

# **Dietary Manipulations for Improving Production Rate, Persistency and Egg Quality in Single Comb White Leghorn (Lohmann) Layers\***

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## Abstract

**T**he study used 90 two-and-a-half-year-old Single Comb (S.C.) White Leghorn (Lohmann) strain already at laying with a rate of 32.55%. The feeding experiment compared the effects of dietary protein (18, 20 and 22%) and added methionine (0.00, 0.15 and 0.30%) on the performance of culled layers over a 12-week period. All treatments with three replications were arranged in a 3 x 3 factorial experiment in a completely randomized design with an inclusion of a reference diet in the treatments.

Results showed significantly lower feed intake in 22% CP treated rations and no differences in methionine level. Average weekly production rate was higher at 18% and the interaction effect of CP and methionine levels. Feed

conversion efficiency (FCE) was higher among the layers fed with 18% CP, while the lowest FCE was at 22% CP in the diet. Significantly better egg production was at 0.15% methionine. Interaction effect revealed significantly higher egg production at 18% CP and 0.30% methionine level. Culling rate was higher at 22% CP and 0.30% methionine. Mortality showed higher among the layers fed with 18% CP and no differences in methionine levels.

Egg weights increased with increasing protein levels and reference diets have significantly lighter eggs. Heaviest eggs were obtained at 22% CP and 0.30% methionine. Egg mass equivalent (EME) was significantly better in layers fed with 18% CP while at 22% CP had, however, lower EME and at 0.30% methionine. Thinner egg shells were observed among layers fed with 22% CP and 0.30% methionine.

Feed cost per dozen egg produced was significantly higher in birds fed 22% CP diet while the lower feed cost was in birds fed with 18% CP. Income over feed cost was positively higher at 18% and negatively higher at 22% CP, while the interaction effects showed positively higher at 22% CP and 0.30% methionine and negatively lowest was obtained at 22% CP and 0.15% methionine.

## **Introduction**

Maintaining high egg yield and improving the layer's persistency during the later half of the laying period is one of the basic problems of economic importance in the poultry industry today. The continually increasing cost of feeds and other inputs demand the adoption of more efficient feeding systems by egg producers to maintain a high level of production on a year round basis which would consequently result in higher net return from the enterprise.

The problem of keeping egg yield at profitable level is particularly important to the small farmers or medium-scale poultry venture. Their limited capital and resources require that small flock be kept in laying houses at a longer period for two reasons: first, to delay the purchase of growing replacement stock (probably 2 to 5 months) and second, to maximize the use of the housing facilities and labor up to the next favorable brooding season.

Yet these advantages can be achieved by other management systems such as systematically replacing expected culls in the flock by periodic brooding. Another option available and probably more economical is by dietary manipulations to improve egg-laying production toward the end of the laying period.

Egg production tends to gradually decline after 9 to 10 months of laying (Nesheim, et. Al. 1979). Also Gapuz (1973) claimed that the cessation of egg laying is accompanied by wing molt. Under tropical conditions, the production peak is generally reached after three months of laying, leveling off up to seven months and decreasing toward the end of the cycle.

Maximum egg yields are supported by laying rations containing 15 to 18 percent protein and metabolizable energy (ME) level of 2860 kcal per kg of feed (North, 1978). A report by Reid and Maiorino (1980) revealed that energy is the first limiting nutrient for laying hens under heat stress, and that an increased energy level tends to improved egg production (Sell, et. al. 1979). Higher egg laying rates and elevated temperatures, appear, therefore, to put a greater demand for nutrients not only for immediate utilization but also for replenishment of the body reserves and for maintenance.

Since the egg contents are predominantly protein and to a lesser extent carbohydrates and fats, higher requirement for protein is needed for body reserve as it may not be able to constantly supply the body after the peak of production is reached. More essentially, there may be a greater need for some of the essential amino acids, particularly methionine, which are principal constituents of feathers.

Increasing the levels of protein and consequently, amino acids or by simply supplementing the diet with synthetic methionine could slow down the aging of the feather coat layers, thereby delaying the wing molt which is closely associated with the cessation of egg laying.

In view of these assumptions, it is worthwhile to determine the protein and methionine supplementation levels to attain maximum egg production rate, persistency and egg quality at certain levels of treatment ration.

## **General Objectives**

The study is conducted to increase egg production of culled layers profitably through dietary manipulations especially in the levels of protein and methionine.

### *Specific Objectives*

1. To determine the laying rate of culled layers egg production.
2. To determine the egg quality in terms of egg weight, standard egg class, egg mass equivalent and eggshell thickness.
3. To evaluate the economic efficiency of the formulated laying mass with varying levels of protein and methionine.

## **Methodology/ Procedure**

The research study was conducted at the Poultry project, Central Mindanao University, University Town, Musuan, Bukidnon, Philippines, with tropical condition.

The experiment started on November 25, 2001 and terminated February 22, 2002 with an experimental period of 90 days.

A total of 90 single comb (S.C.) White Leghorn Layers of a commercial strain (Lohmann) of the same age were randomly selected from a flock that was two-and-a-half years old and had 32.55 per cent egg production. The birds were selected based on health condition and physical characteristics associated with active laying and functional ovaries. Layers were fed uniformly with the standard layer mash and were gradually introduced the required treatment rations for one week.

Sample birds were distributed equally to 10 treatment combinations including the control, with 3 replicates and 3 layers per replicate, following the 3 x 3 factorial in a completely randomized design (CRD). Each replicate group was kept in eight adjacent wire cages at the same level. The cages were of double deck stair-step type construction generally adopted for commercial flock.

Two factors, protein level (Factor A) at 18, 20 and 22% and methionine level (Factor B) at 0.00, 0.15 and 0.30%. All diets contained similar energy levels of 2800 kcal ME per kg of mixed feed. A reference diet (control) was the commercial layer mash containing 18% CP and 2800 kcal ME per kg of feed having 0.5% methionine.

All treatment rations formulated were subjected to proximate chemical analysis by AOAC (1995). The gross energy level of each ration was determined using a bomb calorimeter. The metabolizable energy (ME) was estimated by  $ME = 80\% D.E.$

The prepared experimental rations were given to the birds with average weight of 1.44 kg per layer, and for the whole feeding period at an average of 110 grams per layer per day. Leftover feeds in each replicate were weighed to determine the actual feed intake at weekly intervals. Rations were mixed every week as needed to ensure its freshness.

The following data gathered were: Feed consumption gm/bird; Dozen eggs production; Feed Conversion Efficiency; Occurrence of Culls and Mortality; Average daily Egg Weights gm; Average Egg Mass Equivalent based on the formula,  $Egg\ Mass = P \times W$ , where  $P = \%$  of hen day basis of egg production and  $W =$  Average egg weight in grams; Egg Shell Thickness; and

Persistency in terms of the occurrence and number of culls for the whole period of the experiment.

Analysis of variance by Snedecor and Cochran (1967) for a 3 x 3 factorial in completely randomized design was made to evaluate the effects of treatments. Mortality rate was also transformed through  $(v \times + 0.5)$  considering zero values in the observed to have significant differences.

Treatment means were compared by Duncan's Multiple Observation RANGE test (DMRT). Regression analysis of egg production was also made.

## Results and Findings

Feed intake per layer as affected by levels of dietary protein and methionine is presented in Table 1. Significant differences were observed on feed intake among the levels of protein in the diet (18, 20 and 22%). Layers fed diet with 22% CP, however, consumed lesser feed at 104.60 g daily per bird, compared to 18 and 22% CP diets at 108.04 g and 105.82 g, respectively. Those with the group fed with commercial mash consumed 105.35 g daily per bird.

Non-significant difference was also noted in the feed intake of birds receiving feed without and within two levels of added DL-methionine, including those on commercial feed. These results indicate that the varying levels affected this parameter. It is worth noting, however, that all birds fed with the experimental rations including the control supplied comparatively the same energy levels which were consumed in similar amounts. It has been established that chickens continue to eat as the energy need is not completely satisfied. On the other hand, those on high energy diets would consume just enough to meet energy requirements.

**Table 1. Average daily feed consumption of layers fed rations with varying levels of dietary protein and methionine (g)**

PROTEIN LEVEL (A)	METHIONINE LEVEL (B)			MEAN (A)**
	0.00	0.15	0.30	
18	109.33 <sup>a</sup>	107.72 <sup>a</sup>	107.00 <sup>a</sup>	108.04 <sup>a</sup>
20	107.25 <sup>a</sup>	105.26 <sup>a</sup>	104.25 <sup>a</sup>	105.82 <sup>b</sup>
22	105.60 <sup>a</sup>	104.26 <sup>a</sup>	103.65 <sup>b</sup>	104.60 <sup>b</sup>
Control	105.35 <sup>a</sup>			105.35 <sup>b</sup>
MEAN(B) <sup>ns</sup>	107.41	105.86	105.20	

CV = 26.21%

\*\* = highly significant (P<.01)

ns = not significant

Means with no common letter are significantly different (DMRT)

Table 2 shows the effects of the dietary treatments on average weekly egg production. The varying levels of methionine in the diet did not affect the egg yield of the experimental layers. This combined effects and level of protein, however, resulted to highly significant differences in egg yield ( $P < .01$ ).

**Table 2. Average weekly egg production of layers fed with varying levels of dietary protein and methionine (pieces)**

PROTEIN LEVEL (A)	METHIONINE LEVEL (B)			MEAN (A)**
	0.00	0.15	0.30	
18	10 <sup>a</sup>	12 <sup>a</sup>	11 <sup>a</sup>	11 <sup>a</sup>
20	8 <sup>a</sup>	9 <sup>a</sup>	11 <sup>a</sup>	9.3 <sup>a</sup>
22	8 <sup>a</sup>	9 <sup>a</sup>	7 <sup>a</sup>	8 <sup>b</sup>
Control	8 <sup>a</sup>			8 <sup>a</sup>
MEAN(B) <sup>ns</sup>	8.6	10.00	9.60	

CV = 26.21%

\*\* = highly significant ( $P < .01$ )

ns = not significant

Means with no common letter are significantly different (DMRT)

Two things are obvious from the foregoing observation. First, maximum egg yield can be obtained at 18% protein level. Increasing the CP to this level tend to reduce egg production, especially when such is brought up to 22% CP were highly significant reduction in egg production is observed. This contradicts the hypothesis of this study that a higher protein level can sustain or support higher egg production rate beyond peak egg yield after three months laying. However, this result is supported by the findings of North (1978) that maximum egg yield is attained at a ration level of 18% CP and that no amount of increase in protein or methionine can offset the observed decline in egg production which may be genetic in nature. This also means that the bird's ability to lay eggs after peak production is a function of factors other than protein or amino acid level.

Second, at 18% CP the level of methionine and of other amino acid can be sufficient to meet the requirements for optional egg production, as shown by the significant differences in egg yield even at slightly higher levels of added methionine. Interaction effects of treatment combinations also resulted in highly significant differences especially with 22% CP and 0.30% methionine in the diet.

Feed conversion efficiency (FCE) in this study refers to the amount of feed required to produce a dozen eggs, thus the lesser the amount of feed needed to produce a dozen eggs the more efficient is the layer in converting feeds to egg.

Layers fed with ration containing 18% CP gave no significant differences in FCE (2.69) and the commercial layer mash has 2.89, while those with 20% CP

had 2.84 FCE. Statistically, there was no observed differences among the CP levels, although at 18% had slightly better FCE.

The above observations indicate that the marked increase in egg production 18 and 20% CP can be attributed partly to improved efficiency of the ration at these levels of protein irrespective of methionine supplementation levels. The observed decrease in feed efficiency due to higher protein at 22% CP and 0.30% methionine level is an indication of a certain degree of antagonistic effects since egg production can not be maintained at higher level of methionine which tended to produce a toxic effect that affect egg production. Toxicity is caused by the production of excess ammonia by deamination process which hinders the ovulation and utilization of feeds in layers.

In the study, higher CP level in the treated ration tended to increase the methionine level excess of the requirements for optimum egg production. It should be noted that the FCE of the expected ration was comparable to the positive control which is expected, considering that the ration contained 18% CP and 2800 ME. FCE is summarized below (Table 3).

**Table 3. Feed conversion efficiency of layers fed rations with varying levels of dietary protein and methionine**

PROTEIN LEVEL (A)	METHIONINE LEVEL (B)			MEAN (A)**
	0.00	0.15	0.30	
18	3.26	2.27	2.55	2.69 <sup>a</sup>
20	3.46	2.71	2.75	2.76 <sup>a</sup>
22	3.67	3.59	8.10	5.12 <sup>b</sup>
Control	2.89			2.89 <sup>a</sup>
MEAN(B) <sup>ns</sup>	3.46 <sup>b</sup>	2.86 <sup>a</sup>	4.33 <sup>b</sup>	

CV = 26.21%

\*\* = highly significant (P<.05)

ns = not significant

Means with no common letter are significantly different (DMRT)

Hen-day egg production performances as affected by varying protein and methionine levels are presented in Table 4. The weekly trend in production is graphically represented in Figure 1. At 18% CP the birds obtained the highest production rate of 53.79% followed by 47.41% and 39.25% for 20 and 22%, respectively, while those on control diet had 47.07%. Highly significant (P<.01) differences among treatment combinations and CP levels were observed through the levels of methionine affect significantly higher at 0.15% at 50.63% hen-day egg production. The interaction of 22% CP and 0.30% methionine significantly

depressed hen-day egg production at 32.69%, while 18% CP and 0.30% methionine in the diet resulted to higher egg production of 57.55%.

**Table 4. Hen-day egg production of layers fed with varying levels of dietary protein and methionine.**

PROTEIN LEVEL (A)	METHIONINE LEVEL (B)			MEAN (A)**
	0.00	0.15	0.30	
18	46.61 <sup>a</sup>	57.20 <sup>a</sup>	57.55 <sup>a</sup>	53.79 <sup>a</sup>
20	38.70 <sup>a</sup>	48.66 <sup>a</sup>	54.86 <sup>a</sup>	47.41 <sup>a</sup>
22	39.04 <sup>a</sup>	46.02 <sup>a</sup>	32.69 <sup>b</sup>	39.25 <sup>b</sup>
Control	47.07 <sup>a</sup>			47.04 <sup>a</sup>
MEAN(B) <sup>ns</sup>	41.45 <sup>b</sup>	50.63 <sup>a</sup>	48.37 <sup>a</sup>	

CV = 25.75%

\*\* = highly significant (P<.010)

ns = not significant

Means with no common letter are significantly different (DMRT)

These results are indications that higher egg yield was maintained when the layers were fed with 18% CP ration irrespective of the added methionine. Increasing protein to 20 and 22% of the ration did not result in parallel or better egg production performance. The improved laying rate of 18% CP may be attributed to the slightly higher feed intake, conversion ratio and weekly dozen of egg production at the lowest level of supplementation, as previously noted in Table 1, 2 and 3. This gradual decline in the egg production rate may be due to the toxic effect of methionine at higher level of supplementation at 0.30%. This effect is clearly illustrated by the sharper decrease in weekly egg production rate of birds in a higher level of CP and added methionine of the diet including the control.

A regression analysis of the weekly hen-day egg production rate and duration of laying (Table 5 and Figure 2) indicates that the 18% CP level of the diet and at 0.15% added methionine and 18% CP level of diet and 0.30% methionine have better weekly egg yield was obtained followed by the other treatments in decreasing order as follows: 20% CP and 0.30% methionine; 20% CP and 0.15% methionine; 20% CP and 0.00% methionine; 22% CP and 0.15% methionine; 22% CP and 0.30% methionine, and the control diet (Commercial mash).

The regression analysis showed that the improved egg production rate resulted in layers fed with 18% CP and 0.30% methionine or at the rate of 0.15% added methionine. These observation agreed closely with that of Keshavars and

Austic (1985) that the methionine added to a basal diet lower protein content maintained and improved the egg production rate of layers.

The data of Table 4 (Hen-day production) show higher percentage culls as the protein level was increased from 18 to 22% of the diet. However, based on methionine level, high culling rate was more pronounced among layers fed diet with 0.30% methionine. Nevertheless, when the occurrence of culls is taken into account, i.e., the relative point of time the birds appear as culls during the course of the experiment, there were more culls identified early in the groups fed with 22% CP and 0.30% methionine and less number of culls in groups fed with 18% CP level and 0.30% methionine.

As a whole, this results on culling rate suggests that the better laying persistency may be induced when layers are fed with rations containing 18% CP and 0,15% methionine. Although persistency of laying could have been better assessed if the effects of the treatment on culling rate were observed throughout the entire laying period.

The extent of mortality in each treatment group was also used as criterion of response to the feeding treatments. Mortality was observed at the start of the experiment in groups fed with 18% CP in all methionine levels. With this observation, highly significant ( $P < .01$ ) difference resulted. However, the observed mortality occurred in the early part and mainly due to paralysis, which led to inability of the layers to access feed, thus the death were not influenced by the treatment groups.

The average weight of egg produced by each replicate group was determined daily over a period of three months to evaluate the effects of the dietary treatments on egg size and other quality traits.

Table 6 shows that the marked variations ( $P < .01$ ) in egg weight in the different treatment groups were attributed to protein and methionine level and the interaction between protein and methionine.

**Table 5. Regression function of duration of laying and egg production at 12 weeks of feeding with varying levels of dietary protein and methionine.<sup>1</sup>**

TREATMENT	$Y = a - bx$ Regression Equation	r
<u>18% C.P.</u>		
0.00% Methionine	$46.61 - 1.12x$	0.825*
0.15% Methionine	$55.21 - 0.99x$	0.609*
0.30 Methionine	$57.94 - 1.22x$	0.657*
<u>20% C.P.</u>		
0.00% Methionine	$38.17 - 0.65x$	0.651*
0.15% Methionine	$48.51 - 1.96x$	0.706*
0.30 Methionine	$53.75 - 1.79x$	0.789*
<u>22% C.P.</u>		
0.00% Methionine	$39.12 - 1.30x$	0.842*
0.15% Methionine	$46.02 - 1.23x$	0.614*
0.30 Methionine	$34.38 - 1.04x$	0.725*
Control	$47.39 - 1.80x$	0.745*

<sup>1</sup> The regression equation is given as follows:

$$Y = a - bx$$

Where: Y = estimated egg production rate (%)

a = intercept

x = duration of laying (week)

b = slope of regression line

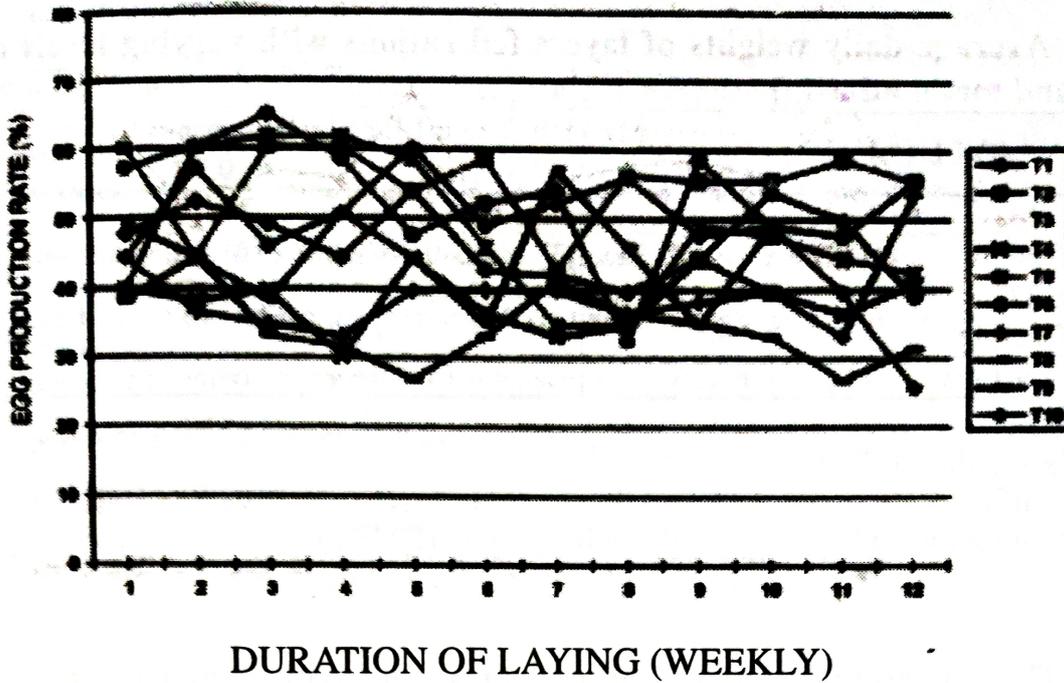


Figure 1. Weekly hen-day egg production rate (%) of birds at 18, 20 and 22 percent CP and varying levels of methionine.

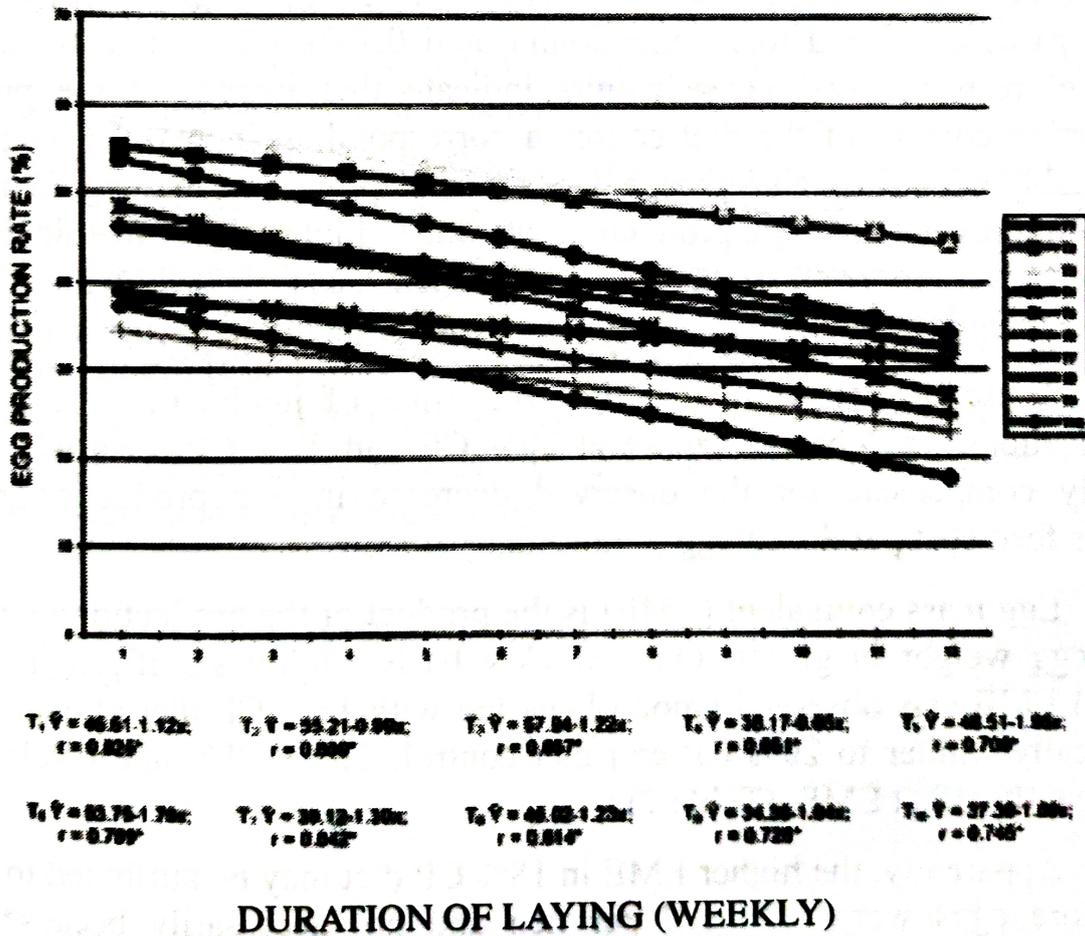


Figure 2. Regression on duration of egg laying and egg production at 18, 20 and 22 percent CP and varying levels of methionine.

**Table 6. Average daily weights of layers fed rations with varying levels of dietary protein and methionine (g)**

PROTEIN LEVEL (A)	METHIONINE LEVEL (B)			MEAN (A)**
	0.00	0.15	0.30	
18	64.93 <sup>b</sup>	64.75 <sup>b</sup>	68.18 <sup>a</sup>	65.95 <sup>a</sup>
20	68.12 <sup>a</sup>	64.30 <sup>b</sup>	66.28 <sup>b</sup>	66.23 <sup>a</sup>
22	68.41 <sup>a</sup>	69.41 <sup>a</sup>	72.07 <sup>a</sup>	69.67 <sup>a</sup>
Control	63.53 <sup>b</sup>			63.53 <sup>b</sup>
MEAN(B)**	66.26 <sup>b</sup>	66.15 <sup>b</sup>	68.84 <sup>a</sup>	

CV = 26.21%

\*\* = highly significant (P&lt;.010)

ns = not significant

Means with no common letter are significantly different (DMRT)

There is an increasing trend of egg weight with increasing protein levels (65.95 g at 18%, 66.23 g at 20%, 69.67 g at 22%), though these are statistically similar. Eggs from layers fed reference diet (18% CP and 0.5% methionine) have significantly lighter weight.

With 0.30% methionine supplementation, egg weights are more heavy (68.84 g) as compared to no methionine and 0.15% methionine (66.26 g and 66.15 g, respectively). These results indicate that increasing the protein or methionine content of the diet causes a corresponding increase in egg weight, presumably caused by an increase deposition of protein in the egg. While there was no improvement in egg production rate due to higher CP or methionine level, the effects were more apparent on the egg contents, as reflected by the significant increase in egg weight at higher level of protein or methionine supplementation.

These results imply that the production of jumbo or extra large egg classifications was observed more at 20% CP and 22% CP diets which might partially compensate for the observed decrease in egg production rate and average feed cost per dozen egg produced.

Egg mass equivalent (EME) is the product of the production rate and the mean egg weight in grams. On a weekly basis, highly significant and better (P<.01) EME was observed among hens fed with 18% CP diet although this is statistically similar to 20% CP and diet control. The methionine levels did not significantly affect EME. (Table 7)

Apparently, the higher EME in 18% CP diet may be attributed to the fact that more eggs were produced per hen and not necessarily because of the improvement in average egg weight as previously stated. This was probably induced by the interaction between CP and methionine. In effect, the higher the production rate the higher egg mass equivalent.

**Table 7. Egg mass equivalent of layers (per hen per day) fed rations with varying levels of dietary protein and methionine (g)**

PROTEIN LEVEL (A)	METHIONINE LEVEL (B)			MEAN (A)**
	0.00	0.15	0.30	
18	30.23 <sup>a</sup>	37.21 <sup>a</sup>	39.06 <sup>a</sup>	35.50 <sup>a</sup>
20	26.28 <sup>a</sup>	31.16 <sup>a</sup>	35.03 <sup>a</sup>	30.82 <sup>a</sup>
22	27.15 <sup>a</sup>	31.57 <sup>a</sup>	19.28 <sup>b</sup>	6.00 <sup>b</sup>
Control	30.41 <sup>a</sup>			30.41 <sup>a</sup>
MEAN(B) <sup>ns</sup>	28.52	33.31	31.12	

CV = 28.98%

\*\* = highly significant (P&lt;.010)

ns = not significant

Means with no common letter are significantly different (DMRT)

Egg shell thickness or strength of shell is an egg trait of commercial value. Results showed that the crude protein and methionine levels, as well as the combinations, significantly (P<.01) affected the marked change in shell thickness. Thinner egg shell (P<.01) were observed among hens fed with 18 and 22% CP at 0.307 mm and 0.317 mm, respectively. Methionine level of 0.30% had a shell thickness of 0.309 mm. Interaction effect showed thinner egg shell at 22% CP and 0.30% methionine at 0.288 mm.

Comparative economic efficiency of the dietary formulations based on protein and methionine level is evaluated in terms of feed cost per dozen eggs produced. Table 8 present the weekly feed cost per dozen egg. Significantly (P<.01) higher feed cost per dozen was incurred in birds fed with 22% CP diet (PhP47.49), control (PhP43.35), 20% CP (PhP36.16). Increasing the protein level from 18% to 22% tended to significantly increase feed cost, less cost being at 18% CP and highest at 22% CP. This is expected on account of the higher cost of protein supplement at higher levels of protein.

**Table 8. Average weekly feed cost per dozen egg of layers fed rations with varying levels of protein and methionine (PhP)**

PROTEIN LEVEL (A)	METHIONINE LEVEL (B)			MEAN (A)**
	0.00	0.15	0.30	
18	41.82 <sup>a</sup>	31.16 <sup>b</sup>	35.49 <sup>a</sup>	36.16 <sup>b</sup>
20	47.81 <sup>a</sup>	38.21 <sup>a</sup>	33.48 <sup>a</sup>	39.83 <sup>a</sup>
22	51.48 <sup>a</sup>	41.96 <sup>a</sup>	49.02 <sup>a</sup>	47.49 <sup>a</sup>
Control	43.35 <sup>a</sup>			43.35 <sup>a</sup>
MEAN(B)**	46.12 <sup>a</sup>	67.11 <sup>b</sup>	39.33 <sup>b</sup>	

CV = 27.60%

\*\* = highly significant (P&lt;.010)

ns = not significant

Means with no common letter are significantly different (DMRT)

Highly significant (P<.01) trend occurred with reference to added methionine in the diets. There were differences between 0.00, 0.15 and 0.30% at PhP46.12, PhP67.11 and PhP39.33, respectively. The increased feed cost per dozen eggs at these levels is attributed to the lower dozen egg produced, higher feed consumption, higher levels of protein in the diet and higher concentration of synthetic methionine in ration.

Table 9 presents the average income over feed cost (IOFC) as influenced by the dietary treatments.

**Table 9. Average total income over feed cost of layers fed rations with varying levels of protein and methionine (PhP)**

PROTEIN LEVEL (A)	METHIONINE LEVEL (B)			MEAN (A)
	0.00	0.15	0.30	
18	-1.49	10.84	6.51	5.29
20	-5.81	3.79	8.52	2.17
22	-4.48	9.33	-104.32	-34.39
Control	-7.35			-7.35
MEAN(B)	-5.78	7.98	-29.52	

Positive income over feed cost were observed in diets with 18%, 20% CP at PhP 5.29 and PhP 2.17, respectively, while the control and 22% CP diets have negative income of PhP -34.49 and PhP -7.35 respectively. With the methionine levels, only supplementation at 0.15% result in positive income of PhP 7.98 while those on diet with no methionine and with 0.30% registered a loss of PhP 5.78 and PhP 29.52.

The above observations suggests that optimum profit above feed cost is attainable with layer rations containing 18% CP and 20% CP and 0.15% methionine.

For the interaction, diets with 18% CP and 0.15% methionine, as well as that of 0.20%; 20% CP at 0.15 and 0.30% methionine and 22% CP with 15% methionine, registered income of PhP 10.84, PhP 6.51, PhP 3.79, PhP 8.52 and PhP 9.33, respectively. The rest registered losses.

## **Summary, Conclusions and Recommendation**

### *Summary*

Ninety two-and-a half year old Single Comb (S.C.) White Leghorn (Lohmann) strain already at two years laying at the rate of 32.55% were subjected to feeding experiment to compare the effects of dietary (18, 20 and 22%) and added methionine (0.00, 0.15 and 0.30) on the performance of layers over a 12-week period. All treatments with three replications were arranged in a 3 x 3 factorial experiment in completely randomized design. The results are summarized as follows:

1. Significant differences were observed ( $P < .01$ ) in feed intake among the levels of protein in the diet. Layers fed diet with 18% CP consumed greater amount of feed at 108.04 g per layer per day while layers fed 22% CP diet consumed lesser feed at 104.60 g. Non-significant difference was noted in the feed intake of birds receiving feed without and within two levels of DL-methionine including those fed commercial mash.
2. Average weekly egg production was significantly ( $P < .01$ ) higher at 18% CP and the interaction effect of CP and methionine levels. There were no differences among the levels of methionine in the diets.
3. There was significantly ( $P < .01$ ) higher FCE among the layers fed with 18% CP at 2.67 kg, while the lowest FCE was noted in layers fed with 22% CP at 5.12 kg. Significantly higher was noted in the levels of methionine in the diet.
4. Highly significant ( $P < .01$ ) differences was observed among the treatment combination of CP levels with 18% performing best. Methionine levels for the diet did not affect significantly egg production. Interaction effect showed significant differences ( $P < .01$ ) higher egg production at 18% CP and 0.30% methionine.
5. Culling rate was observed to be higher at 22% CP and 0.30% methionine. Mortality showed highly significant ( $P < .01$ ) differences among the layers fed with 18% CP. Non significant differences was noted in the methionine levels and interaction effect of CP and methionine.

6. There was marked variation ( $P < .01$ ) in egg weights in the different treatment groups to protein and methionine levels and the interaction between protein and methionine. There was an increased weight of eggs with increasing protein levels and reference diet had significantly lighter eggs. At 22% CP and 0.30% methionine treatment combination resulted to heaviest egg weights.

7. Classification of egg size obtained more in highest level of CP and the level of methionine in the diet.

8. Highly significant and better ( $P < .01$ ) EME was observed among layers fed with 18% CP. The 22% CP diets, however, had a significantly lower EME. Interaction of 22% CP and 0.30% methionine resulted in a significantly lower EME.

9. Thinner eggshell ( $P < .01$ ) were observed among layers fed with 18 and 22% CP, .030% methionine, 18% CP and 0.15% methionine, 22% CP and 0.30% methionine.

10. Significantly ( $P < .01$ ) higher feed cost per dozen was measured in birds fed 22% CP diet (PhP 47.49) and the lower feed cost was obtained significantly ( $P < .010$ ) in birds with 18% CP (PhP 36.16).

11. Positive income over feed cost was observed in diet with 18 and 20% CP while the control and 22% CP have negative income. Interaction effect on positive control were observed at 18% CP and 0.15% methionine and 22% CP and 0.15% methionine.

### *Conclusion and Recommendation*

Under the conditions of this study, the overall results indicate the optimum egg production rate of old culled layers could be obtained through dietary manipulations as compared to the reference diet. Feeding higher CP or methionine supplemented rations, however, increased feed cost and decreases IOFC or the profitability of layer rations.

Higher protein level of 22% tended to increase egg size but thinner eggshell of poor quality. It is recommended, therefore, that a series of study in nutritional requirements in energy (ME) and protein as well as amino acids and protein supplementation be conducted to determine the best level of ratio to improve eggshell quality to decrease breakage and improve income in the egg industry.

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