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RENDERED WHOLE-BIRD LAYER MORTALITY AS AN INGREDIENT IN LAYER DIETS

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SUMMARY

In an effort to gather information about an environmentally acceptable alternative for mortality disposal and utilization, we explored the nutritional acceptability of a rendered product in the diets of White Leghorn hens. Approximately 2,275 kg of commercial laying hen mortalities were collected and frozen over 3 wk. The whole birds were then rendered at a commercial facility, stabilized, dried, and sampled for analysis. Two experiments, each 84 d long, were completed using 0,2.5,5.0,7.5, or 10% of the rendered product in the diet. With the exception of lowered egg weights, rendered layer mortality (RLM) supported comparable or superior performance to controls when used at dietary levels up to 10%.

2001 J. Appl. Poult. Res. 10:371-375

DESCRIPTION OF PROBLEM

Mortality disposal is a never-ending chore for the poultry industry, but because it is accomplished daily, the magnitude of the problem may not fully be realized. For example, the US has an average annual inventory of 320 million laying hens. If one assumes 6% mortality and a body weight of 1,500 g, yearly losses would amount to 19.2 million hens weighing 28.8 million kg.

Disposal of normal mortality from broiler and layer operations has been the subject of evolving technology over the years. Burial has been the method of choice because of its convenience and low cost. But, as pointed out in a review paper by Blake and Donald [1], burial and incineration invoke environmental concerns that are making them less acceptable. Predators, weather, and groundwater contamination are problems with the burial method. Incineration is slow and expensive and has generated a lot of nuisance complaints. Composting was described by Blake and Donald [1] as an environmentally sound, relatively inexpensive disposal method that has gained widespread acceptance. However, it results in more, low-value "manure-type" material that requires land spreading. Extrusion has also been looked at as a means of disposing of both mortality and spent hens by Haque et al. [2]. During processing the whole birds were ground and incorporated into a corn-soybean diet, which was then passed through the extruder. The authors reported considerable variation in dry matter, crude protein, and fat analyses but demonstrated satisfactory performance while using the meal in 21-d broiler chick trials.

Rendering is one of the best means for converting carcasses of on-farm mortality into a valuable, biologically safe protein byproduct meal according to Blake and Donald [1]. They pointed out that perhaps the greatest benefit of rendering is the removal of carcasses from the farm and elimination of environmental pollution related to other methods of disposal. Zimmerman [3] discussed the handling of broiler mortality by freezing and subsequent hauling to a rendering plant. Pilot work with layer mortality rendering at the University of Florida [4] found an average yield of 36.1% before fat removal and a moisture-adjusted protein level very close to that of poultry byproduct meal. Christmas et. al. [5] fed levels up to 12% RLM in two full-term broiler studies and concluded that the product was acceptable and highly utilizable as a protein and nutrient substitute in commercial broiler diets.

The emphasis for this work was to explore rendering as a method of whole-bird mortality disposal and utilization.

MATERIALS AND METHODS

Our research effort began by arranging with a major Florida egg producer to collect and freeze mortalities that were later transported to northern Georgia for processing in a batch cooker. The details of that process are provided in a paper by Christmas et al. [5]. Immediately after processing and cooling, samples were taken for nutrient analysis and pathogen screening. The nutrient analysis of the resulting product is shown in Table 1.

Two feeding experiments were conducted with egg-type Hy-Line W-36® hens. Each study was 84 d long. In the first experiment, six replicate pens of five individually caged (25.6 x 46.2 cm) hens received each dietary treatment from 48 wk of age, and eight replicate groups (43 wk old) were assigned in the second study. Dietary treatments consisted of 0, 2.5, 5.0, 7.5, or 10% RLM replacing portions of other ingredients. Corn-soybean diets were used, and all were formulated using linear programming to contain equal levels of metabolizable energy, calcium, available phosphorus, sodium, and sulfur amino acids. Other nutrient values were above NRC [6] suggested requirements. It was necessary to allow protein and related nutrients to range upward to use a practical-type diet and test RLM at the higher levels. The same batches of corn and soybean meal were used in both experiments. The composition of these diets is shown in Table 2. Feed and water were supplied ad libitum throughout the studies.

Individual egg production was recorded daily, and pen-average egg weights and specific gravity were determined on 3 d of egg production each week. Specific gravity was determined by passing eggs through a graded series of 10 sodium chloride solutions (0.005 increments), progressing from lowest to highest concentrations. Feed consumption of each pen was measured on 3 different d at 28-d intervals for calculation of daily feed intake and feed conversion. Haugh units were measured every 28 d on 2 consecutive d of egg collection. Body weight changes were evaluated by individual weights taken at the beginning and end of each experiment.

Data were statistically analyzed using analysis of variance, and, when significant treatment differences were identified, Duncan's multiple range test procedures were used to further separate treatment means [7]. Treatments and blocks were the main effects, and all statements of significance were based on $P < 0.05$.

TABLE 1. Nutrient analysis of rendered layer mortality

NUTRIENT	PERCENTAGE
Protein	55.73
Moisture	10.12
Fat	22.9
Fiber	0.41
Methionine	1.04
Methionine + cystine	2.09
Lysine	3.15
Arginine	3.51
Tryptophan	0.28
Histidine	1.06
Threonine	2.03
Calcium	3.73
Phosphorus	1.47
Sodium	0.47
Chloride	0.54
Metabolizable energy,A kcal/kg	3,529

[A]Energy estimated using high-fat prediction equation: MEn = 31.02 x CP + 78.87 ether extract (NRC, [6]).

TABLE 2. Composition and calculated analysis of diets

	RENDERED LAYER MORTALITY (%)				
	Control	2.5	5.0	7.5	10.0
	(%)				
Ingredient					
Yellow corn	63.29	65.12	66.94	66.50	63.59
Soybean meal, 48.5%	23.63	20.45	17.28	16.09	17.05
Ground limestone	8.88	8.75	8.63	8.49	8.36
Dicalcium phosphate	0.95	0.78	0.61	0.43	0.24
Salt	0.38	.35	0.32	0.29	0.26
Microingredients[1]	0.50	0.50	0.50	0.50	0.50
Corn Oil	2.25	1.44	0.63	0.14	-
DL-Methionine	0.12	0.11	0.09	0.06	0.01
Rendered layer mortality	-	2.50	5.00	7.50	10.0

Table 2 continued

Calculated Analysis[2]					
Protein	16.90	16.60	16.90	17.66	19.25
Fat	4.89	4.69	4.49	4.55	4.88
Fiber	2.31	2.24	2.17	2.12	2.10
ME, kcal/kg	2,900	2,900	2,900	2,900	2,900
Calcium	3.66	3.66	3.66	3.66	3.66
Total phosphorus	0.50	0.49	0.48	0.48	0.48
Available phosphorus	0.28	0.28	0.28	0.28	0.28
Sodium	0.17	0.17	0.17	0.17	0.17
Chloride	0.27	0.26	0.26	0.25	0.25
Arginine	1.06	1.05	1.03	1.08	1.19
Lysine	0.86	0.85	0.84	0.89	0.98
Methionine	0.39	0.39	0.38	0.37	0.34
Methionine + cystine	0.68	0.68	0.68	0.68	0.68
Tryptophan	0.21	0.20	0.18	0.18	0.19
Threonine	0.63	0.62	0.62	0.65	0.71
Xanthophyll, mg/kg	13.93	14.32	14.74	14.63	13.99

[1]Provided the following vitamin and trace mineral activities per kilogram of diet: vitamin A, 6,600 IU; cholecalciferol, 2,200 ICU; menadione dimethylpyrimidinol bisulfite, 2.2 mg; riboflavin, 4.4 mg; pantothenic acid, 13.2 mg; niacin, 39.6 mg; choline chloride, 499.4 mg; vitamin B_{12}, 22 μg; ethoxyquin, 0.0125%; manganese, 60 mg; iron, 50 mg; copper, 6 mg; cobalt, 0.198 mg; zinc, 35 mg; iodine, 1.1 mg; selenium, 0.1 mg. [2]Based on analytical values from Table 1 and NRC [6].

TABLE 3. Average performance of White hens (48 to 60 wk of age) fed rendered layer mortality for 84 d, Experiment 1.

Rendered Layer Mortality (%)	Hen-day Egg Production (%)	Daily Feed (g)	Feed Conversion (kg/doz.)	Egg Weight (g)	Specific Gravity	Haugh Units	Body Weight Change (g)
0	75.40^{c}	95.4	1.53^{a}	66.80^{a}	1.0777^{c}	77.72	44.7^{b}
2.5	77.94^{bc}	97.3	1.50^{a}	66.7^{a}	1.0785^{b}	79.05	70.0^{ab}
5.0	80.20^{ab}	98.1	1.47^{a}	65.8^{b}	1.0783^{b}	79.61	106.5^{ab}
7.5	79.53^{b}	97.4	1.52^{a}	65.6^{b}	1.0792^{a}	78.17	127.8^{a}
10.0	82.70^{a}	94.0	1.37^{b}	62.5^{c}	1.0775^{c}	79.74	88.8^{ab}
SEM	1.49	1.60	0.033	0.35	0.0004	0.83	17.3

$^{a-c}$Means within a column with no common superscript differ significantly ($P \leq 0.05$).

Table 4. Average performance of White Leghorn layers (43-55 wk of age) fed rendered layer mortality for 84 d, Experiment 2

Rendered Layer Mortality (%)	Hen-Day Egg Production (%)	Daily Feed (g)	Feed Conversion (kg/doz.)	Egg Weight (g)	Specific Gravity	Haugh Units	Body Weight Change (g)
0	86.30	102.3	1.44	63.6	1.0802	72.72	79.4
2.5	85.00	96.8	1.35	62.6	1.0812	74.68	80.4
5.0	84.18	99.2	1.42	62.9	1.0809	74.90	83.20
7.5	87.13	99.8	1.38	62.6	1.0805	73.82	81.90
10.0	86.24	100.6	1.40	62.1	1.0816	74.46	69.1
SEM	1.07	1.34	0.015	0.30	0.0005	0.55	23.7

[a-d]Means within a column with no common superscript differ significantly ($P \leq 0.05$).

RESULTS AND DISCUSSION

No bacterial pathogens, including *Salmonella* species, were found during screening of after-rendered samples conducted by the Florida Diagnostic Laboratory [8]. Virology, as determined by chick embryo inoculations, was negative for virus isolation. Chick embryo inoculations were also negative for the presence of *Chlamydia.*

In Experiment 1, egg production was significantly improved by addition of 5% or more RLM (Table 3). Daily feed intake was not altered by RLM inclusion in the diet. On the other hand, feed conversion at the 10% supplementation was better than that of control and other levels of RLM because of enhanced egg production. Five percent or more of the product was associated with reduced egg weights. Eggshell quality was improved for the 2.5 through 7.5% levels, and the 10% treatment was equivalent to the controls. Haugh unit measurements of interior egg quality were not influenced by treatment. Body weight change over the experimental period was significantly higher for only the 7.5% treatment com-pared with the controls; all other levels were unchanged from controls.

In Experiment 2, all levels of egg production were equivalent to controls (Table 4). For unexplained reasons, which are probably not related to treatment, daily feed intake was lower than the control for the 2.5% RLM treatment; however, higher levels were the same as controls. Feed conversion was significantly better than the control for all but the 5% RLM treatment group. Feeding RLM at levels of 2.5, 5.0, and 7.5% resulted in specific gravity values equal to controls, whereas the 10% treatment value was significantly improved. For all but the 7.5% level, Haugh unit scores were significantly improved over controls, and the 7.5% results were fully equivalent to controls. Body weight change was not affected by dietary treatment. Egg weights were lower for all levels of RLM supplementation in Experiment 2. These egg weight results may be the combined effect of a sensitive statistical evaluation because a large sample of eggs was used, and possible lower amino acid availability in the RLM. Douglas et al. [9] and Douglas and Parsons [10] suggested that diets containing substantial amounts of rendered whole hens should be formulated on a digestible amino acids basis because of the findings of lowered amino acid digestibility in rendered spent hen meal. They also reported substantial differences in amino acid digestibility between processing plants.

CONCLUSIONS AND APPLICATIONS

1. Rendered layer mortality substituted into laying hen diets at levels up to 10% supported daily feed intake, egg production, feed conversion, egg specific gravity, Haugh Unit, and body weight values comparable or superior to control performance.
2. Some egg weight reduction occurred in both experiments, possibly related to lower amino acid digestibility in the rendered layer mortality product.
3. It appears that rendered hen mortality can have substantial nutritional potential as a poultry feed ingredient, once the paucity of currently available information concerning laying hen feeding trials is overcome and the cause of rendered egg weights identified.

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ACKNOWLEDGEMENTS

The authors are grateful to Georgia Protein, Cumming, Georgia and Nathan Martin for their assistance in rendering the research material.

The authors express appreciation to Novus International, Inc., St. Louis, Missouri and especially to Andrew Giesen for providing analytical services.