed intake (g/bird/d)	117.180	−1.479	−0.756**[1]	101.358	−1.029	−0.738**
Protein intake (g/bird/d)	4.344	0.655	0.941**	2.958	0.662	0.975**
Energy intake (kcal ME/bird/d)	336.209	4.260	−0.882**	291.620	2.921	−0.741**
Final body weight (g)	1158.333	34.604	0.769**	1189.479	26.333	0.730**
Feed efficiency (feed/gain)	29.965	−0.708	−0.805**	25.274	0.520	−0.692**
Shank length (cm)	9.533	0.016	0.186**	9.273	0.010	0.229NS
Length of digestive tract (cm)	136.099	0.310	0.764**	131.309	0.378	0.414*
Liver weight (%)	2.319	0.0007	0.100NS	2.238	0.00229	0.424*
Gizzard weight (%)	2.699	0.0041	0.447*	2.732	0.0043	0.463**
Eviscerated carcass weight (%)	60.074	0.034	0.291NS	56.875	0.207	0.428*
Edible carcass weight (%)	64.008	0.154	0.529**	63.663	0.145	0.368*
X = Metabolizable energy (ME) in diets (kcal/kg)						
Feed intake (g/bird/d)	98.154	−0.0024	−0.201NS	126.400	−0.0148	−0.608**
Protein intake (g/bird/d)	17.139	−0.00047	−0.109NS	21.649	−0.0024	−0.207NS
Energy intake (kcal ME/bird/d)	171.552	0.031	0.371*	119.633	0.042	0.611**
Final body weight (g)	699.639	0.380	0.484*	575.233	0.373	0.594**
Feed efficiency (feed/gain)	42.336	−0.0082	−0.0537NS	39.546	−0.007	−0.609**
Shank length (cm)	6.462	0.0011	0.751**	9.200	0.00009	0.309NS
Length of digestive tract (cm)	140.519	0.00037	0.148NS	102.512	0.012	0.783**
Liver weight (%)	2.259	0.00002	0.204NS	2.154	0.000043	0.461**
Gizzard weight (%)	2.729	0.000014	0.090NS	2.743	0.000022	0.137NS
Eviscerated carcass weight (%)	54.112	0.002	0.685**	43.208	0.006	0.712**
Edible carcass weight (%)	59.359	0.0023	0.466**	54.160	0.0041	0.608**

[1] NS $p > 0.05$; * $p < 0.05$; ** $p < 0.01$.

Discussion

Current findings revealed that the hens fed on high CP-ME diets consumed less feed than those fed on low CP-ME diets. In contrast to the present results, Reddy et al. (1979) and Keshavarz (1984) reported the improved feed intake with the increased dietary CP levels. This might have been due to increased rate of egg production (Gleaves et al., 1977). The decreased feed intake at the higher CP and ME levels found in this study are supported by Doran et al. (1983). The higher nutrient (protein and energy) intakes at their increasing dietary levels were possibly due to higher rate of egg production (not shown) and body weight gain at the increasing dietary CP and ME levels. Similar results were reported by Reddy et al. (1980), and Doran et al. (1980). The increased protein or energy intakes with the increase of their dietary contents observed in the present study are confirmed by the observations of Leeson and Summers (1989). However, in contrast to the present observations (Experiment 1 & 2), Bolton et al. (1987) reported that the increased dietary CP levels depressed the CP intake which might possibly be due to increased rates of decrease in feed intake. But the early observations by Keshavarz (1984), and Spratt and Leeson (1987) revealed that increasing dietary CP contents improved the ME intake in the rearing period compared to those diets containing higher ME contents. The increased CP and ME intakes at the higher CP and ME levels were perhaps related to the increased rates of live weight gain and egg production.

The results of the present study (Experiment 1 & 2) showed evidence that the live weight gain might be improved with increase of dietary CP and/or ME levels. These results are in agreement with the observations of Doran et al. (1980). Inconsistently, some other findings by Hamilton (1978), Kissikinen (1984) and Saxena et al. (1986) revealed the lack of effect of dietary CP or ME levels on body weight of pullets. This might possibly be due to ingredient variability, better amino acid pattern, rate of weight gain and stage of egg production. Most probably due to increased nutrient (protein, energy, mineral, amino acids, fat etc.) intakes (Experiment 1 & 2), the hens receiving high CP-ME diets gained more weight compared to those receiving the low CP-ME diets (Nagabhushanam et al., 1979). Moreover, the increased pre-larging body weight gain might have interacted with improved CP and ME intakes and the final body weight gain was enhanced at the higher dietary CP and ME levels.

The apparent metabolizable energy (AME) might also be associated with increased live weight gain at the increasing dietary CP and ME levels (Pearson and Herron, 1982). The results of this study indicated that the simultaneous increase of CP and ME may promte growth more than increasing CP or ME alone in the diets (Charles, 1986).

Results in both experiments exhibited that hens reared on high CP-ME diets showed the highest feed conversion efficiency (with respect to live weight gain) compared to those on low CP-ME ones. With respect to live weight gain, the feed conversion efficiency increased with the increasing dietary CP levels (Nagabhushanam et al., 1979). Contradicting the general believe, Chi (1985) failed to detect any difference in feed conversion efficiency (7 to 24 weeks) that could be explained by the nature of starter (18.2 to 14.9% CP) and grower (15.1 to 10.9% CP) diets. Most probably due to higher increasing rates of live weight gain with higher nutrient intakes and ligher decreasing rates of feed intake at the higher CP and ME levels, the feed conversion efficiency increased linearly (Nagabhushanam et al., 1979).

Data presented in table 2 showed that the increased dietary CP and ME increased the lengths of the shanks. The increased shank lengths with increasing dietary ME levels agree with the findings of Lesson and Summers (1989). Increasing ME intake might have been resulted in improved shank length but the CP intake had no significant effect on shank length. These results are in consistent with those of Spratt and Leeson (1987). The early increased growth response at the higher CP levels reflected in shank length during the growing period (Leeson and Summers, 1989).

It is evident that the increased length of the digestive tracts for the hens fed on the high CP-ME diets was possibly the function of increased body size. The digestive organs of birds (Gallinaceious birds and water fowl) have been recorded to differ in size and structure with changes in the quality or quantity of diet (Ankney, 1977).

Current findings (Experiment 1 & 2) provided documentations that the dietary CP or ME profile may have no consistent effect on the percentages of liver and gizzard weights (Virk et al., 1979; Keshavarz, 1984). The improving tendency of liver weight with the increasing dietary ME concentrations are also in concurrence with observations of Ivy and Nesheim (1973) and Cunningham and Morrison (1977).

Present observations support that the eviscerated and edible carcass weight increased as the dietary CP and ME level increased simultaneously. Similar findings were reported by Summers et al. (1985), Kubena et al. (1972), Abdel Hakim and El-Naggar (1987). It might be assumed that the eviscerating and dressing losses were greater with the smaller birds fed on low CP and ME containing diets which decreased the percentages of the eviscerated and edible carcass weight. Early observations by Card and Nesheim (1978) revealed the similar results. Possibly due to increased deposition of subcutaneous and intramuscular fat in the body of the spent hens offered high ME diet, the edible carcass weight percentages increased.

Present results obtained in both experiments illustrated that the dietary CP and ME concentrations may exert no influence on the carcass composition (dry matter, crude protein and crude fat) as supported by early observations (Leeson and Summers, 1989). Slightly increasing tendency of crude protein, fat and decreasing tendency of drymatter and ash percentages are, however, confirmed by Bennet and Leeson (1990). Insignificantly increasing tendency ($p > 0.05$) of the carcass protein, fat and ash percentages towards the increasing dietary CP levels are also in consistent with the early findings by Leeson and Summers (1989) and Bennett and Leeson (1990). In experiment by Adekunmis and Robbins (1990), the body composition analysis indicated significant decrease in concentration of carcass drymatter and of increased concentration of carcass crude protein in birds fed the high protein diets. Also, the birds fed the low CP (14%) high mineral acid base balance diet contained less carcass fat than did the birds fed on low CP, low acid base balance diet.

Richter et al. (1980) and Rose and Michie (1982) have difficulty of explaining their performance results with heavy turkeys fed on varying dietary CP and ME levels, while Auckland and Morris (1971) and Salmon (1974) reported that the dietary ME intake did not correlate with carcass composition.

It is evident from the table 2, that the carcass energy concentrations were not affected by the concentrations of the dietary CP and ME in the diets. This lack of effect of dietary CP levels on carcass energy contents is in line with those of Azhan and Forbes (1989). Similarly, Salmon et al. (1982) failed to show the significant effect of dietary ME content on the carcass energy content. This might possibly be due to insignificant differences in fat content of the carcass (table 2).

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