

Utilization of Spent Hen Meal in Diets for Laying Hens¹

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Abstract: Protein supplements produced by rendering of whole hens at the end of their production cycle (spent hen meal) was used to provide a portion of the diets of laying hens in an 84 d feeding trial. Diets were formulated to provide 0, 5, 10, or 15% spent hen meal (SHM) from three different locations using conventional rendering procedures. The diets were formulated to provide digestible amino acids at a minimum of 95% of recommended (NRC, 1994) total amino acids for laying hens consuming 100 g of feed per day. Results of the study indicate that nutritionally valuable high-protein meals can be produced from whole spent hens using conventional rendering procedures. Such meals may be safely used at levels up to 10% in diets for laying hens provided good analytical procedures are followed to determine nutritional content. Due to the high level of residual fat and the highly unsaturated nature of this fat, it will be necessary to insure that adequate amounts of a suitable antioxidant is used during manufacturing to prevent rancidity development.

Key Words: Protein supplements, rendered hen meal, laying hens, spent hens

Introduction

Approximately 250 million hens are produced annually in the United States. Genetic selection for smaller body weights has resulted in lower yields of edible meat, and problems with bone breakage during processing and residual bone fragments in meat from processed hens have combined to make disposal of hens at the end of their laying cycle increasingly difficult. Processing these hens through conventional rendering facilities to produce a product typically described as "spent hen meal" (SHM) offers a means of disposal while providing a valuable feed ingredient (Christmas *et al.*, 1996; Kersey *et al.*, 1997; Douglas *et al.*, 1997). Previous studies from this laboratory have demonstrated that SHM from commercial rendering facilities can be effectively utilized at levels up to 10% in diets for growing broilers provided adjustments are made in nutrient content and amino acid digestibility (Kersey and Waldroup, 1998). The objective of the present study was to evaluate SHM produced at three different locations as a component of diets for laying hens.

Materials and Methods

Spent hen meals were produced in conventional rendering plants in three separate locations (Bastrop TX; Tulsa OK; Omaha NE) using proprietary procedures. All products were stabilized with ethoxyquin during processing. The meals contained 65 to 70% CP, 8.8 to 11.2% fat, 3.3 to 4.8% Ca, and 1.9 to 2.1% total P. Kersey *et al.* (1997) reported nutrient composition values and amino acid digestibility of the three SHM products. Nutrient composition and amino acid digestibility coefficients of corn and soybean meal were obtained from NRC (1994).

Diets were formulated by linear programming to contain 0, 5, 10, or 15% of the three different meals. The diets were formulated with digestible amino acid requirements set at a minimum of 95% of the total amino acid needs of egg-type hens consuming 100 g of feed daily suggested by NRC (1994). All diets were fortified with complete vitamin and trace mineral mixes obtained from a commercial poultry company. Composition of the diets containing the highest levels of SHM and the positive control diet with no SHM are shown in Table 1. Digestible Isoleucine was at minimum levels in all diets; digestible TSAA was at minimum levels in all but one diet. Diets were mixed on biweekly intervals

and fed in meal form.

Laying hens of a commercial strain of SCWL² were placed on test diets at 26 week of age. Six replicate groups of 12 individually caged hens (30.48 x 45.72 cm) were fed each of the test diets for three 28-d periods. A minimum of 14 hr light was provided with incandescent lamps supplementing natural sunlight.

All diets were analyzed for crude protein, calcium, phosphorus, and sodium content (AOAC, 1990). Fat extracted from samples of the SHM were subjected to analysis for Initial Peroxide Value and accelerated rancidity using the Active Oxygen Method by a laboratory specializing in these procedures³. Daily records of egg production and mortality were maintained to calculate hen-day egg production. At the end of each 28 d test period feed consumption was determined and a three d sample of eggs was collected. After overnight storage in a refrigerated cooler, egg weights, shell thickness, and Haugh Units were determined.

Pen means over the 84 d test period were subjected to ANOVA suitable for a factorial arrangement of treatments with source of SHM and level of SHM as main effects along with the interaction of source and level (SAS Institute, 1991). The performance of the hens fed the diet without SHM was not included in the factorial arrangement and used as a benchmark to verify that performance of hens fed the diets with SHM reached a satisfactory level. Significant differences among or between treatment means were separating using multiple t tests derived using the lsmeans option of SAS. Statements of probability are based on P # 0.05.

Results and Discussion

Both source and level of SHM had a significant effect on rate of egg production, with a significant interaction of source and level of SHM (Table 2). Overall, egg production of hens fed the Omaha meal was significantly lower than that of hens fed the meals from Bastrop or Tulsa. Hens fed diets with 10 or 15% SHM produced significantly fewer eggs than those fed diets with 5% SHM; this was due primarily to reduction in production from hens fed the meals from Omaha and Bastrop as production from hens fed meal from Tulsa remained constant over all levels of inclusion.

The cause of this reduction in performance is not clear, as analysis of the diets indicated that the levels of nutrients in the

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²Hy-Line W-36. Hy-Line International, West Des Moines IA 50266

³Novus International, Inc., St. Charles MO 63304

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Table 1: Composition (g/kg) and calculated nutrient content of laying hen diets with different sources of spent hen meal

Ingredient	Control Diet	Bastrop meal	Tulsa meal	Omaha meal
Bastrop meal	0.00	150.00	0.00	0.00
Tulsa meal	0.00	0.00	150.00	0.00
Omaha meal	0.00	0.00	0.00	150.00
Yellow corn	633.29	661.26	703.25	674.03
Soybean meal (47.5%)	220.04	91.94	51.36	84.74
Dicalcium phosphate	13.59	0.00	0.00	0.00
Ground limestone	94.52	89.80	88.30	84.19
Poultry oil	30.56	0.00	0.00	0.00
Iodized salt	4.00	4.00	4.00	4.00
DL-Methionine (99%)	1.00	0.00	0.09	0.04
Vitamin premix ¹	2.00	2.00	2.00	2.00
Trace mineral mix ²	1.00	1.00	1.00	1.00
	1000.00	1000.00	1000.00	1000.00
Nutrient analysis ²				
ME, Kcal/kg	2900.00	2900.00	2900.00	2900.00
Crude protein, %	16.27	19.90	18.87	19.38
Crude protein, % (A)	16.96	19.43	18.06	19.13
Calcium, %	4.00	4.00	4.00	4.00
Calcium, % (A)	4.05	4.27	4.12	4.08
Phosphorus, %	0.56	0.53	0.54	0.58
Phosphorus, % (A)	0.53	0.53	0.48	0.54
Nonphytate P, %	0.35	0.36	0.38	0.41
Methionine, %	0.36	0.34	0.35	0.35
Lysine, %	0.85	1.00	0.91	0.96
Isoleucine, %	0.67	0.71	0.71	0.74
TSAA, %	0.64	0.71	0.70	0.71
Digestible Met, %	0.34	0.30	0.30	0.31
Digestible Lys, %	0.76	0.86	0.73	0.77
Digestible Ile, %	0.62	0.62	0.62	0.62
Digestible TSAA, %	0.55	0.57	0.55	0.55

¹Provides per kg of diet: vitamin A (from vitamin A acetate) 7714 IU; cholecalciferol 2204 IU; vitamin E (from dl-alpha-tocopheryl acetate) 16.53 IU; vitamin B₁₂ 0.013 mg; riboflavin 6.6 mg; niacin 39 mg; pantothenic acid 10 mg; menadione (from menadione dimethylpyrimidinol) 1.5 mg; folic acid 0.9 mg; thiamin (from thiamin mononitrate) 1.54 mg; pyridoxine (from pyridoxine HCl) 2.76 mg; d-biotin 0.066 mg; ethoxyquin 125 mg; Se 0.1 mg.

²Provides per kg of diet: Mn (from MnSO₄•H₂O) 100 mg; Zn (from ZnSO₄•7H₂O) 100 mg; Fe (from FeSO₄•7H₂O) 50 mg; Cu (from CuSO₄•5H₂O) 10 mg; I from Ca(IO₃)₂•H₂O, 1 mg.

³Calculated unless noted; A = analyzed value.

diets were in good agreement with calculated values (Table 1). Analysis of fat extracted from the meals indicated higher Initial Peroxide Value (IPV) for the Omaha meal (2.8 meq/kg fat) compared to the Tulsa and Bastrop meals (0.4 and 1.2 meq/kg, respectively). In addition the fat extracted from the Omaha meals showed higher peroxide values during accelerated rancidity testing by the Active Oxygen method (12.2 and 38.0 meq/kg at 4 and 24 hr, respectively) compared to the Tulsa (0.6 and 1.0 meq/kg) and Bastrop meals (3.6 and 8.6 meq/kg). Although all samples of meals had been treated with ethoxyquin during processing, the processors did not note the amounts used. The meals were rather high in residual fat (8.8 to 11.2%; Kersey *et al.*, 1997) and poultry fat has a high degree of unsaturation (Waldroup and England, 1995). Thus, it is possible that oxidative or hydrolytic rancidity may have induced the lower rate of egg production noted in the hens fed the Omaha meals.

Neither source nor level of SHM had any significant effect on daily feed intake (Table 3); however there was a reduction in feed intake as overall levels of SHM increased. There was no indication of any effect of source or level of SHM on feed required to produce an egg (Table 4).

Mean egg weight was significantly affected by source of SHM and by an interaction between source and level of meal (Table 5). Mean egg weight from hens fed the SHM from Tulsa was

Table 2: Effect of source and level of spent hen meal in diets formulated to provide adequate levels of digestible amino acids on percent hen-day production of laying hens (84 day study)

Source of meal	Inclusion rate of spent hen meal (%)			
	5	10	15	Mean
Tulsa	84.7 ^{abc}	84.7 ^{abc}	84.8 ^{abc}	84.8 ^r
Omaha	85.4 ^{ab}	80.1 ^d	75.8 ^a	80.4 ^s
Bastrop	86.5 ^a	82.8 ^{bcd}	81.4 ^{cd}	83.5 ^r
Mean	85.5 ^x	82.5 ^y	80.7 ^y	
Positive control =	83.8			
Source of variance	Prob > F			SEM
Source of meal	0.006			0.8
Level of meal	0.0001			0.8
Source x Level	0.017			1.3

^{abcde, rs, xy}Within comparisons, means with common superscripts do not differ significantly.

significantly lower than that of hens fed meals from Bastrop; weight of eggs from hens fed the SHM from Omaha was intermediate. There was a decline in egg weight from hens fed the meal from Tulsa as the amount of meal in the diet increased;

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Table 3: Effect of source and level of spent hen meal in diets formulated to provide adequate levels of digestible amino acids on daily feed intake (g/hen/d) of laying hens (84 day study)

Source of meal	Inclusion rate of spent hen meal (%)			
	5	10	15	Mean
Tulsa	94.6	93.5	86.6	91.6
Omaha	94.1	94.9	93.1	94.0
Bastrop	96.4	93.2	92.1	93.9
Mean	95.1	93.8	90.6	
Positive control = 91.8				
Source of variance	Prob > F		SEM	
Source of meal	0.55		1.8	
Level of meal	0.19		1.7	
Source x Level	0.77		2.9	

Table 4: Effect of source and level of spent hen meal in diets formulated to provide adequate levels of digestible amino acids on grams feed consumed per egg produced by laying hens (84 day study)

Source of meal	Inclusion rate of spent hen meal (%)			
	5	10	15	Mean
Tulsa	110.77	116.73	114.25	113.90
Omaha	108.78	114.61	114.37	112.57
Bastrop	113.81	112.96	108.61	110.73
Mean	111.22	113.76	114.13	
Positive control = 109.55				
Source of variance	Prob > F		SEM	
Source of meal	0.43		1.5	
Level of meal	0.48		1.5	
Source x Level	0.47		2.5	

Table 5: Effect of source and level of spent hen meal in diets formulated to provide adequate levels of digestible amino acids on mean egg weight (g) of laying hens (84 day study)

Source of meal	Inclusion rate of spent hen meal (%)			
	5	10	15	Mean
Tulsa	58.9 ^{abc}	58.1 ^{bcd}	57.3 ^d	58.1 ^y
Omaha	58.5 ^{bcd}	60.0 ^a	58.0 ^{cd}	58.8 ^{xy}
Bastrop	59.5 ^{ab}	58.5 ^{bcd}	59.4 ^{ab}	59.1 ^x
Mean	59.0	58.9	58.2	
Positive control = 59.1				
Source of variance	Prob > F		SEM	
Source of meal	0.059		0.3	
Level of meal	0.169		0.3	
Source x Level	0.026		0.5	

^{abcd, xy} Within comparisons, means with common superscripts do not differ significantly.

this was not observed in weight of eggs from hens fed the meal from Omaha or Bastrop. The source and level of SHM in the diet had no adverse effects on interior egg quality as measured by Haugh Units (Table 6) or eggshell thickness (Table 7).

Conclusions: Nutritionally valuable high-protein meals can be produced from whole spent hens using conventional rendering procedures. Such meals may be safely used at levels up to 10% in diets for laying hens provided good analytical procedures are followed to determine nutritional content. Due to the high level of residual fat and the highly unsaturated nature of this fat, it will be necessary to insure that adequate amounts of a suitable antioxidant is used during manufacturing to prevent rancidity development.

Table 6: Effect of source and level of spent hen meal in diets formulated to provide adequate levels of digestible amino acids on Haugh Units of eggs produced by laying hens (84 day study)

Source of meal	Inclusion rate of spent hen meal (%)			
	5	10	15	Mean
Tulsa	93.8	93.5	94.2	93.8
Omaha	93.6	95.7	94.2	94.5
Bastrop	93.2	95.5	94.9	94.6
Mean	93.6	94.9	94.4	
Positive control = 93.3				
Source of variance	Prob > F		SEM	
Source of meal	0.46		0.46	
Level of meal	0.10		0.46	
Source x Level	0.36		0.79	

Table 7: Effect of source and level of spent hen meal in diets formulated to provide adequate levels of digestible amino acids on mean egg shell thickness (mm x 1000) of laying hens (84 day study)

Source of meal	Inclusion rate of spent hen meal (%)			
	5	10	15	Mean
Tulsa	352	350	348	350
Omaha	347	340	340	342
Bastrop	338	338	349	342
Mean	345	343	346	
Positive control = 348				
Source of variance	Prob > F		SEM	
Source of meal	0.80		0.39	
Level of meal	0.97		0.39	
Source x Level	0.98		0.67	

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