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Induced Molting in Culled White Leghorn (*Gallus gallus*) Using Fasting and Low Protein Diet

Eddie C. Bautista Jr.

Cagayan State University, Piat Campus, Philippines

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Abstract

When birds return to the full feed, new plumage develops and the birds resume egg production at a higher rate with better egg quality. Induced molting extends the productive life of commercial chicken flocks and results in a substantial reduction in the number of chickens needed to produce the nation's egg supply. The study was conducted to evaluate induced molting in culled white leghorn (*Gallus gallus*) using a fasting and low-protein diet. The completely randomized design (CRD) with ten replication was used to test the following treatments: T_1 (fasting); T_2 (medium-cracked maize); T_3 (rice bran); T_4 (cracked rice); and T_5 (control). Results revealed that T_1 has the highest test value of crude fat with 48.30 percent. In terms of crude protein, T_3 obtained 42.82 percent, while crude fiber T_2 had 0.90 percent. On the other hand, T_3 and T_4 produced the highest protein-content eggs, while T_1 produced a total fat level of 48.30%. Each treatment's egg yield varies in terms of crude protein and crude fats, according to laboratory examination. The lab research also shows that eggs from T_3 and T_4 are far healthier than eggs from other treatments. Induced hens should be kept for 290 days to achieve maximum laying percentage; keeping them longer will boost feed intake but reduce laying percentage. Keeping hens for a long time increases their risk of developing reproductive anomalies such as uterine prolapse and vent hemorrhages.

* **Corresponding Author:** Eddie C. Bautista Jr.✉ eddiebautistajr07555@gmail.com

Introduction

Molting is the process of shedding and renewing feathers. During the molt, the reproductive physiology of the bird is allowed a complete rest from laying and the birds build up its body reserves of nutrients.

Normal molting in adult birds occurs once a year in their natural environment, while it may occur twice in a single year in a particular individual and only once every two years in a rare individual under certain conditions. The pullet chick goes through one complete molt and three partial molts during its development to the stage of lay, after which the mature bird goes through one complete molt per year, usually in the autumn, although this is dependent on the time of year at when the bird began laying. Generally, entire molting takes place between 1-6 weeks, with partial molting occurring at 7-9 weeks, 12-16 weeks, and 20-22 weeks, the latter of which is when the stiff tail feathers are developed. The normal molting of laying hens, on the other hand, usually occurs around March and April and should be completed by July, when egg production can begin again.

When a bird molts, it is a natural process that occurs in all birds, and it occurs after a lengthy production period of around four months in domestic birds. Although it is not possible to expedite molt induction, it is possible to do so through a process called a "productive rest program," which should last no more than 6-8 weeks (Garcia *et al.,* 2001), which would result in a faster resumption of egg production.

When a flock of birds is artificially provoked to molt simultaneously (also known as forced molting), some poultry industries use a technique known as forced molting or induced molting. This is accomplished by withholding food for 7–14 days and sometimes also withholding water for an extended period. Molting is often performed when egg production begins to decline naturally at the end of the first egg-laying phase. For the birds to regress and regenerate their reproductive systems, they must stop generating eggs for at least two weeks during the forced molt. Following the molt, the hen's egg production rate often peaks at a somewhat lower rate than the preceding peak, but the quality of the eggs is generally better. Consequently, by depriving the hen's body of the necessary time to rejuvenate during the natural cycle of feather replenishment, the goal of forced molting is to increase egg production, egg quality, and profitability of flocks in their second or subsequent laying phases, as well as the profitability of the flock as a whole.

Forced molting is a planned approach to bird replacement used in commercial layer hen production to decrease expenses associated with the purchase of replacement pullets and maximize the utilization of available facilities. This practice has become increasingly popular in commercial farms as a means of extending the laying period to allow the bird's reproductive system to rest for a shorter period than the bird's natural resting period to restore reproductive capacity, improve eggshell quality, and reduce eggshell losses (Ramos *et al.*, 1999). To allow the reproductive system of hens to rest (regress and rejuvenate), multiple molting methods are used to induce weight loss to vary degrees. From 20 percent to 30 percent of one's body weight should be lost, according to recommendations (Baker *et al.*, 1983). In commercial flocks as well as in experimental investigations, a variety of molting strategies have been tried and tested. Briefly stated, the oldest and most conventional methods include withdrawal of food with or without water and light restriction for various durations, supplementation of diets with some drugs or hormones [Gonadotropin-releasing hormone (GnRH), melengestrol acetate, thyroxine, and so on] (Onbaşlar *et al.*, 2007), and feeding supplemented diets with some drugs or hormones [Gonadotropin-releasing hormone (GnR Although it has been claimed that the desired performance values cannot be attained, the cost is considerable, and undesired behaviors (such as cannibalism) arise as a result of the molting methods that involve minerals and hormones, it is possible that the desired performance values can be achieved.

Since alternative methods of molt induction without total feed restriction might better bird welfare while maintaining satisfactory egg production and quality, they are in the foreground of the current egg industry scenario. The use of high-fiber diets and/or diets with the inclusion of anti-nutritional, molt-inducer ingredients has been researched as an alternative to fasting. Among these ingredients are alfalfa, with its high protein and fiber levels and low bird-digestive-tract passage rates, and saponin, which can suppress feed intake and bird growth (Garcia *et al.*, 2000). The results of the study would be beneficial to all farmers in the backyard and the commercial layer industry. The study aims to maximize the whole potential egg production of culled hens by inducing molting after cessation of laying.

Generally, the study aimed to evaluate induced molting in culled white leghorn (*Gallus gallus*) using a fasting and low-protein diet. Specifically, the study aimed to evaluate the effect of induced molting in terms of the following: (a) pre-molting, (b) post-molting, (c) quality of egg laid, (d) cost of post molting products, (e) egg production life, (f) nutrient analysis of egg, and (f) conduct cost and return of investment.

Materials and methods

The study used fifty (50) heads of culled White Leg Horn layer hens (80 weeks of age), local feedstuff (rice bran, cracked corn, cracked rice), layer feeds, weighing scale, experimental cages, lighting equipment, record notebooks, water and feed containers.

Experimental design and treatments

The Completely Randomized Design (CRD) with ten (10) replications per treatment was used to analyze and evaluate the different parameters. The following experimental treatments were: (T_1) fasting, (T_2) cracked corn *ad libitum*, (T_3) - rice bran *ad libitum*, (T_4) cracked rice *ad libitum*, (T_5) production diet. Table 1 was used as the basis for the experimental hens in the treatments observed until 26% loss of body weight is achieved during the induced molting.

Procedures in molting the stocks

During the induced-molting period (35 days), all birds were exposed to natural photoperiod and received experimental diets based on the designated treatment. After losing 26% of their body weight, the birds were fed with a production diet restricted to 30, 60 and 90 g/bird/day for three consecutive days.

From the fourth day onwards, birds were given a production diet at 100 grams per bird/day and also provided with water and a lighting program of 14 hours of light per day with a weekly increase of 30 minutes to reach a daily photoperiod requirement of 16 hours of light.

During the first 35 days, the birds were weighed on days 0, 3, 7, 10, 14, 17, 21, 28, 31 and 35 to evaluate changes in body weight. For each treatment, egg production and mortality were monitored daily, while feed intake and egg weight were recorded weekly.

The characteristics of the birds were evaluated during induced molting; feed intake, body weight change and cost of pre-molt production. Subsequently, birds were also evaluated individually on their post-molt performance onset of receiving the gradual extension of daylight (14 to 16) hours.

This is to prevent a drastic change in the bird's circadian rhythm following the rule of thumb in layer production to never increase the duration or intensity of light during the growing period and never decrease the duration or intensity of light during the production period.

The following parameters for the post-molting were (feed intake, laying interval per bird, cost of post-molt production) and egg quality (egg weight, eggshell thickness and yolk color) throughout the 30 days of laying upon receiving 16 hours of light.

Preparation of cages

The birds were housed in a porch equipped with 5 cages made up of slatted bamboo and plastic screens. The experimental cages measure 10 feet long by 1 foot wide by 1 m height composed of 10 compartments measuring 1 foot long by 1 foot wide by 1.4 foot high, each cage holding 10 birds per cage.

Independent trough feeders were placed in front of the cages and plastic water drinkers were also used. Cages were constructed to provide convenience in cleaning, giving feeds and providing water to the experimental birds.

Procurement of stocks

A total of (50) heads of culled layers 80 weeks of age were procured from the Jumaoan layer farm at San Gabriel, Tuguegarao, Cagayan.

Feeding management

During the pre-molting period (35 days), all birds were exposed to natural photoperiod and received experimental diets based on the designated treatment. After the birds lost 26% of their body weight, they were fed with a production diet restricted to 30, 60 and 90 g/bird/day for three consecutive days. From the fourth day onwards, the birds were fed with a production diet of 100 g/bird/day.

Data gathered

Pre-molting stage

Feed consumption

This was determined by subtracting the feed orts from the pre-weighed feeds.

Body weight change

This was taken by weighing the experimental birds during the first 35 days; the birds were weighed on days 0, 3, 7, 10, 14, 17, 21, 28, 31and 35 to evaluate changes in body weight.

Cost of pre-molting production

This was taken by getting the overall feed consumption multiplied by the price per kilogram.

Post-molting stage

Feed consumption

This was determined by subtracting the feed orts from the pre-weighed feeds. Egg weight: This was determined by weighing the eggs produced per replication of different treatments and classified by the following parameters based on the Philippine National Standard Table Egg Specification (Table 2).

Yolk color intensity

This was taken by using a Roche egg Yolk color fan (Fig. 1).

Cost of post-molting production

This was taken by getting the overall feed consumption multiplied by the price per kilogram.

Nutrient analysis of egg produced

This was accomplished by laboratory testing in the allied agency.

Production life

This was taken by getting the overall egg production life of the hen.

Return on Investment

This was taken by subtracting the cost of production from the sales of the egg.

Results and discussion

Feed consumption

The feed consumption of hen during induced molting is presented in Table 3. It was observed that the highest feed consumption was recorded in Treatment 2 with 20.6 kg, followed by Treatment 3 with 12 kg. Treatment 5 with 9.4 kg and no feed consumed was noted in Treatment 1.

The high feed consumption of birds in treatment was attributed to the low fiber content of corn that can easily be digested by the birds. Corn has a crude protein content of about 7.5% which causes prolonged weight regression for about 14-35 days during pre-molt. However, in Treatment 2, birds were given rice bran and consumed a lower amount of feed because of its bulkiness in terms of nutrient content. Rice bran has a crude fiber content of 7 to 11.4%, protein content of 11.3 to 14.9% and available carbohydrates of 34 to 62 g (Juliano and Maniṅgat, 1982).

Table 1. Treatment descriptions of the experiment.

Treatment no.	Treatment description
T1	Fasting- Layers did not receive any feed until 26%loss of body weight is achieved.
T2	Cracked corn (medium cracked) – Layers received cracked corn until 26% of body weight loss is achieved.
T3	Rice Bran (D1) - Layers received rice bran until 26% of body weight loss is achieved.
T4	Cracked rice- Layers received cracked rice until 26% loss of body weight is achieved.
T5	Control (Production Diet) - Layers received production diet only.

A similar observation was in Treatment 5 (Control), where birds had low feed intake; however, no physical changes were observed in all birds in the treatment, while Treatment 4 (Cracked rice) had the lowest feed consumed, which was attributed to the low crude protein of cracked rice of 7.11% and had the available carbohydrates of 78 - 89 g which greatly affects the feed consumption of birds given with cracked rice (T4) that causes birds' early weight regression.

Weight regression (kg)

As shown in Figure 2, Treatment 2 obtained the longest desired 26% of body weight loss for about 35 days, followed by Treatment 3 (rice bran) ranging from 21-28 days, Treatment 4 (cracked rice) ranging from 14-17 days. Treatment 1 (fasting) reached the shortest days to regress for about 10 days.

However, Treatment 5 (control) did not undergo weight loss and molting due to pure commercial laying mash given to the birds from day 1 to day 35.

After losing 26% of their body weight, they were subjected to a gradual increase in light from 14 hours to 16 hours of extended daylight with 30 minutes weekly increase to facilitate egg production.

Table 2. Philippine national standard table egg specification.

Egg specification	Weight (g)
Jumbo	70 and up
Extra Large	65 – 70
Large	60 – 65
Medium	55 – 60
Small	50 – 55
Pullets	45 – 50
Pewee	40 – 45

Body weight changes (kg)

Table 3 shows the numerical changes in the body weight of the hens during the stage of pre-molting; this also shows the day-to-day decrease in weight as affected by different molting diets.

Treatment 2 reached the longest required weight loss in 35 days, followed by Treatment 3 in 31 days, Treatment 4 in 21 days and Treatment 1 the fastest, reaching the required weight loss within 10 days, while Treatment 5 (control) remained constant in weight because no induced molting was applied.

Feed intake during the post- molting

Figure 3 shows the feed intake of birds during post-molting; birds in Treatment 2, consumed the highest amount of feed, 280 kg, followed by Treatment 3, Treatment 4, and Treatment 1 with 278 kg, 270 kg and 266 kg, respectively, and the least feed consumed was in Treatment 5 with 262 kg.

Egg weight (g)

Fig. 4 shows the average egg weight of culled layer as affected by induced molting. Treatment 3 (rice bran) attained the heaviest egg weight with a mean of 70.6 grams, Treatment1 (fasting) with a mean of 70.1 grams, Treatment 4 (cracked rice) with a mean of 68.8 grams, Treatment 2 (cracked corn) with a mean of 65.8 grams, and the lightest was recorded in Treatment 5 (control).

Table 3. Feeds consumption of hens during induced molting.

Treatments	1-10 DAYS	1-14 DAYS	1-21 DAYS	1-31 days	1-35 DAYS
T1	0Kg				
T2					20.6 Kg
T3				12.Kg	
T4			7.7Kg		
T5		9.4Kg			
TOTAL	0Kg	9.4Kg	7.7Kg	12.Kg	20.6 Kg

Table 4. Body weight change of birds during induced molting (days).

Ttreatments	Wt. of birds (Kg)	3 Days	7 days	10 days	14 days	17 days	21 days	28 days	31 days	35 days
T1	1.38	1.23	1.12	1.01						
T2	1.38	1.32	1.36	1.3	1.27	1.25	1.23	1.08	1.23	1.02
T3	1.36	1.36	1.25	1.2	1.15	1.13	1.04	1.09	1	
T4	1.34	1.34	1.26	1.18	1.12	1	0.99			
T5	1.33	1.37	1.44	1.43	1.41					

Analysis of variance reveals no significant difference was observed among treatment means tested; this result is parallel to the study conducted by Berry and Brake (1991) that different molting program does not significantly affects the weight of the egg produced by molted layer hens.

Total number of eggs produced

Fig. 5 shows the total number of eggs produced based on their yolk color. It was observed that all eggs produced in all the treatments had an egg yolk color of 14 as its highest grade and an egg yolk color of 12 as its lowest grade. As reflected, Treatment 3 produced the highest number of eggs, 255 with a color grade of 14, followed by Treatment 4, 251 eggs with a 14 color grade; treatment 1, 192 eggs with a 14 color grade; treatment 2, 162 eggs with a color grade of 14 respectively, and the lowest number of eggs produced was in Treatment 5 with same color grade quality.

These results are similar to the study of Christmas *et al.*, 1985; Garlich, 1995; Said *et al.*, 1984 that induced molting programs increased the internal egg quality and shell quality. Statistical analysis revealed significant differences among the induced molting treatment in terms of egg produced and yolk color intensity as compared to the control, Egg yolks range in color from pale yellow to deep orange. Richer-colored egg yolks are more likely to come from free-range hens.

Table 5. Classification of egg based on weight and size as affected by induced molting.

Treatment	Peewee (40g-45g)	Pullets (45g-50g)	Small (50g-55g)	Medium (55g-60g)	Large (60g-65g)	Extra large (65g-70g)	Jumbo (70g-up)
T1				6	51	44	134
T2			1	28	41	80	78
T3			1	6	8	77	171
T4			8	23	54	54	150
T5	1		7	14	18	20	56

Table 6. Nutrient Analysis of egg laid by hens as affected by induced molting.

Treatment	Crude protein%	Crude Fiber%	Crude fat%	Moisture %	Ash %
T1	34.14	0.40	48.30	8.74	5.75
T2	38.82	0.90	42.35	9.61	5.65
T3	42.82	0.35	39.50	9.46	5.93
T4	40.46	0.20	41.54	10.88	4.04
T5	39.79	0.75	41.65	10.22	3.68

According to Dr. Hilary Shallo Thesmar, director of food safety programs for the Egg Nutrition Center (ENC): Free-range hens have the opportunity to eat more pigmented foods, and the pigment is then transferred to the yolk. But the macronutrients (protein and fat) remain the same regardless of yolk color, Thesmar says. "However, there might be small changes in some of the micronutrients such as vitamin A and/or lutein."

The Egg yolk color ranging from 12 to 15 is highly accepted and has a good market price.

Table 7. Monthly Egg Productivity of White Leghorn Chicken after Induced Molting at 10 birds per treatments.

Treatments	MONTH											TOTAL
	F	M	A	M	J	J	A	S	O	N	D	
T1	85	125	130	174	146	187	158	137	100	74	35	1351
T2	11	105	115	170	170	161	143	144	125	106	56	1306
T3	121	160	181	188	158	157	147	156	144	136	85	1633
T4	113	140	161	192	166	180	179	174	167	145	90	1707
T5	54	75	85	123	27	24	22	27	21	21	15	494
Result	*	*	*	*	*	*	*	*	*	*	ns	

Note: asterisk means significant result.

Table 8. Cost and Return Analysis.

Particulars	TREATMENTS														
	T1 fasting			T2 cracked corn			T3 rice bran			T4 craked rice			T5 control		
A. Expenditure	Quantity	Unit Cost	Total Cost	Quantity	Cost	Total Cost	Quantity	Cost	Total Cost	Quantity	Cost	Total Cost	Quantity	Cost	Total Cost
Culled layers (head)	10	85	850	10	85	850	10	85	850	10	85	850	10	85	850
Feeds															
Pre-molt (kg)	0	0	0	20.56	18	370.2	12.01	9	108.1	7.7	30	231	9.4	24	225
Post-molt (kg)	266	24	6384	280	24	6720	278	24	6672	270	24	6480	262	24	6288
LABOR			300			300			300			300			300
WATER AND ELECTRICITY			150			150			150			150			150
-TOTAL			7684			8390.2			8080			8011			7813
B. Sales															
Total Egg (pcs)	1266	8	10128	1294	8	10352	1502	8	12016	1594	8	12752	440	8	3520
C. Net Income (B-A)			2444			1961.8			3936			4741			-4293
D.Net return per invested (C/A)			0.318			0.2338			0.487			0.592			-0.549
E. Internal rate of return (%C/A x 100)			32%			23%			49%			59%			-55%

Egg size classification

Table 4 shows that the majority of the produced eggs from all treatments are classified as jumbo size numerically; Treatment 3 produced the highest number of jumbo-size eggs 171 followed by Treatment 4, Treatment 1, Treatment 2 and Treatment 5 with 150 eggs,134 eggs, 78 eggs and 56 eggs respectively.

Egg sizes produced by culled birds are still of economic importance since they commence a high price in the market; the sizes of eggs are closely related because of the genetic makeup of the culled birds.

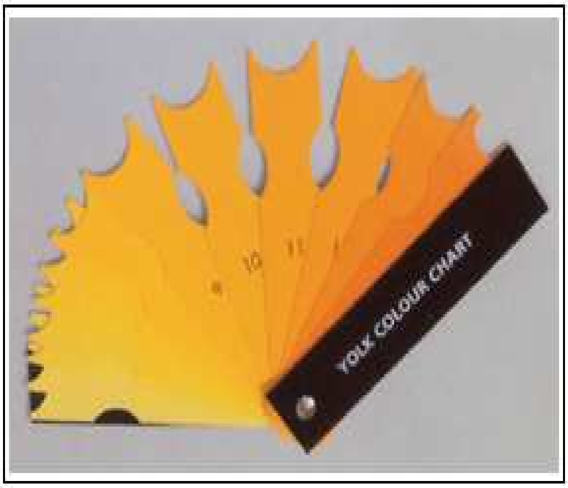

Fig. 1. Yolk color chart.

Nutrient analysis

The nutritive analysis is based on the actual value of crude protein, crude fiber, crude fat, moisture and ash content of the different treatments subject to laboratory analysis (Table 5). Shows the total nutritive value of each treatment based on different components. For example, crude protein (%) T1 obtained the lowest for about 34.14% CP while T2 ranked 2nd to the lowest, having a value of 38.82%CP; meanwhile, T5 got a 39.79%CP. T4 got a value of 40.46%CP next to T3, obtaining 42.82%CP, the highest in five treatments. For crude fiber, T4 obtained the lowest at 0.20%; next is T3 having a value of 0.35%, followed by T1, with a value of 0.40%. T5 obtained a value of 0.75% next, to T2 obtaining 0.90% highest among the treatments.

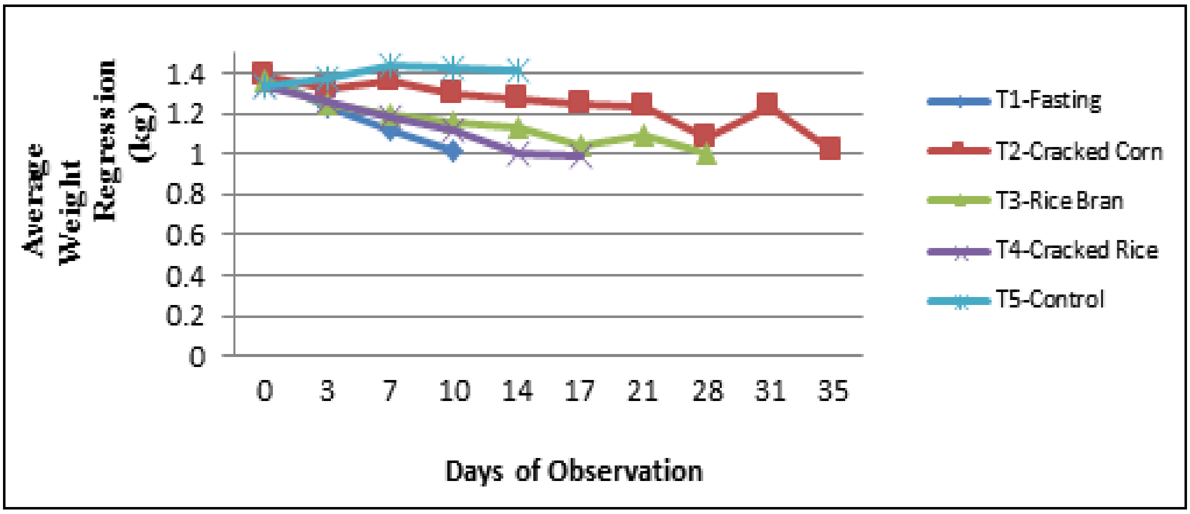

Fig. 2. Weight regression and egg production of white leghorn.

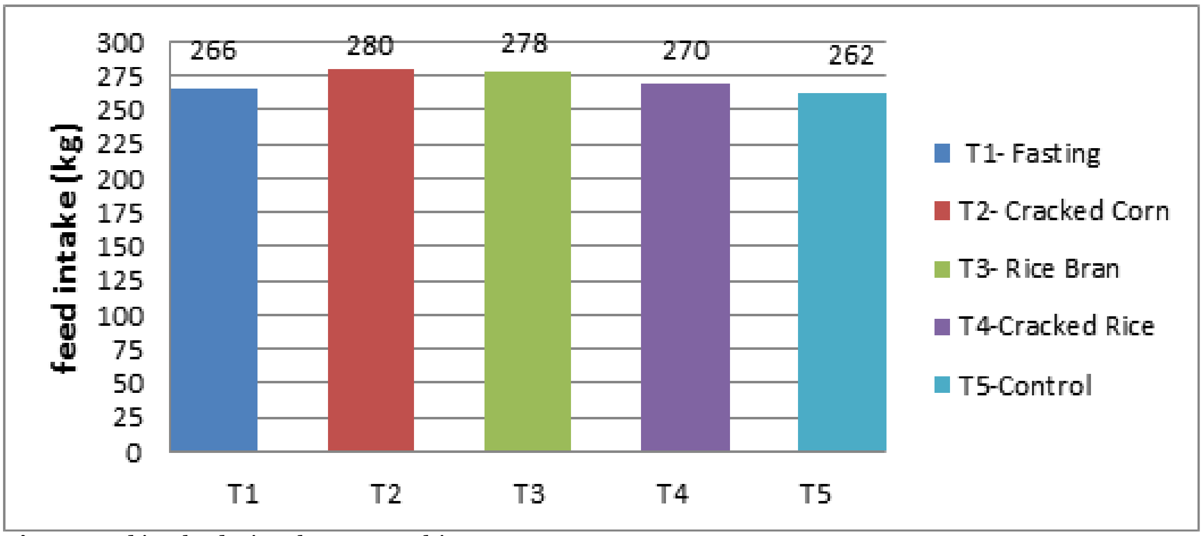

Fig. 3. Feed intake during the post- molting.

In crude fat, T1 obtained the highest at 48.30%, followed by T2 with a value of 42.35%, while T4 and T5 obtained 41.54%, and 41.65%, respectively, with a slight difference between each other, while T3 is the lowest, obtaining a value of 39.50%. The moisture content of each treatment varies from T4 and T5 having a value of 10.88% and 10.22%, respectively, with a slight difference, while T2 and T3 are close with a value of 9.61% and 9.46%, respectively, while T1 obtain the lowest value at about 8.74%. In ash T3, T1 and T2 obtain a value of 5.93%, 5.75% and 5.65%, with a significant difference. T4 obtained a value of 4.04%, 2nd to the lowest, while T5 obtained 3.68%, the lowest among all treatments.

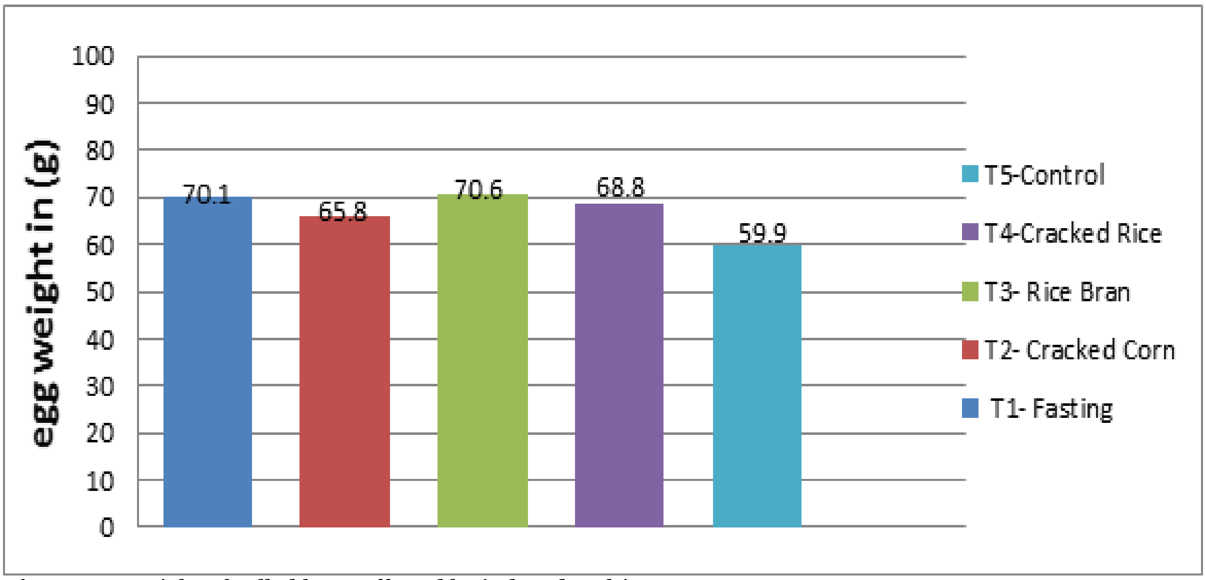

Fig. 4. Egg weight of culled layer affected by induced molting.

Productive capability

Table 6 shows the productive capability of white leghorn chicken throughout the 290 days laying period. It further shows that T4 (outranked all other treatments producing 1,707 eggs, followed by T3, T1 and T2, with a total of eggs produced 1633, 1351 and 1306, respectively. The least produced was observed in T5, producing a total egg of 494. Analysis of variance shows significant results among all treatments tested.

The result of the study was attributed to the result of the study conducted by (Koelkebeck *et al.,* 1992), who obtained the same result that molting of hens can improve egg production, albumen quality and eggshell quality, compared to non-molted hens.

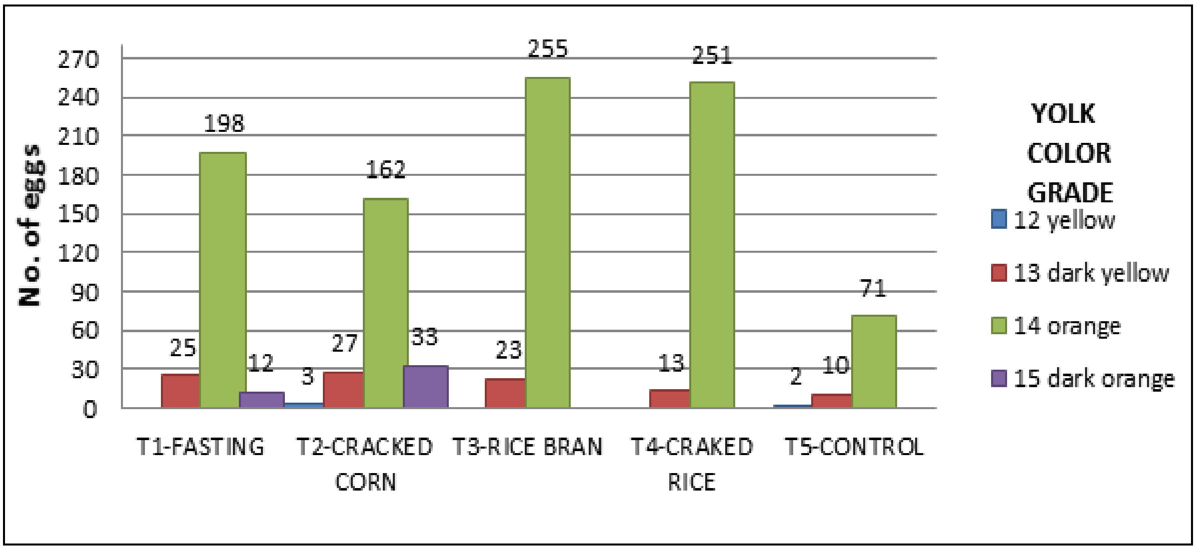

Fig. 5. Total number of eggs produced by culled layer hen (White leghorn) based on its egg yolk color as affected by induced molting.

Cost and return analysis

The economic analysis was based on 10 head production capacity (Table 7) shows the total feed intake during the pre-molting period wherein T1 did not consume any; on the other hand, T2 (cracked corn) has the highest cost in terms of consumption with ₱ 370.20, followed by T3 (rice bran) with ₱108.10. Treatment 5 (control) follows with the highest consumption of layer feeds with ₱225.00 and T4 (cracked rice) with ₱231.00, while in the post-molting period, the consumption of layer-feeds varies from treatment to treatment.

Treatment 2 (cracked corn) consumed the highest amount of feed which is 280 kg with ₱6,719.88, followed by T3 (rice bran) with ₱6,672. On the other hand, T5 (control) and T1 (fasting) consumed the lowest amount of feed, with ₱6,288 to ₱6,398 and lastly, T4 (cracked rice) consumed the third highest amount of feed, with ₱ 6,504 throughout the 290 days upon recieving14 hours of extended daylight.

As to the net income, T4, T3 and T1 obtained a positive income of ₱1846.00, ₱1093.00 and ₱209.00, respectively, while T5 and T2 got a negative net income of ₱-3953.00 and ₱-345.00 respectively. On the relative value net return per peso T4 obtained the highest with a value of .27 while T3 and T1 obtained the highest at .16 and .0319 value, Converting this to return on investment (ROI %) T4 obtained the highest with 27% while T3 followed at a value of 16% and T1 with a value of 3.19%. With this performance, T4, T3 and T1 are profitable or economically feasible as molting inducers of culled layer (White Leghorn) compared to the other treatments.

Conclusion and Recommendations

Based on the study, it has been proven that culled layer can still be of significant in term of egg production and egg quality, it also is recommended that the induced hen must be kept for a 290-day laying period only to attain its maximum laying percentage; thus, keeping the hens in a longer period will increase feed intake but a much lower laying percentage. Keeping the hens for a much longer period increases their susceptibility to many reproductive anomalies, e.g., uterine prolapse and vent hemorrhages.

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