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# DEHYDRATED POULTRY WASTE AND UREA AS FEED SUPPLEMENTS IN LAYER RATIONS[1]

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**Abstract** – A total of 450 Single Comb White Leghorn pullets were used in a 224-day experiment in which 5 diets were tested. Dried poultry waste (DPW) was fed to two groups at 5 and 10% of the diet. A third group received feed grade urea equivalent to 5% protein nitrogen, while a fourth group was a low protein diet (11%) supplemented with lysine and methionine. The fifth group served as control with 16% protein. All diets were isocaloric and isonitrogenous with the exception of the low protein diet. Egg production of birds receiving 5 and 10% DPW was not different from those receiving a standard corn–soybean type ration. Rations supplemented with 2% urea caused a 20% drop in egg production as compared to the control, whereas the low protein diet supplemented with lysine and methionine decreased egg production by about 10%. DPW addition did not affect egg weight, whereas the urea supplemented diet and the low protein diet both depressed egg weight significantly. DPW addition had no effect on feed efficiency, while urea supplementation depressed feed efficiency significantly. DPW-supplemented diets produced significantly deeper colored yolks than that of the control. No significant differences in the overall acceptability of boiled eggs were observed from feeding DPW at 5 or 10% levels.

## INTRODUCTION

The intentional inclusion of poultry waste in the diet of poultry as a feed ingredient is a relatively new idea. Interest in the use of DPW has developed because the energy yielding components of modern, high energy, poultry rations were digested and metabolized only to the extent of 70–80% [19]. Most of the early work on the use of DPW in laying hen rations has been conducted at Michigan State University [4–6]. Most of these studies indicated that including DPW in layer rations at relatively low levels (10–15%) had no adverse effects on performance as long as the low energy content of the product is corrected. Nesheim [10], Young [18] and Young and Nesheim [19] conducted several studies on DPW collected from hens housed in cages. These workers concluded that DPW was a low energy, low protein material, with an apparent utilization of not more than 30% and which could be utilized at levels up to 25% of the total laying diet without affecting egg production.

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Blair and Lee [1] fed laying hens a low protein (11.5%)-diet deficient in essential amino acids, supplemented with amino acids and with 9.6% DPW. The percentage egg production of the groups on these diets were 53.3, 76.5 and 62.8%, respectively. This illustrated that laying hens were able to utilize some of the essential amino acids found in DPW. Rinehart *et al.* [12] reported studies in which laying hens were fed DPW at levels of 7, 14 and 21% of the diet each with 80, 100 and 110% levels of the amino acids required by these birds. It is apparent from this report that laying hens could utilize a portion of the essential amino acids from DPW. Vogt [16], on the other hand, reported that incorporation of 10% DPW in an all mash laying ration significantly decreased egg production and feed conversion without affecting egg weight in 3 different laying tests.

The objective of this study was to evaluate DPW as a feed supplement at 5 and 10% levels in a layer ration, 2% urea as a supplement in a low protein layer ration and a low protein layer ration supplemented with methionine and lysine.

Table 1. Composition of experimental diets

| Ingredients, % | Positive control | 10% DPW | 5% DPW | 2% Urea | Negative control |
|---|---|---|---|---|---|
| Yellow corn | 63.05 | 64.55 | 63.90 | 64.40 | 60.40 |
| Barley | 5.95 | – | 2.80 | 15.10 | 21.00 |
| Soybean meal, 50% protein | 17.00 | 13.00 | 15.00 | 3.50 | 3.50 |
| Poultry byproduct meal*, 70% protein | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Animal fat | 1.00 | 2.00 | 1.50 | 2.00 | 2.00 |
| Limestone | 4.00 | 3.55 | 4.00 | 4.35 | 4.45 |
| Bonemeal | 5.30 | 3.20 | 4.10 | 4.37 | 4.70 |
| Vitamin and trace mineral mixture† | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 |
| Salt | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 |
| DL-methionine | 0.10 | 0.10 | 0.10 | 0.15 | 0.15 |
| L-lysine–HCl | – | – | – | 0.20 | 0.20 |
| Dehydrated poultry waste | – | 10.00 | 5.00 | – | – |
| Urea | – | – | – | 2.00 | – |
| *Calculated composition*‡ | | | | | |
| Protein, % | 16.64 | 16.61 | 16.61 | 10.88 | 11.09 |
| ME, kCal/kg | 2900 | 2900 | 2900 | 2900 | 2900 |
| Calcium, % | 3.03 | 3.03 | 3.13 | 3.00 | 3.03 |
| Phosphorus, % | 0.70 | 0.76 | 0.77 | 0.72 | 0.72 |
| Lysine, % | 0.79 | 0.70 | 0.71 | 0.56 | 0.57 |
| Methionine, % | 0.39 | 0.36 | 0.37 | 0.34 | 0.34 |
| Cystine, % | 0.28 | 0.27 | 0.28 | 0.19 | 0.20 |
| Linoleic acid, % | 1.41 | 1.36 | 1.35 | 1.44 | 1.41 |
| Xanthophylls, mg/kg | 15.76 | 16.14 | 15.98 | 16.10 | 15.13 |

*This is a local product composed of blood, feathers and viscera, excluding head and legs.

†Vitamin and trace mineral mixture supplied the following (per kg of ration) according to specifications of manufacturer: vitamin A, 8000 i.u.; vitamin $D_3$, 1500 i.c.u; vitamin E, 4 mg; vitamin $K_3$, 2 mg; riboflavin, 2 mg; pantothenic acid, 3 mg; nicotinic acid, 27 mg; vitamin $B_{12}$, 10 mcg; vitamin C, 8 mg; Fe, 12 mg; Mn, 20 mg; Cu, 2 mg; I, 3 mg; Zn, 8 mg; BHT, 50 mg.

‡Feedstuffs analysis values taken from Scott *et al.* [14].

## MATERIALS AND METHODS

The pullets used were commercial strains of Single Comb White Leghorns used in Lebanon. At 22 weeks of age, the birds were randomized into 15 groups of 30 birds per group and housed in floor pens. Each of the 5 diets shown in Table 1 was fed to 3 pens. Replicate means of egg production, feed consumption and feed efficiency were calculated on a hen day basis of 28-day periods. All birds were individually weighed at the beginning and end of the experiment for the calculation of weight gains. A 14-hr light period was used throughout the experiment.

All the experimental diets were isocaloric and isonitrogenous except the negative control which was low in total nitrogen. One diet was supplemented with 2% feed grade urea to supply nitrogen equivalent to 5% dietary protein. The L-lysine and DL-methionine supplementations were made to achieve the NRC [9] recommended level of these amino acids. The composition of the DPW used is shown in Table 2. The excreta for dehydration were obtained from 1 yr old layers housed in cages and fed a standard layer ration.

Table 2. Composition of dehydrated poultry waste

| Item | Composition* |
|---|---|
| Moisture, % | 7.58 |
| Protein, % | 24.55 |
| Crude fiber, % | 12.77 |
| Calcium, % | 7.23 |
| Phosphorus, % | 2.47 |
| Ether extract, % | 1.85 |
| Ash, % | 25.20 |
| Gross energy, kCal/kg DM | 3640 |

*Values are averages of 3 samples.

Egg weight, interior quality and shell thickness measurements were made for 3 consecutive days every 28-day period. Eggs produced from all treatment groups were collected and stored overnight before measurements were taken on them the next day. Egg yolk color was measured by visual comparison with the color Roche fan. Shell thickness was measured with a paper micrometer gauge. A total of 6 weekly organoleptic triangular taste panel tests were organized on boiled eggs of the type proposed by Roessler *et al.* [13]. Tests were conducted 4 months after feeding the experimental diets. The panelists were requested to taste the samples and score different traits: color, odor, flavor and overall acceptability. The scoring scale ranged from 0 to 9. The scale was as follows: extremely disliked, 0–1; moderately disliked, 2–3; not disliked, 4–5; moderately liked, 6–7; extremely liked, 8–9. Data were subjected to analysis of variance according to Snedecor and Cochran [15]. Mean differences were tested by Duncan's [2] multiple range test.

## RESULTS AND DISCUSSION

The overall means for all dietary treatments on egg production, egg weight, feed consumption, feed efficiency, initial average body weight per bird, weight gain per bird and mortality percentage are presented in Table 3.

Egg production of birds receiving 5 and 10% DPW was similar to those receiving the positive control ration. Birds receiving 2% urea gave the lowest egg production rate. These findings are similar to the report of Flegal and Zindel [6] and Flegal and Dorn [4] who reported that egg production was not adversely affected by DPW supplementation at 12.5% level of the diet. In fact, according to Quisenberry and Bradley [11] DPW supplementation can be made at the rate of 10–20% of the diet without any adverse effect on production. The fact that 2% urea depressed egg production significantly indicates that there was no nitrogen utilization from urea as the supplemented low protein diet gave higher egg production. This finding is confirmed by the work of Kazemi and Balloun [7] who reported a non-significant effect of urea supplementation on egg production. In contrast, Michie [8] reported that 20% of the protein of layer rations can be replaced by urea without a deleterious effect on egg production. The negative effect of urea in this study may be due to the high level of urea used and the fact that only two of the essential amino acids (metionine and lysine) were added. This is supported by the report of Zenisek and Lautner [20] who supplemented a basal diet with 0.9% urea along with essential amino acids and achieved a 6.9% increase in egg production. Fernandez *et al.* [3] supplemented a 12.5% dietary protein ration with 0.65 and 1.25% urea and a

Table 3. Average egg production, egg weight, feed intake per bird per day, feed consumption per dozen eggs, weight gain and mortality

| Treatments | Egg production (%) | Average egg weight (g) | Feed intake per hen/day (g) | Feed efficiency (kg feed/ dozen eggs) | Weight gain/ bird (g) | Mortality (%) |
|---|---|---|---|---|---|---|
| Positive control | 74.34 A* ±8.49† | 58.52 A ±1.30 | 111 ab ±5 | 2.18 A ±0.50 | 582 A ±22 | 6.67 |
| 10% DPW | 74.94 A ±8.21 | 58.36 A ±1.50 | 119 c ±5 | 2.27 A ±0.50 | 526 A ±40 | 13.33 |
| 5% DPW | 74.45 A ±8.09 | 59.16 A ±1.26 | 115 bc ±5 | 2.22 A ±0.48 | 507 A ±30 | 13.33 |
| 2% urea | 58.74 B ±6.77 | 54.15 B ±1.31 | 109 a ±4 | 2.69 B ±0.59 | 246 B ±19 | 16.67 |
| Negative control | 65.80 B ±6.44 | 54.70 B ±1.20 | 114 bc ±4 | 2.28 A ±0.35 | 294 B ±14 | 16.67 |

*Means in the same column having the same letters are not significantly different; small and capital letters indicate significance at the 0.05 and 0.01 levels, respectively.

†Mean ± S.E.

graded response in egg production was noticed.

Egg weight followed the same trend as egg production with groups receiving 5% DPW giving the highest weights. Several workers have previously reported similar findings [6, 11, 19]. The hens on the urea supplemented diet produced eggs of the lowest weight. This reduction in egg weight due to urea supplementation has also been observed previously by Kazemi and Balloun [7]. The reduced egg weight on the low protein (11.09%) diet was expected as it has been observed by a number of workers, including Fernandez *et al.* [3], that a 13% protein level was insufficient for maintenance of egg size.

Both the 10 and 5% levels of DPW supplementation resulted in higher feed consumption per bird per day than the positive control. The difference between the 10% and positive control was statistically significant. As the DPW supplementation rate increased, there was a direct increase in feed intake, in spite of the fact that the diets were isocaloric and isonitrogenous. Flegal and Dorn [4] have previously reported increased feed consumption with DPW supplementation. It is postulated that the increased feed consumption may be due to the rapid passage rate of ingesta through the intestinal tract. This rapid passage may have been caused by enhanced intestinal mobility resulting from the irritant effects of uric acid content of DPW. Urea supplementation caused a significant reduction in feed consumption as compared to the positive control diet. Kazemi and Balloun [7] also reported a significantly lower feed consumption with urea supplemented than with non-supplemented diets.

Feed efficiency expressed in kg of feed per dozen eggs was significantly poorer in the urea supplemented group than in all other treatments tested. Kazemi and Balloun [7] also reported significantly poor feed efficiency with urea supplemented diets. DPW supplementation did not adversely affect feed efficiency which is in line with previous reports [4, 5].

Body weight gains followed the same trend as egg production and egg weight. Similar results on body weight gain have been reported by Quisenberry and Bradley [11]. Young and Nesheim [19], however, reported adverse effects on weight gain as a result of DPW supplementation. This may have been due to differences in the quality of DPW used and/or level of metabolizable energy per unit of feed. Analysis of variance showed no significant difference in mortality.

The dietary treatment effects on egg-yolk color, Haugh unit score and shell thickness are summarized in Table 4. It is interesting to note that DPW supplemented groups produced darker colored egg yolks than did the control or other treatments. This finding is not in agreement with York *et al.* [17] who found no effect on yolk color even with 30% DPW supplemented diets. The Haugh unit score showed no significant differences between any of the treatments. The 5% DPW supplemented groups resulted in similar shell thickness to that of the control while the 10% DPW group gave thinner shells than the control, although the difference was not statistically significant. This may be due to interference in calcium absorption caused by high intestinal motility resulting from irritant effect of uric acid in the high DPW group. The thicker shelled eggs produced from urea supplemented and low protein diets may be due to the small sized eggs and also significantly lower egg production rate.

It is observed in Table 5 that differences in odor, flavor or overall acceptability were not detected by taste panelists between boiled eggs from DPW fed hens and those receiving a control diet. The color score, however, of boiled eggs from 5% DPW diets was significantly higher than that of eggs from the control or 10% DPW groups. This is further confirmation of the higher yolk color score observed with the 5% DPW group. The similarity in overall acceptability between the DPW supplemented and non-supplemented groups has previously been reported by Flegal and Zindel [6], Flegal *et al.* [5] and Quisenberry and Bradley [11].

Table 4. Effect of DPW and urea on interior egg quality and egg-shell thickness

| Treatment | Egg yolk color, Roche color fan | Haugh units | Egg shell thickness |
|---|---|---|---|
| Positive control | 7.38 a* ±0.09† | 88.03 ±0.81 | 0.348 ab ±0.004 |
| 10% DPW | 7.59 b ±0.06 | 87.97 ±0.80 | 0.345 a ±0.004 |
| 5% DPW | 7.66 b ±0.08 | 87.65 ±0.94 | 0.349 b ±0.004 |
| 2% urea | 7.50 ab ±0.08 | 88.77 ±0.79 | 0.355 c ±0.032 |
| Negative control | 7.36 a ±0.12 | 87.97 ±0.57 | 0.350 b ±0.004 |

*Means in the same column having the same letters are not significantly different at the 0.05 level.

†Mean ± S.E.

Table 5. Effect of DPW on organoleptic value of boiled eggs

| Treatment | No. of taste panellists | Color | Odor | Flavor | Overall |
|---|---|---|---|---|---|
| | 58* | 6.34±0.17‡ A§ | 5.67±0.14 | 6.21±0.52 | 6.13±0.17 |
| Positive control | 8† | 6.54 | 5.80 | 6.36 | 6.37 |
| | 58 | 6.07±0.20 A | 5.96±0.49 | 6.19±0.97 | 6.20±0.39 |
| 10% DPW | 8 | 6.37 | 6.17 | 6.10 | 6.12 |
| | 58 | 6.58±0.35 B | 6.22±0.33 | 5.96±0.20 | 5.87±0.24 |
| 5% DPW | 8 | 6.60 | 6.12 | 6.00 | 6.10 |

*Total taste-panellists participated in 6 organoleptic tests.

†Regular participants.

‡Mean ± S.E.

§Means having the same letters are not significantly different at the 0.01 level.

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