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Researches on the Responses of Different Hybrid Layers with Respect to Egg Production Performances to Forced Molting Programs with and Without Feed Withdrawal

Ali Aygün and Ramazan Yetisir
Department of Animal Science, Faculty of Agriculture, Selcuk University, Konya, 42031, Turkey

Abstract: This research was carried out to determine the effects of four forced molting programs including three non-feed withdrawal programs (BB: Barley Based, WB: Wheat Bran based and OB: Oat Based) which supplied with alfalfa meal and one feed withdrawal method (FW: control 8 days FW + 34 days resting diet) on egg production performances of 320 brown (H and N Brown Nick) and 320 white (Hy-Line W-36) hybrid layers at 57 week of age. The experiment lasted totally 46 weeks including for 6 weeks molting period followed by a 40 weeks post molt production period. According to the results obtained, the genotype had significant ($p<0.05$) effect on body weight loss, feed consumption, hen day egg production (number%), cracked egg (%) and Heterophil:Lymphocyte (H:L) ratio ($p<0.01$) in molting period. Molting methods had significant ($p<0.01$) effects on body weight loss, feed consumption, hen-day egg production (number%) in molting period. In the production period; BB group had lower ($p<0.05$) hen-day egg production (%) than those of OB and FW groups. Feed efficiency values of WB group were better ($p<0.05$) than the values of OB and FW groups. As conclusion, after examining these production criteria, it can be stated that; non feed withdrawal methods, especially OB program can be used alternative to FW program. But, other non-feed withdrawal programs also can be used successfully as molting procedure.

Key words: Forced molting, non-feed withdrawal, egg production, heterophil:lymphocyte ratio, alfalfa meal, hybrid layer

INTRODUCTION

Induced molting of laying hens is a widely utilized management technique in the commercial egg industry to extend the productive life of a flock. The main purpose of molting is to cease egg production in order to enter hens to a non reproductive state, which increase egg production and egg quality postmolt (Webster, 2003). There are several molting methods. Feed to Withdrawal (FW) has been the most popular due easy of application, economic benefits and agreeable postmolt performance (Bell, 2003). However, recent concerns have been raised about animal welfare during the FW period because it is thought to be harmful to hens (Webster, 2003) and hens undergoing fasting appear to be more susceptible to *Salmonella enterica* serovar Enteritidis (*S. enteritidis*) colonization of the gastrointestinal tract and infections (Holt, 2003; Ricke, 2003) and weakening of the immune response (Holt, 1992). It has been reported that leukocyte numbers decreased and differential leukocyte populations changed during different molting regimes (Alodan and Mashaly, 1999). Davis *et al.* (2000) reported that hens in caged layer system undergoing molting by feed restriction showed a significant increase in heterophil to lymphocyte ratio. Decrease in efficiency of heterophil functionality has also observed in hens deprived of feed (Kogut *et al.*, 1999). Efforts have been made to reduce or even eliminate the use of such programs that require complete removal of feed from hens. For this reason, alternative methods that do not require complete removal of feed are being considered (Donalson *et al.*, 2005). Historically researchers have examined alternative diets to FW that provide similar benefits while not altering the health of the animals. In the past, studies have been conducted using diets mixed with high zinc concentrations (Sarica *et al.*, 1996; Bell, 2003; Bar *et al.*, 2003) and low sodium concentrations (Berry and Brake, 1985) to induce molt. However, such diets have yielded inconsistent results are costly and can cause such as cannibalistic pecking (Webster, 2003; Biggs *et al.*, 2004), osteoporosis and temporary paralysis (Webster, 2003).

Recently, the use of insoluble plant fibbers have been investigated and successful alternative molt induction diets have been developed from grape pomace, wheat

Corresponding Author: Ali Aygün, Department of Animal Science, Faculty of Agriculture, Selcuk University, Konya, 42031, Turkey

middling, cottonseed meals, jojoba meal and alfalfa meal (Vermaut *et al*., 1997; Seo *et al*., 2001; Davis *et al*., 2002; Keshavarz and Quimby, 2002; Biggs *et al*., 2003, 2004; Landers *et al*., 2005; Donalson *et al*., 2005).

The objective of the current study was to examine the use of diets high in barley, oat and wheat bran or corn, readily available and inexpensive feed ingredients in Turkey, as alternatives to fasting for induced molting of laying hens.

MATERIALS AND METHODS

An experiment was conducted using 320 Hy-Line W-36 and 320 H and N Brown Nick hens (57 weeks of age).

Hens were housed 4 per cage for the molting procedure. The hens were divided into 8 treatment groups: FW (control); BB (70% barley and 27% alfalfa); WB (32% wheat bran, 44% corn and 21% alfalfa) and OB (70% oat and 27% alfalfa) for Hy-Line W-36 and H&N Brown Nick, each treatment having four replicate of 20 hens. The three diets were formulated to containing no salt, 1% Ca, 0.5% non-phytate P and 10% and more crude fiber using NRC (1994) table values. Vitamin and amino acid (as percent of crude protein) contents of the experimental diets were supplied adequately considering the management guides of used hybrid genotypes. All treatments were allowed *ad-libitum* access to water and their respective diets. On day 1, the photoperiod was reduced to 10 h. On day 43, the daily photoperiod was increased 30 min weeks^{-1} for 12 weeks until a 16 h photoperiod was established. The experiment consists of a 6 weeks molt period followed by a 40 weekss post molt production period. Blood samples were taken from the wing vein from 2 hens per replicate group from the FW, BB, WB and OB treatments for a total of 8 hens per treatment on day 0 and 42. In addition, blood samples were also taken from the hens in FW treatment on day 8. Each hen sampled on day 0 was leg-banded after blood was drawn and the same hen from each replicate group was sampled on day 42. One drop of blood smeared on each of 2 glass slides. The smears were stained with May-Grunwald-Giemsa stain (Konuk, 1975). On the total leukocyte count were includes heterophils, lymphocytes, monocytes, basophils and eosinophils. About 100 cells were counted for each ratio. The heterophil:lymphocyte ratio was calculated by dividing the number of heterophils by that of lymphocytes (Gross and Siegel, 1983). The means of the 2 slides were calculated for each bird.

FW treatment, which was carried out with 8-d feed withdrawal, was followed by feeding a resting diet (13% CP and 2500 Kcal kg^{-1} ME) for 32 days and three other treatments were provided adlibitum for 42 days with their own diets. On day 43, all hens were placed on a 15.5% CP layer diet (Table 1). Egg production performance was measured for 46 weeks following the initiation of feed

Table 1: Composition of experimental molting diets, resting diet used after feed withdrawal and the layer diet used in post molt production period

Ingredients and analysis	Barley based (%)	Oat based (%)	Wheat bran-corn based (%)	Resting diet (%)	Layer diet (%)
Corn, yellow (8.8%)	-	-	43.67	55.89	65.42
Alfalfa (13%)	26.97	27.47	21.16	-	-
Oat (11.4%)	-	70.00	-	-	-
Barley (11.6%)	70.00	-	-	-	-
Soybean meal (43%)	-	-	-	4.98	18.56
Sunflower seed meal (36%)	-	-	-	-	4.75
Wheat bran (15.7%)	-	-	32.15	35.47	-
Limestone	0.342	0.030	0.688	1.479	7.997
Dicalcium phosphate	2.198	2.152	1.829	1.742	1.924
Salt	-	-	-	-	0.176
Vit-Min. Premix[1]	0.250	0.250	0.250	0.250	0.250
DL-Methionine (98%)	0.114	0.074	0.099	0.083	0.091
L-Lysine	0.126	0.024	0.154	0.106	-
Vegetable oil	-	-	-	-	0.832
Total	100	100	100	100	100
Calculated analysis[2]					
Crude protein (%)	11.8	12.2	11.84	13	15,5
Metabolizable energy (kcal/kg)	2207	2133	2200	2500	2800
Crude fiber (%)	10.6	10.5	10	5.29	1.44
Calcium (%)	1	1	1	1	3.60
Available phosphorus (%)	0.5	0.5	0.5	0.5	0.45
Sodium (%)	0.062	0.071	0.052	0.160	0.188
Lysine (%)	0.531	0.550	0.533	0.585	0.733
Methionine + cystine (%)	0.449	0.464	0.449	0.490	0.603
Threonine (%)	0.438	0.412	0.415	0.461	-
Tryptophan (%)	0.156	0.191	0.179	0.189	0.194

[1]Provided per kilogram of diet; vitamin A, 12000 I.U; vitamin D_3, 2400 I.U; vitamin E, 25.0 mg; vitamin K_3, 4.0 mg; vitamin B_1 (thiamine), 3.0 mg; vitamin B_2 (riboflavin), 5.0 mg; vitamin B_6 8.0 mg; vitamin B_{12} 0.015 mg; niacin, 25.0 mg; calcium-D-pantothenate, 8.0 mg; D-Biotin, 0.05 mg; folic acid, 0.5 mg; choline choride, 125.0 mg; manganese, 80.0 mg; iron, 60.0 mg; zinc, 60.0 mg; copper, 5.0 mg; iodine, 1.0 mg; cobalt, 0.2 mg; Selenium, 0.15 mg.
[2]Based on NRC (1994) feed composition tables

withdrawal or feeding the molt diets. Egg production and mortality were recorded daily throughout the 46 weeks experimental period. Egg weight was measured on all eggs produced on two consecutive days. Egg mass (g egg/hen per day) were calculated using hen-day egg production and average egg weight. During molt, hen weights were monitored at day 1 and 42. Body weights of hens deprived of feed for 8 days were measured on day 8. Feed consumption was measured in every 4 week for production period (1-40 weeks). Feed efficiency (g of feed/g of egg) was calculated using feed consumption and average egg weight.

All percent data were tested for normality (Shapiro-Wilk's test) and abnormal data were transformed to arc sin to normalize them prior to statistical analysis (Yurtsever, 1984). Collected data were analyzed as to the factorial (2×4) randomized plot design (Düzgünes *et al*., 1987). Differences between treatment groups were determined using Duncan's multiple range tests (Düzgünes *et al*., 1983). The statistical analyses were conducted using the Balanced ANOVA procedure of MINITAB (2000). The significant differences between means were obtained by MSTAT-C Range Program (1989) using Duncan's Multiple Range Test.

RESULTS AND DISCUSSION

There were no significant differences for mortality between treatments during the molting period. Mortality of the HL and BN hens fed the BB diet was 1.25%. Mortality rate of HL hens (1.25%) on BB program were found similar with the results of Biggs *et al*. (2003) and it is found comparable with the mean values reported by Biggs *et al*. (2004) that is between 0-2.4% for non-FW programs. Mortality rate of BN hens on BB program (1.25%) was lower than value (2.60%) determined by Petek (2001) for non-FW programs. Mortality rate of other without and with FW programs were found almost 0%. HL and BN hens lost 13.36 and 11.50%, respectively, of their initial body weight ($p<0.05$) at the end of the molting period. HL and BN hens deprived of feed for 8 days lost 23.5 and 22.8%, respectively, of their original body weight at the end of their feed removal period. By the end of the 42 days molt period, HL hens and BN hens then fed the resting diet had regained a substantial amount of weight and had final body weight losses of 6.01 and 5.25%, respectively. Body weight losses of the HL hens on BB (15.22%) and on OB (17.34%) programs and body weight loss of BN hens on WB program (17.15%) are in agreement with the report of Ruszler (1998) who states that for successful molting the body weight loss should be between 15-40% during molting period. Body weight loss values of HL hens on OB program (17.34%) and BB program (15.22%) are similar to the values reported by Biggs *et al*. (2003) and Landers *et al*. (2005). Low body weight loss values (5.63%) obtained from FW groups was due to the resting diet (2500 ME, 13% CP) given to the birds after the feed withdrawal period of 8 days. As a result, it can be stated that more starved animals consume more feed to compensate the body weight loss. The animals in this group (FW) consumed more feed than the other groups duringthe rest of the molting period even that were not fed for 8 days. For desired level of weight loss, it can be suggested that resting diets having less condensed nutrient densities is suitable, if only the production performance after this diet is not adversely affected. At HL hens that were deprived of feed for 8 days and hens fed the OB diet ceased egg production by day 6. None of the hens in the other HL groups totally ceased egg production during the molting period. Hen-day egg production of HL hens in OB program decreased to 0% on the 6th day which is in agreement with the values of Biggs *et al*. (2003) and Donalson *et al*. (2005). At BN hens that were deprived for 8 days ceased egg production by day 7. None of the hens on the other BN hens groups totally ceased egg production during the molting period. HL hens showed lower ($p<0.01$) egg production (10.99%) than BN hens (24.39%) during the molting period. In the other programs without feed withdrawal, there were decreases in egg production but never reached to 0%. This result is also in agreement with the results of Biggs *et al*. (2003, 2004). Hen-day egg production during the molting period are shown in Table 2. HL hens that fed the OB diet (6.46%) exhibited more ($p<0.01$) decreases in egg production than hens fed the WB diet (12.77%) and FW treatment (14.41%) but were not different from BB treatment. BN hens that fed the OB diet (12.83%) exhibited more ($p<0.01$) decreased in egg production than hens fed the WB diet (22.89%), fed the BB diet (29.81) and FW treatment (32.03%). HL hens that fed the OB diet (53.44 g) and BB diet (55.16 g) exhibited lower ($p<0.01$) feed consumption than WB diet (65.94 g) and FW treatment (78.65 g). BN hens that fed the OB diet (73.71 g), BB diet (75.79 g) and WB diet (79.73 g) exhibited lower ($p<0.01$) feed consumption than FW treatment (Table 2).

On day 0 and 42 of the molting period heterophil:lymphocyte ratio of HL hens were lower ($p<0.01$) than of BN hens (Table 2). On the other hand, there were no significant differences in the heterophil:lymphocyte ratio between forced molting programs at day 0 and 42 of the molting period. The FW method has reached almost four times of heterophil:lymphocyte ratio (0.34; 1.26) at day 8 of the

Table 2: Effect of different genotype and forced molting programs on body weight loss, egg production, feed consumption and heterophil:lymphocyte ratio during the 6 weeks of molting period ($\bar{X} \pm S_{\bar{x}}$)

Genotype	Body weight loss (%)	Egg production (Hen-day %)	Feed consumption (g/hen/day)	H: L ratio	
				Day 0	Day 42
HL	13.36±0.694	10.99±0.983	63.30±2.747	0.27±0.009	0.55±0.017
BN	11.50±0.675	24.39±1.974	83.62±3.280	0.42±0.013	0.68±0.017
Mean	12.43±0.488	17.69±1.620	73.46±2.786	0.34±0.011	0.62±0.013
Significance	*	**	**	**	**
FM Programs					
FW	5.63±0.878^c	23.22±3.545^a	91.96±5.276^a	0.34±0.025	0.62±0.026
BB	14.01±0.685^b	20.06±3.700^b	65.48±3.937^c	0.33±0.022	0.67±0.028
WB	16.02±0.656^a	17.83±1.994^b	72.83±2.651^b	0.34±0.029	0.60±0.027
OB	14.07±0.755^b	9.64±1.361^c	63.57±3.884^c	0.34±0.019	0.60±0.023
Significance	**	**	**	NS	NS
Genotype x FM Programs					
HL					
FW	6.01+1.425^d	14.41±2.248^c	78.65±3.420^b	0.27±0.027	0.54±0.021
BB	15.22±0.824^a	10.32±0.720^{cd}	55.16±1.072^d	0.27±0.022	0.62±0.035
WB	14.89±0.973^{ab}	12.77±0.774^c	65.94±0.956^c	0.27±0.015	0.53±0.039
OB	17.34±0.608^a	6.46±1.113^d	53.44±1.338^d	0.27±0.012	0.55±0.049
BN					
FW	5.25±1.056^d	32.03±1.352^a	105.28±0.182^a	0.42±0.024	0.70±0.041
BB	12.79±1.045^{bc}	29.81±0.256^a	75.79±0.499^b	0.42±0.016	0.72±0.039
WB	17.15±0.828^a	22.89±0.940^b	79.73±0.438^b	0.42±0.032	0.67±0.028
OB	10.80±0.918^c	12.83±0.804^c	73.71±0.349^b	0.42±0.025	0.63±0.013
Significance	**	**	**	NS	NS

*: Significant ($p<0.05$); **: Significant ($p<0.01$); NS: No Significant; HL: White egg Layer (Hy-Line W-36); BN: Brown egg layer (H and N Brown Nick); FM: Forced MOLTING; FW: Feed Withdrawal; BB: Barley Based; WB: Wheat Bran-corn based; OB: Oat Based

molting period as to beginning molting periods. H:L ratio obtained at the end of the 42th day from HL groups on the WB and OB programs (0.53, 0.55) were found similar with the value (0.54) found at the study of Biggs *et al.* (2004) which obtained at 28th day. However, even if the differences were not significant, H:L ratio of OB and WB groups were found better than the others.

At the end of the molting period, the H:L ratio were found approximately two times to the pre molt period values. But, at 8th day of FW, H:L ratio were found 4 times as to the pre molt period values. According to these results, it can be stated that H:L ratio is elevated with FW treatment, but it is not already determined that What is the tolerable H:L ratio of the hens?, also considering genotypes.

While hen-day (%) egg production effected ($p<0.05$) by molting programs, hen-housed egg production (%) not effected by any treatments involved in this research. BB treated hens (71.29%) exhibited lower ($p<0.05$) post molt hen-day egg production than FW (74.60%) and OB treatment (74.90%), but were not different from WB treatment (Table 3).

There were no significant difference between in FW (74.60%), WB (72.42%) and OB (74.90%) treatments. Hen-day egg production (73.05%) of HL hens fed the OB diet were found higher than Donalson *et al.* (2005) and Biggs *et al.* (2004) and lower than value (74%) reported by Biggs *et al.* (2003) obtained by a molting program of without FW based on wheat middling. Hen-day egg production value (71.33%) of BN hens fed the BB diet were found higher than values reported by Yilmaz and Sahan (2003) and Petek (2001).

Post molt egg weight, egg mass, feed consumption and cracked egg (1-40 weeks) are depicted in Table 3. All the treatments did not show significant differences for these four parameters. Daily egg mass (g) produced per hen was not affected by any treatment (Table 3). BN hens produced daily 2.8 g more ($p<0.01$) egg mass than HL hens. Egg mass obtained from white egg laying HL hens on WB and BB molting programs (47.94 and 47.52 g/hen/day) similar to values reported by Biggs *et al.* (2003), but higher than values obtained with forced molting program conducted by Biggs *et al.* (2004). There was no significant difference with respect to egg mass between the molting programs. It seems that non-FW programs can be an alternative to the FW programs at least for this reason.

Cracked egg ratio (1.72%) of BN hens on BB programs was found fairly lower than value (10.89%) reported by Petek (2001). This is economically important, because of the cracked egg ratio decreases, the saleable egg ratio would increase. Even if there is no significant difference between molting programs, non-FW programs showed less cracked egg ratio than the FW program.

No significant differences were found among treatments for viability (mortality). There were no mortality in HL hens fed the WB diet and in BN hens fed the BB diet. The mortality level (4.17%) in HL hens on BB

Table 3: Effect of different genotype and forced molting programs on the production performances during the 40 weeks of post molt ($\bar{X} \pm S_{\bar{X}}$)

Genotype	Hen-day (%)	Hen-housed (%)	Egg mass (g egg/hen per d)	Cracked egg (%)	Egg weight (g/egg)	Feed consumption (g/hen per d)	Feed efficiency (g feed/g egg)	Viability (%)
HL	72.76±0.772	71.69±0.836	48.25±0.519	1.37±0.082	66.32±0.190	118.62±1.265	1.79±0.020	96.53±0.998
BN	73.85±0.757	72.25±0.995	51.06±0.437	1.97±0.188	69.18±0.343	121.75±0.815	1.76±0.014	95.49±1.620
Mean	73.30±0.541	71.97±0.641	49.66±0.418	1.67±0.115	67.75±0.321	120.18±0.792	1.77±0.012	96.01±0.940
Significance	NS	NS	**	**	**	*	NS	NS
FM programs								
FW	74.60±0.930^{a}	73.48±1.247	50.39±0.784	2.07±0.333	67.54±0.609	121.53±1.064	1.80±0.018^{ab}	96.53±1.460
BB	71.29±0.926^{b}	70.74±0.938	48.43±0.654	1.52±0.196	67.95±0.623	118.56±1.432	1.75±0.022^{bc}	97.92±1.460
WB	72.42±1.184^{ab}	71.58±1.435	49.42±0.996	1.62±0.204	68.25±0.881	118.24±1.803	1.73±0.014^{c}	96.53±1.800
OB	74.90±0.870^{a}	72.10±1.492	50.39±0.832	1.47±0.100	67.25±0.453	122.40±1.676	1.82±0.028^{a}	93.05±2.518
Significance	*	NS	NS	NS	NS	NS	*	NS
Genotype x FM programs								
HL								
FW	74.42±1.795	72.46±2.285	49.17±1.153	1.32±0.187	66.07±0.152	120.52±1.275	1.83±0.019	94.44±2.720^{ab}
BB	71.25±1.070	70.16±1.010	47.52±0.872	1.31±0.181	66.70±0.608	117.34±2.680	1.76±0.033	95.83±2.660^{ab}
WB	72.31±2.229	72.31±2.229	47.94±1.543	1.39±0.221	66.29±0.446	114.67±0.780	1.73±0.022	100.00±0.000^{a}
OB	73.05±0.891	71.86±1.283	48.38±0.649	1.45±0.121	66.22±0.236	121.93±3.470	1.84±0.056	95.83±1.390^{ab}
BN								
FW	74.79±0.889	74.50±1.158	51.61±0.741	2.82±0.327	69.00±0.525	122.54±1.725	1.78±0.028	98.61±1.390^{a}
BB	71.33±1.689	71.33±1.689	49.34±0.828	1.72±0.343	69.21±0.625	119.78±1.185	1.73±0.034	100.00±0.000^{a}
WB	72.53±1.249	70.84±2.069	50.91±0.882	1.85±0.332	70.21±0.929	121.81±2.460	1.73±0.020	93.06±2.660^{ab}
OB	76.75±0.667	72.34±2.949	52.40±0.339	1.50±0.176	68.28±0.441	122.88±0.955	1.80±0.014	90.28±4.745^{b}
Significance	NS	NS	NS	NS	NS	NS	NS	*

*: Significant ($p<0.05$); **: Significant ($p<0.01$); NS: No Significant; HL: White egg Layer (Hy-Line W-36); BN: Brown egg layer (H and N Brown Nick); FM: Forced Molting; FW: Feed Withdrawal; BB: Barley Based; WB: Wheat Bran-corn based; OB: Oat Based

program was found similar with the value (4.8%) reported by Biggs *et al*. (2003). On the other side, mean mortality level of BN hens on BB program was determined as 0% and found better than value (5.2%) reported by Yilmaz and Sahan (2003).

Egg weight was not affected by any treatment. Mean egg weight (66.22 g) value obtained from HL hens on OB program was higher than values (64.07 and 65.6 g) obtained by Landers (2004) and Landers *et al*. (2005), but lower than value (70.78 g) obtained by Donalson *et al*. (2005).

On the other side, mean egg weight (66.70 g) of the same layer group on BB program was found higher than value (65 g) obtained by Biggs *et al*. (2003), but similar to value (67 g) reported by Biggs *et al*. (2004). Also, mean egg weight (69.21) of BN hens fed the BB diet was found higher than values reported by Petek (2001) and Yilmaz and Sahan (2003). With respect to egg weight, non-FW programs had been alternative to the FW programs in this study.

Feed consumption not effected by any treatment groups. Mean daily feed consumption (114.67 g) of HL hens on WB program was found higher than value (109 g) reported by Biggs *et al.* (2003), but similar to the value (114 g) reported by Biggs *et al*. (2004). On the other side, mean daily feed consumption (119.78 g) of BN hens on BB program was found higher than value (105.09 g) reported by Petek (2001).

Feed efficiency was effected ($p<0.05$) by molting programs, but neither genotype nor interaction effects. WB treatment hens (1.73) exhibited better ($p<0.05$) Feed Efficiency (FE) than OB (1.82) and FW treatment (1.80) but were not different from BB treatment (1.75). FE value (1.7 g feed/g egg) of HL hens on WB and BB programs was found better than values reported by Biggs *et al.* (2003, 2004). While OB and FW groups having similar FE, better FE had been determined in WB group. This may be due to low feed consumption and heavy egg production in post molt production of WB group.

CONCLUSION

Responses of brown and white egg laying hens to forced molting programs examined with respect to production performances in current research. The below concluding remarks could be drawn from the results obtained.

Conventional FW programs were blamed for stress and *S. enteritidis* development condition. According to the result obtained in this research, non-FW programs can be applicable without any beneficial lost. These programs could be implemented with diets including low level of ME (2200 Kcal kg^{-1}) and CP (12-13%), no salt, 1% Ca, 0.5% non-phytate P, >10% CF and adequate level of vitamins and amino acids.

This type of diets can be formulated using local feed ingredients abundant in Turkey. But, cease of egg laying in these programs is not possible at all the time. If the stress is not the main problem for using this type of programs, water withdrawal for 1-2 days at the beginning, or when needed during the molting period, could solve this problem.

As to the production performance results, even if OB (70% oat and 27% alfalfa) program was found as the favorite one, other two non-FW programs which are BB (70% barley and 27% alfalfa) and WB (32% wheat bran, 44% corn and 21% alfalfa) can also applicable as molting procedures. FW program used in this research can be further refined increasing the period to 10 days or the resting diet having less dense with respect to ME and CP content.

Further researches can be focused on to determine the level of stress, which detrimental to laying hens, using standard methods. Because, even if FW program increased H:L ratio 4 times at 8th day of withdrawal period, non-FW programs also increased in the molting period two times as to the normal period.

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