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Nutritional Manipulations During Induced Moult in White Leghorn Layers I. Effects on Carcass Characteristics and Visceral Organs

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ABSTRACT
This experiment was conducted to investigate the effects of varying protein and energy levels on carcass characteristics and visceral organs in induced moult white leghorn layers. One hundred and sixty eight, White Leghorn Single Comb commercial layers (70 weeks old) were used as experimental birds and six experimental rations varying in crude protein (CP) i.e. 14%, 16% and 18% and metabolizable energy (ME) i.e. 2700 and 2900 kcal/kg and a corn based ration were fed to them, during post-fast-pre-lay interval. No differences (P>0.05) were found in liver weight of layers fed different moult diets varying in protein and energy levels both at post-moult and 50% production stage. Maximum (P<0.05) heart (0.63g/100g body weight (BW)) and spleen (0.15 g/100g BW) weights were found with diet having pure corn. At 50% production stage, higher (P<0.05) gizzard (2.24 g/100g BW) and proventriculus (0.45 g/100 g BW) weights were noticed in the birds having 16% CP, 2900 kcal/kg ME, while the maximum (P<0.05) gastrointestinal length (222.33cm) was noticed at 18% CP, 2900 kcal/kg ME, as compared to non-significant differences among other diets. Maximum (P<0.05) spleen (0.13 g/100 g BW), heart (0.48 g/100 g BW), gizzard (2.12 g/100 g BW), proventriculus (0.33 g/100 g BW) and gastrointestinal (5.99 g/100 g BW) weights were noticed at post-moult stage as compared to the 50% production.

Key Words: Moult; Protein; Energy; Visceral organs; Live weight; Dressed weight

INTRODUCTION

Forced moulting as a practical management technique was first introduced by Rice in 1905. Now it has become a standard husbandry practice in many commercial egg operations, to extend the productive life of a flock (Wolford, 1984). Various procedures such as low calcium (Ca) or low sodium diet, high levels of zinc and iodine, pharmaceutical products and hormones have been used. However, feed withdrawal with and without water and light restriction have been commonly used to induce moult due to its efficacy.

Though induced moulting is apparently a replacement of all feathers, yet physiologically, it is coupled with complete cessation of laying and involution of reproductive tract involving all other visceral organs. During moulting, starvation of nine and 13 days are required to reduce 30% BW in cold and hot weather, respectively (Zubair & Leeson, 1994). One fourth of this weight reduction during moulting could be attributed directly to decrease in weight of various organs (Brake & Thaxton, 1979). They further noticed that much of this loss was presumably the loss of adipose tissue and labile protein reserves under the process of gluconeogenesis.

There is a dearth of information on the nutritional needs of the induced moulted hen during the latter stage of the induced moult period and the early stage of the PM period. It appears that decline in both egg production and quality could be improved considerably, which would enhance economic advantage of an induced moulting program (Wolford, 1984). The availability of a nutritionally adequate diet while the body tissues were being restructured would be expected to increase the efficiency of restructuring reproductive tract (Brake & Thaxton, 1979).

Different nutritional manipulations had been adopted during induced moult but a very little information is available that how the protein and energy levels can be manipulated during latter part of moult. So present study was carried out to explore the effects of varying protein and energy levels in post-fast-pre-lay interval on carcass characteristics and visceral organs in the commercial white leghorn layers.

MATERIALS AND METHODS

To study the effects of protein and energy manipulations on induced moult white leghorn layers during PM period, a trial was conducted at the Department of Animal Nutrition in unity with the Poultry Husbandry Department at the University of Agriculture, Faisalabad. For this purpose, 168, 70-week-old White Leghorn Single Comb layers of commercial Euribred strain were used. These hens were randomly divided into 21 experimental units of eight hens each and maintained in the cages. The schedule adopted to moult the birds is given in Table I.

Seven experimental rations varying in crude protein (CP) content i.e. 14, 16 and 18% and each combining with metabolizable energy (ME) 2700 and 2900 kcal/kg in addition to control which is purely corn were allotted at random to three replicates of eight hens each. These

Table I. Moulting schedule

Days	Medication/vaccination	Feed	Water	Light
		PRE-MOULT		
1	Farbenda @ 0.1 ml/kg BODY WEIGHT (Deworming)	ad-lib	24 hrs.	24 hrs.
2	ND (vaccine)	ad-lib	24 hrs.	24 hrs.
3-5	NFC-100 @ 1.5g/l(Antibiotic)	ad-lib	24 hrs.	24 hrs.
		MOULT		
	1-fasting			
1-10	Electrolyte	No	6 hrs.	6 hrs.
	2-Post-fast			
11-35		45 g/bird skip a day EP*	6 hrs.	6 hrs.
		POST-MOULT		
1-12 weeks		ad-lib(layer mash)	Step-up to 16 hr.	same as light

(Akram *et al*., 1998, Ahmed *et al*., 1995; Abdullah *et al*., 1996); Note *= Experimental rations

rations *viz.* A, B, C, D, E, F and G were formulated according to the Nutrient Requirement of poultry (Anonymous, 1994) by using the local ingredients. The ingredients and chemical composition of these rations are mentioned in Table II.

Slaughter data including carcass characteristics (live body weight (LBW) and dressed weight (DW)) and visceral organs (liver, heart, spleen, gizzard, proventriculus and gastrointestinal tract (GIT) weight and GIT length) were recorded at PM and at 50% production (50% P) stages. The data thus, collected were subjected to statistical analysis for interpretation of results by using analysis of variance technique in completely randomized design (Steel & Torrie, 1980).

RESULTS AND DISCUSSION

Carcass characteristics. Data regarding LBW and DW were collected at the end of each stage, prior to slaughter. The average LBW and DW of five birds at pre-moult and post-fast stages were given in Table III.

Maximum (1.45 kg) LBW was recorded in birds fed on diet having 16% CP, 2700 kcal/kg ME at PM stage. It was similar ($P<0.05$) to that of birds having 14% CP, 2700 kcal/kg ME and 18% CP, 2900 kcal/kg ME; and higher ($P<0.05$) than birds fed all other diets. Although no significant difference exist between three protein levels (14, 16 & 18%) but medium (16%) protein with low energy (2700 kcal/kg ME) have numerically higher LBW. It had been found that feeding high (18%) protein, high energy (2900 kcal/kg) diets led to more weight gain due to more body fat deposition (data not

Table II. Composition of experimental rations and layer mesh

INGREDIENTS	A	B	C	D	E	F	G	H*
	RATIONS (%)							
Corn	100	21	40	22	31	26	40	40
Rice Broken	-	44	24	38	28	29	14	17
Rice Polishing	-	5	5	5	5	5	5	6
Wheat Bran	-	3	3	3	3	3	3	2
Cottonseed meal	-	4	4	4	4	4	4	4
Rapeseed meal	-	4	4	4	4	4	4	5
Corn Gluten 30%	-	5	5	5	5	5	5	2
Corn Gluten 60%	-	-	-	-	-	-	-	5.3
Fish meal	-	-	-	-	-	-	-	6
Blood meal	-	-	-	-	-	-	-	1
Sunflower meal	-	7	5.5	5	1	4	1	3
Soybean meal	-	2	3	9	12	15.2	17.2	-
DI-Calcium Phosphate	-	1.2	1.2	1.2	1.2	1.1	1.1	0.7
Limestone	-	1.3	1.3	1.3	1.3	1.2	1.2	4.5
Molasses	-	2	2	2	2	2	2	2
Soybean oil	-	-	1.5	-	2	-	2	1
Vitamin mineral Premix	-	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Chemical composition				(%)				
Crude Protein	9	13.98	13.95	16	16	18.00	17.91	17
Metabolizable Energy (K cal/ Kg)	3400	2722	2901	2707	2898	2701	2904	2900
Crude fiber	2.49	4.43	4.55	4.69	4.48	5.08	4.99	3.79
Calcium	0.02	0.83	0.82	0.84	0.84	0.80	0.79	2.05
Phosphorus	0.08	0.29	0.30	0.31	0.32	0.31	0.31	0.33

Note = * Where H stands for layer mesh

shown), making the bird less productive in the PM production cycle (not published). Effects of varying protein levels during moulting on post fast body weight gain was studied by number of workers (Harms, 1983; Andrews *et al.*, 1987; Koelkebeck, 1991) and found to be greater for hens fed a 16 Vs 9% CP moult diet.

Table III. Pre-treatment average live and dressed body weight; liver, spleen, gizzard, proventriculus and GIT weight; and GIT length at different stages

	Stages	
Average*	**Pre-moult**	**Post-fast**
Live Body Weight (kg)	1.880	1.286
Dressed Weight (g)	919.00	802.0
Heart (g/100g BW)	0.43	0.38
Spleen (g/100g BW)	0.07	0.10
Gizzard (g/100g BW)	1.26	1.67
Liver (g/100g BW)	1.79	1.41
Proventriculus (g/100g BW)	0.31	0.28
GIT weight (g/100g BW)	4.21	4.89
GIT length (cm)	182.80	176.40

Average* = average of five birds

Present study revealed that medium protein with low energy diet have the similar potential to that of high protein and high energy for weight gain, in moulted white leghorn layers, without depositing extra fat in the body.

Lower LBW can be seen with corn diet (1.13 kg), with moderate type of body fat, showing that high energy diet goes in waste and need fortification of protein. On the same line, Brake *et al.* (1979) found that the pullet grower (PG) fed hens exhibited a small abdominal fat pad as determined visually, while the fortified ground corn fed hens had developed a noticeably larger abdominal fat pad than the PG fed hens.

However, no differences (P<0.05) were found in LBW at 50% P stage and in DW both at PM and 50% P stages, in bird fed rations, having different CP and ME contents. Between stages, higher LBW (1.37 kg) was noted at 50% P stage as compared to PM stage, however no difference (P>0.05) exist in DW (Table IV). In the present study, the overall trend in LBW shows that the body weight of hens declined sharply during fasting but latter on start to increasing up during PM period. Similar trend was also observed by Roland and Brake (1982). Brake and Thaxton (1979) and Baker *et al.* (1983) showing that long egg laying stop with the weight loss and regression of reproductive tract has beneficial effects on egg production in second production cycle.

Visceral organs. After slaughtering, the data regarding visceral organs including liver, heart, spleen, gizzard, proventricuclus and GIT weight and GIT length were recorded. There average weights and GIT length both at pre-moult and post-fast stages, of five birds, were given in Table III.

a. Heart, Spleen, Gizzard and Liver Weight. Maximum (0.63 g/100 g BW) weight of heart was found in birds fed a diet having 10% CP, 3400 kcal/kg ME at PM stage, which was similar (P<0.05) to that recorded for birds fed a diet having 14% CP, 2900 kcal/kg ME; and higher (P<0.05) than birds fed all other diets. At 50% P stage maximum (0.50 g/100 g BW) weight of heart was recorded in birds fed a diet having 10% CP, 3400 kcal/kg ME, which was similar (P<0.05) to that of the birds fed diets having 14% CP, (2700 & 2900 kcal/kg ME), 16% CP, 2900 kcal/kg ME and 18% CP, 2700 kcal/kg ME (Table V).

Maximum (0.15g/100g BW) weight of spleen was found in birds fed diet having 10% CP, 3400 kcal/kg ME, at PM stage, being similar (P<0.05) to that of birds fed a diet having 14% CP, 2900 kcal/kg ME, 16% CP, 2700 kcal/kg ME and 18% CP, (2700 & 2900 kcal/kg ME) and was higher than all other treatments (Table V). It has been noticed that spleen weight increased during fasting as well as during restricted feeding period (Table III) and reach maximum at PM stage. At PM spleen weight was found to be higher (P<0.05) than 50% P stage. Brake *et al.* (1981) explained an increase relative spleen weight during the forced moult was coincident with an increase in hematocrit and hemoglobin. Brake and Thaxton (1979) also reported a similar trend. It is interesting to note that spleen weight reaches the same level at 50% P, as on pre-moult stage.

Table IV. Effects of diets varying in protein and energy levels on live and dressed body weight at different stages in induced moult commercial layers

			Treatments							
Slaughter Parameters	**Stages**	**CPME**	**103400**	**142700**	**142900**	**162700**	**162900**	**182700**	**182900**	**Stages**
Live body Weight[1]	PM		1.13^{bc}	1.23^{abc}	0.99^{c}	1.45^{a}	1.17^{bc}	1.10^{bc}	1.36^{ab}	1.20^{b}
	50% P		1.29	1.25	1.31	1.72	1.18	1.27	1.60	1.37^{a}
Dressed Weight[2]	PM		676.70	66/8.33	696.17	826.33	661.33	655.90	809.53	713.47
	50% P		723.40	756.87	780.30	973.97	720.77	678.63	913.50	792.49

Note =Means with the different superscripts in the same row differ significantly at P<0.05, while in stages the mean with the same superscript in the same column differs non-significantly; PM= Post-moult; 50% P= 50% production stage; CP= Crude protein; ME= Metabolizable energy.1= Mean expressed as kg 2= Mean expressed in g

Maximum (2.24 g/100 g BW) weight of gizzard was recorded at 50% P stage in birds fed a diet having 16% CP, 2900 kcal/kg ME, which was higher (P<0.05) than that recorded for the birds on diet having 16% CP, 2700 kcal/kg ME, and similar (P<0.05) to those recorded for all other treatments. It is possible that at 50% P stage digestive system of hens becomes more active, after a rejuvenation period, and hence shows higher weight, especially with high energy diet.

There was no difference (P>0.05) in weight of liver (both at PM and 50% P stages), spleen (at 50% P stage) and gizzard (at PM stage) of birds fed diets varying in CP and ME contents (Table V). The results of the present study were also confirmed by number of workers (Hollands *et al.,* 1965; Katanbaf *et al.,* 1989; Haq, 1995), reporting no significant effects on liver weight of birds reared on different feeding regimes. The weight of liver decreased numerically after PM upto 50% P stage, but this difference is not significant. It might be due to some environmental influence or random sample error. If we compare the weight of liver at pre-moult and post-fast (Table III), it is evident that the weight of liver reduces during fasting, but to a lesser extent and needs more severe fasting to achieve more liver weight reduction. In contrast to our results, Roland and Brake (1982) reported that weight of the liver was significantly decreased by forced moulting. On the other hand, between post-fast and PM the liver weight increases substantially in this trial. It may be due to the reason that the moult diets were offered and better nutrition increased the liver weight.

Between stages, higher (P<0.05) heart (0.48 g/100 g BW), spleen (0.13 g/100 g BW) and gizzard (2.12 g/100 g BW) weights were recorded at PM stage as compared to 50% P stage. However no difference (P>0.05) exist between stages in the weight of liver (Table V). Relative weight of visceral organs like heart, liver, gizzard, spleen and proventriculas shows the similar trend. All shows the higher values at PM and then declining trend in 50% P stage, except liver.

Table V. Effects of diets varying in protein and energy levels on heart, spleen, gizzard and liver weights at differen stages in induced moult commercial layers

			Treatments							
Slaughter Parameters	**Stages**	**CPME**	**103400**	**142700**	**142900**	**162700**	**162900**	**182700**	**182900**	**Stages**
Heart	PM		0.63^{a}	0.43^{b}	0.54^{ab}	0.49^{b}	0.41^{b}	0.43^{b}	0.46^{b}	0.48^{a}
	50% P		0.50^{a}	0.41^{ab}	0.45^{a}	0.35^{b}	0.43^{ab}	0.48^{a}	0.35^{b}	0.43^{b}
Spleen	PM		0.15^{a}	0.11^{bc}	0.13^{abc}	0.13^{ab}	0.09^{c}	0.12^{abc}	0.15^{a}	0.13^{a}
	50% P		0.07	0.07	0.08	0.05	0.08	0.06	0.10	0.07^{b}
Gizzard	PM		2.23	2.11	2.22	2.21	2.00	2.22	1.84	2.12^{a}
	50% P		1.61^{bc}	1.93^{ab}	1.79^{b}	1.29^{c}	2.24^{a}	1.64^{bc}	1.96^{ab}	1.78^{b}
Liver	PM		2.45	2.38	2.30	2.45	2.46	2.79	2.04	2.41
	50% P		2.39	2.60	2.95	2.23	2.32	2.04	1.78	2.33

Note =Means with the different superscripts in the same row differ significantly at P<0.05, while in stages the mean with the same superscript in the same column differs non-significantly.PM= Post-moult; 50% P= 50% production stage; CP= Crude protein; ME= Metabolizable energy.All the means expressed as g/100g BW

b. Proventriculus and GIT Weight and GIT length. Maximum (0.45 g/100 g BW) proventriculus weight was recorded in birds fed a diet having 16% CP, 2900 kcal/kg ME at 50% P stage, which was similar (P<0.05) to that recorded for the birds fed diets having 10% CP, 3400 kcal/kg ME and 14% CP, 2700 kcal/kg ME; and higher (P<0.05) than all other treatments (Table VI). Higher proventriculus weight with corn and medium protein and high energy diets, shows activation of metabolism for higher production performance, at 50% P stage.

Maximum (222.3cm) length of GIT was noted for the birds fed a diet having 18% CP, 2900 kcal/kg ME at 50% P stage, which was similar (P<0.05) to that of birds

Table VI. Effects of diets varying in protein and energy levels on proventriculus and GIT weight and GIT length a different stages in induced moult commercial layers

			Treatment							
Slaughter Parameters	**Stages**	**CPME**	**103400**	**142700**	**142900**	**162700**	**162900**	**182700**	**182900**	**Stages**
Proventriculus	PM		0.40	0.45	0.43	0.44	0.38	0.38	0.32	0.40^{a}
	50% P		0.38^{ab}	0.37^{ab}	0.33^{b}	0.24^{c}	0.45^{a}	0.33^{b}	0.23^{c}	0.33^{b}
GIT weight	PM		6.70	5.60	6.40	6.23	5.58	6.23	5.19	5.99^{a}
	50% P		4.83	4.96	5.96	4.15	5.63	4.96	4.58	5.01^{b}
GIT length[1]	PM		153.0	154.0	156.0	179.7	151.0	145.7	144.7	154.9^{b}
	50% P		180.7^{b}	182.0^{b}	195.0^{ab}	165.7^{b}	174.3^{b}	179.7^{b}	222.3^{a}	185.7^{a}

Note =Means with the different superscripts in the same row differ significantly at P<0.05, while in stages the mean with the same superscript in the same column differs non-significantly; PM= Post-moult; 50% P= 50% production stage; CP= Crude protein; ME= Metabolizable energy.[1]=expressed as cm; All other mean expressed as g/100g BW fed a diet having 14% CP, 2900 kcal/kg ME and higher (P<0.05) than all other treatments (Table VI). Length of GIT showed no differences (P<0.05) among moult diets during restricted feeding period (Table III) but significantly higher GIT length during 50% P phase, in the hens having a diet with high protein and energy (Table VI), which reflects that digestive system become more active in response to higher nutrient density. Length of GIT increased (P<0.05) after PM upto 50% P, showing that birds gear up its metabolism for egg production. The length of GIT in layers had been increased with feed restriction as shown by number of workers (Hollands *et al.*, 1965; Nitsan *et al.*, 1984; Katanbaf *et al.*, 1989), Which might be the result of body adjustment in response to feed restriction.

No difference (P>0.05) was recorded in the weight of proventriculus (at PM stage) and GIT (both at PM and 50% P stage) and length of GIT (at PM stage) in birds fed a diets having different levels of CP and ME (Table VI). Between stages higher (P<0.05) proventriculus (0.40 g/100 g BW) and GIT (5.99 g/100 g BW) weight was noted at PM stage. But GIT length (185.7cm) was higher (P<0.05) at 50% P stage (Table VI).

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