AN ABSTRACT OF THE THESIS OF

Roger Allen Burger for the degree of Master of Science

in Poultry Science presented on May 26, 1982.

Title: Nutritional and Management Factors Affecting Foot Pad Dermatitis in Single-Comb White Leghorn Dwarf and Normal-Sized Layers

Redacted for Privacy

Abstract approved: George M. Arscott

Two studies were undertaken to evaluate the effects of nutrition and management factors on foot pad dermatitis in single-comb White Leghorn dwarf and normal-sized layers. In the nutrition study, caged layers were fed one of six different diets. These included three diets with different combinations of the trace minerals cobalt, copper, iodine, iron, manganese and zinc; one diet with a high level of linoleic acid from safflower oil; another diet with meat and bone meal; and a diet with fish meal as a source of possible unidentified factors. Diets were fed during the production period from age twenty-four weeks to sixty-four weeks. No significant ($P > .05$) decrease in the incidence of dermatitis was

observed in dwarf or normal-sized layers with any of the diets.

In the management study, the incidence of dermatitis in dwarf and normal-sized birds reared in cages was compared with dermatitis in birds reared in floor pens containing wood shavings as litter. In addition, the effects of plastic-coated cage floor inserts and wooden perches (inserted into cages) on the incidence of dermatitis was evaluated for both dwarf and normal-sized layers. Birds reared in floor pens showed no incidence of foot pad dermatitis. Cage-reared normals had a non-significant but numerically higher incidence of dermatitis than did floor-reared normals. Cage-reared dwarfs developed a significantly ($P < .05$) higher incidence of dermatitis than did floor-reared dwarfs. Normals reared with either plastic-coated cage floor inserts or wooden perches showed no difference in the incidence of dermatitis from normals on control wire floors. Dwarfs reared with either plastic-coated floors or perches showed a significantly ($P < .05$) lower incidence of foot pad dermatitis than did dwarfs on control wire floors.

NUTRITIONAL AND MANAGEMENT FACTORS AFFECTING FOOT PAD DERMATITIS IN SINGLE-COMB WHITE LEGHORN DWARF AND NORMAL-SIZED LAYERS

By

Roger Allen Burger

A THESIS

Submitted to

Oregon State University

in Partial Fulfillment of the Requirements for

the Degree of

Master of Science

Completed May 1982

Commencement June 1983

APPROVED:

Redacted for Privacy

Head of Department of Poultry Science and Professor in Charge of Major

Redacted for Privacy

Dean of Graduate School

Date thesis is presented May 26, 1982

Typed by Arlene Helm for Roger Allen Burger

ACKNOWLEDGEMENTS

I would like to express my appreciation to Mary Goeger, Jim Morrison and Jeanne Fazio for their help with data collection for this study. I would also like to thank Mr. George Lamont, of Lamont's Featherland Farms, for the normal layers in this study, supplied as chicks.

Much of the work in this project was supported by a scholarship from the J.A. Hanson Memorial Scholarship Fund. This financial assistance was greatly appreciated.

I am deeply grateful to Dr. George Arscott for his assistance, guidance, and friendship during my tenure at Oregon State University.

Finally I wish to thank my wife, Arly, for her dedication and understanding in all my endeavors.

TABLE OF CONTENTS

LIST OF TABLES

NUTRITIONAL AND MANAGEMENT FACTORS AFFECTING FOOT PAD DERMATITIS IN SINGLE-COMB WHITE LEGHORN DWARF AND NORMAL-SIZED LAYERS

INTRODUCTION

Observations on dwarf and normal-sized single-comb White Leghorn layers reared in cages at the Oregon State University Agricultural Experiment Station revealed a severe incidence of foot pad dermatitis. In order to ascertain the cause of this dermatitis, both nutritional and management factors which might be involved were investigated.

Certain nutritional factors commonly related to foot pad dermatitis were initially considered. The effects of six different diets, including trace minerals, meat and bone meal, safflower oil as a source of linoleic acid and fish meal as a source of possible unidentified factors were observed and recorded.

Further, in order to determine which management factors might be involved, dermatitis from birds reared in floor pens on deep litter was compared with dermatitis from birds reared in wire cages. In addition, dermatitis from birds provided with either plastic-coated cage floor inserts or wooden perches was compared with dermatitis from layers in standard wire cages.

The results of the nutrition study are presented

first in the paper, followed by the results of the management study. Each is accompanied by a separate literature review.

Nutritional Factors Affecting Foot Pad Dermatitis in Dwarf and Normal-Sized Single-Comb White Leghorn Layers[1]

R.A. Burger and G.H. Arscott

Department of Poultry Science

Oregon State University

Corvallis, OR 97331 - 3402

Key Words: Dermatitis, Trace Minerals, Fatty Acids, Unidentified Growth Factors, Meat and Bone Meal, Dwarf Layers, Normal-Sized Layers

Section Preference: Metabolism and Nutrition

ABSTRACT

Studies were conducted to determine the effects of increased dietary levels of trace minerals, meat and bone meal, fish meal and safflower oil on foot pad dermatitis in dwarf and normal-sized single-comb White Leghorn layers. One thousand fifty-two birds were maintained in wire cages throughout forty weeks of egg production. Individuals were scored for the incidence of foot pad dermatitis and production parameters were recorded. No significant ($P > .05$) decrease in the incidence of dermatitis was observed from the following dietary supplements: 0.25% of a standard trace mineral mix, 0.25% of an iron, copper, iodine and cobalt mixture, 0.25% of a manganese and zinc mixture, 5% meat and bone meal, 3% herring fish meal or 2% safflower oil.

INTRODUCTION AND LITERATURE REVIEW

An observation of foot pad dermatitis was noted by Roush(1979), on dwarf and normal-sized single comb White Leghorn hens at the Oregon State University Agricultural Experiment Station. Previous workers, including McElroy and Jukes (1940), Patrick et al. (1942) and Frigg (1976), observed foot pad dermatitis in poultry and attributed the development of the lesions to a nutritional deficiency of biotin. Whitehead (1977) described the progressive development of biotin deficiency in chicks as an initial growth depression, followed by dryness and flakiness of the foot pads which generally, at a later time,

develope into hemorrhagic fissures. The occurrence of encrustations at the corners of the beak and the eyelids later became evident.

The biotin content of common poultry rations is usually adequate for good nutrition and the prevention of deficiency symptoms (Scott et al., 1976). However, the presence of biotin inhibitors such as avidin or streptavidin (Chaiet and Wolf, 1964) or inactivation of biotin in diets undergoing oxidative rancidity (Pavcheck and Shull, 1942) may initiate the occurrence of dermatitis.

More comprehensive reviews on biotin in poultry nutrition are presented by Whitehead (1977), Atuahene (1979), and Scott (1981).

Another water-soluble vitamin related to dermatitis in poultry is pantothenic acid. Deficiency symptoms were first described by Norris and Ringrose (1930). These symptoms are often difficult to distinguish from those observed with a biotin deficiency. However, in the case of pantothenic acid deficiency, the dermal lesions generally occur around the mouth and eyelids first and later progress to the foot pads (Scott, 1976).

An essential amino acid, methionine, has been shown to be effective in reducing foot pad dermatitis in turkey poults. Chavez and Kratzer (1972) found that dermatitis observed in poults on diets containing iso-

isolated soy protein or soybean meal was reduced by the addition of methionine. Murillo and Jensen (1976) were not able to completely eliminate foot pad dermatitis in poults raised in wire battery brooders, although additional dietary methionine did result in some improvement.

A dietary zinc deficiency may cause the foot pads of chickens to become dry and thickened and develop epidermal fissures, which may penetrate to the subcutaneous tissue (Titus and Fritz, 1971). The addition of zinc to the drinking water of broiler chickens caused a significant decrease in dermatitis found on the hip (Musbah et al., 1978).

The addition of linoleic acid to poultry rations may also have a positive influence on foot pad dermatitis. A deficiency generally results in slow growth, an enlarged liver, and, in conjunction with a biotin deficiency, a severe incidence of dermatitis (Scott, 1976). Roland and Edwards (1971) were able to demonstrate that the addition of hydrogenated coconut oil as a source of arachidonic acid to the biotin-deficient diet of chicks would decrease the severity of dermal lesions of the foot pads.

This study was undertaken to investigate the effects of increased dietary trace minerals, meat and bone meal, safflower oil as a source of linoleic acid and fish meal

(as a possible source of unidentified factors) on foot pad dermatitis observed in dwarf and normal-sized single-comb white Leghorn (SCWL) layers during forty weeks of egg production.

MATERIALS AND METHODS

Dwarf SCWL pullets were obtained from a mating of Shaver Starcross 288 females[2] and pure Oregon State University Agricultural Experiment Station dwarf SCWL males from a previous generation. Normal-sized SCWL pullets used were Shaver Starcross 288[2] birds during the initial 40-week experiment in the trace mineral and meat and bone meal treatments. During the second 40-week experiment, Dekalb XL[2] birds were used for the fish meal and safflower oil treatments. Three 24-bird replicates were used for each ration. Housing and management conditions for the caged pullets are described elsewhere (Burger and Arscott, 1982).

Rations and experimental treatments are detailed in Tables 1 and 2. Dwarf rations include 0.10% more methionine than do rations for normal-sized pullets, as required for improved egg size (Bernier and Arscott, 1972). Data were analyzed using the analysis of variance (McClave and Dietrich, 1979).

[2] Layers were provided as chicks by Lamont's Featherland Farms, Inc., Coburg, OR 97401.

RESULTS AND CONCLUSIONS

The results of the dermatitis scores from dwarf and normal-sized layers in Experiment 1 are presented in Table 3. A 50% increase in dietary trace minerals and the addition of 5% meat and bone meal produced no significant ($P > .05$) effect on mean dermatitis scores from either type of bird.

Dermatitis scores from dwarf and normal-sized layers in Experiment 2 are presented in Table 4. The addition of 2% safflower oil or 3% fish meal had no significant effect ($P > .05$) on mean dermatitis scores from either type of layer.

The dermatitis scores for normal-sized layers numerically higher in Experiment 1 than in Experiment 2. This may be explained in part by the fact that in the first experiment Shaver Starcross 288 birds were used. Another explanation may be a random variation in the incidence of foot pad dermatitis from year to year similar to that observed by Hill (1975).

The similarity of mean dermatitis scores between dietary treatments made it possible to combine the dwarf layer data and to combine the normal-sized layer data as shown in Table 5. The mean dermatitis score for dwarf pullets is significantly ($P < .05$) higher than the score for the normal-sized birds.

Production parameters for both experiments are

presented in Tables 6 and 7. Parameters for normal-sized birds on all diets are similar to the control group of normal-sized birds. The parameters for dwarf birds on all diets are similar to the dwarf control group. Egg production, feed consumption, and body weights are significantly ($P < .05$) lower for dwarfs than for normals. Values for feed conversion (feed/dozen eggs) are significantly ($P < .05$) better for dwarfs than for normal-sized birds.

Increases of dietary biotin (Atuahene, 1979), trace minerals, meat and bone meal, safflower oil and fish meal did not significantly ($P > .05$) reduce the incidence of this particular type of foot pad dermatitis. These results led to the hypothesis that management rather than nutritional factors might be involved. Further research (Burger and Arscott, 1982) revealed that the dermatitis was management-related, and resulted from the abrasive effects of the wire used in cage floor construction.

TABLE 1: Composition of Dwarf and Normal-Sized Layer Rations (Exp. 1)

Ingredients	Control (%)	Mineral Mix (%)	Manganese and Zinc (%)	Iron, Iodine, Copper, Cobalt (%)	Meat and Bone Meal (%)
Corn, Yellow[a]	70.50	70.475	70.475	70.475	73.22
Soybean Meal (47.5%)	18.00	18.00	18.00	18.00	11.95
Meat and Bone Meal	——	——	——	——	5.00
Alfalfa Meal, Dehy. (17%)	2.50	2.50	2.50	2.50	2.50
Defluorinated Phosphate	2.00	2.00	2.00	2.00	1.00
Limestone Flour	3.65	3.65	3.65	3.65	3.08
Oystershell Flour	2.50	2.50	2.50	2.50	2.50
Salt (Iodized)[b]	.50	.50	.50	.50	.40
Vitamin Premix[c]	.20	.20	.20	.20	.20
Trace Mineral Mix 65[d]	.05	.075	.05	.05	.05
Trace Mineral Mix 65A[e]	——	——	.025	——	——
Trace Mineral Mix 65B[a]	——	——	——	.025	——
DL-Methionine (98%)	.10	.10	.10	.10	.10

[a]Normal rations did not include DL-methionine. The percent corn in those rations was increased accordingly (see explanation in text).

[b]Vitamin Premix (per Kg): vitamin A, 750,000 IU; vitamin D_3, 250,000 ICU; riboflavin, 750 mg; d-pantothenic acid, 1,250 mg; niacin, 5,000 mg; choline, 43,395 mg; vitamin B_{12}, 1,250 µg; vitamin E, 250 mg; vitamin K, 125 mg; folacin, 50 mg; ethoxyquin, 31.2 g

[c]Mineral Mix 65 (per Kg): Mn, 120,000 mg; Fe, 40,000; Cu, 4000 mg; I 2400 mg; Zn, 55,000 mg

[d]Mineral Mix 65A (per Kg): Min, 120,000 mg; Zn, 55,000 mg

[e]Mineral Mix 65B (per Kg): Fe, 40,000 mg; Cu, 4,000 mg; I, 2,400 mg; Co, 400 mg

TABLE 2: Composition of Dwarf and Normal-Sized Layer Rations (Exp. 2)

Ingredients	Control		Fish Meal		Safflower Oil	
	Dwarf (%)	Normal (%)	Dwarf (%)	Normal (%)	Dwarf (%)	Normal (%)
Corn, Yellow[a]	70.50	70.60	72.00	72.10	68.50	68.60
Soybean Meal (47.5%)	18.00	18.00	13.50	13.50	18.00	18.00
Fish Meal, Herring (72%)	—	—	3.00	3.00	—	—
Safflower Oil	—	—	—	—	2.00	2.00
Alfalfa Meal (17%)	2.50	2.50	2.50	2.50	2.50	2.50
Limestone Flour	3.65	3.65	3.65	3.65	3.65	3.65
Oystershell, Med.	2.50	2.50	2.50	2.50	2.50	2.50
Defluorinated Phosphate	2.00	2.00	2.00	2.00	2.00	2.00
Salt, Iodized	.50	.50	.50	.50	.50	.50
Vitamin Mix[b]	.20	.20	.20	.20	.20	.20
Trace Mineral Mix 65[c]	.05	.05	.05	.05	.05	.05
DL-Methionine (98%)[a]	.10	—	.10	—	.10	—

[a]See footnote a, Table 1.

[b]See footnote b, Table 1.

[c]See footnote c, Table 1.

TABLE 3: The Effects of Trace Minerals and Meat and Bone Meal on Mean Dermatitis Scores from Dwarf and Normal-Sized SCWL Layers (Exp. 1)

Ration[a]	Mean Dermatitis Score	Range
	Normal[b]	
Control	1.3	1-2
Mineral Mix	1.3	1-2
Mn, Zn	1.4	1-2
Fe, I, Cu, Co	1.4	1-2
Meat and Bone Meal	1.2	1-2
	Dwarf[b]	
Control	2.6	1-5
Mineral Mix	2.5	1-5
Mn, Zn	2.4	1-5
Fe, I, Cu, Co	2.8	1-5
Meat and Bone Meal	2.4	1-5

[a]See Table 1.

[b]No significant differences ($P > .05$) were observed within these groups.

TABLE 4: The Effects of Fish Meal and Safflower Oil on Mean Dermatitis Scores from Dwarf and Normal-Sized SCWL Layers (Exp. 2)

Ration	Dwarf[b] Mean Score	Range	Normal[b] Mean Score	Range
Control	2.6	1-4	1.1	1-2
Fish Meal	2.5	1-4	1.1	1-2
Safflower Oil	2.6	1-5	1.2	1-2

[a]See Table 1.

[b]No significant differences ($P > 0.05$).

Table 5: Mean Dermatitis Scores for Dwarf Versus Normal-Sized Layers

	Mean Score[a]	Range
Normal	1.2	1-2
Dwarf	2.6	1-5

[a]Values are significantly different ($P < .05$).

TABLE 6: Performance of Dwarf and Normal-Sized SCWL Layers Supplemented with Trace Minerals and Meat and Bone Meal During Forty Weeks of Egg Production (Exp. 1)

Ration[a]	Hen-Day Egg Prod.[b] (%)	Daily Feed Cons.[b] (g)	Feed/Doz. Eggs[b] (Kg)	Body Weight[c] (Kg)	Mortality Cumulative (%)
			Normal[d,e]		
Control	75.6	118	1.90	1.81	5.6
Mineral Mix	75.9	109	1.91	1.86	6.7
Mn, Zn	75.1	117	1.91	1.84	4.2
Fe, I, Cu, Co	77.2	117	1.84	1.81	5.6
Meat and Bone Meal	75.6	115	1.85	1.81	1.4
			Dwarf[d,e]		
Control	68.1	88	1.59	1.49	2.8
Mineral Mix	69.2	87	1.53	1.54	1.0
Mn, Zn	70.2	89	1.55	1.54	1.4
Fe, I, Cu, Co	69.6	88	1.54	1.50	1.4
Meat and Bone Meal	70.3	89	1.54	1.50	4.2

[a] See Table 1.

[b] Averages of forty weeks of egg production.

[c] At forty weeks.

[d] No significant differences ($P > .05$) were observed within these groups.

[e] Except for mortality, values for normal-sized birds differ significantly ($P < .05$) from dwarf birds.

TABLE 7: The Effects of Fish Meal and Safflower Oil on Performance of Dwarf and Normal-Sized SCWL Layers During Forty Weeks of Egg Production (Exp. 2)

Treatment	Hen-Day Egg Prod.[a] (%)	Daily Feed Cons.[a] (g)	Feed/Doz. Eggs[a] (Kg)	Body Weight[b] (Kg)	Mortality Cumulative (%)
			Normal[c,d]		
Control	77.3	108	1.72	1.86	2.8
Fish Meal	77.1	109	1.71	1.95	2.8
Safflower Oil	73.8	103	1.72	1.86	1.9
			Dwarf[c,d]		
Control	61.5	84	1.64	1.45	5.6
Fish Meal	67.2	88	1.61	1.41	1.4
Safflower Oil	57.5	82	1.72	1.54	6.9

[a]Averages of forty weeks of egg production.

[b]At forty weeks.

[c]No significant differences ($P > .05$) were observed within these groups.

[d]Except for mortality, values for normal-sized birds differ significantly ($P < .05$) from dwarf birds.

REFERENCES

Atuahene, Yaw, 1979. Biotin supplementation of corn- and wheat-based rations and its influence on dermatitis and hatchability in dwarf and normal-sized single comb white Leghorns. Master's Thesis, Oregon State University, Corvallis, OR.

Bernier, Paul E. and G.H. Arscott, 1972. Fifteen years of observations on the dwarf gene in the domestic fowl. Ann. Genet. Sel. Anim. 4(2): 183-215.

Burger, R.A. and G.H. Arscott, 1982. A cage-related foot pad dermatitis in dwarf and normal-sized single-comb white Leghorn pullets. Poultry Sci. (To be submitted for publication.)

Chaiet, L. and F.J. Wolf , 1964. Properties of strept-avidin, a biotin-binding protein produced by Streptomycetes. Arch. Biochem. and Biophys. 106: 1-5.

Chavez, E. and F.H. Kratzer, 1972. Prevention of foot pad dermatitis in poults with methionine. Poultry Sci. 51: 1545-1548.

Frigg, M., 1976. Bioavailability of biotin in cereals. Poultry Sci. 55: 2310-2318.

Hill, A.T., 1975. Foot sore incidence among de-clawed leghorn-type layers, as affected by strain, density and birds per cage. Can. J. Sci. 55: 165-166.

McClave, J.T. and F.H. Dietrich II, 1979. Statistics. Dellen Publishing Co., San Francisco, CA. 681 pp.

McElroy, L.W. and T.N. Jukes, 1940. Biotin deficiency in growing chicks. Proc. Exp. Biol. Med. 45: 296 (Abstract).

Murillo, M.G. and L.S. Jensen, 1976. Sulfur amino acid requirements and foot pad dermatitis in turkey poults. Poultry Sci. 55: 554-562.

Musbah, M.G., C. Harris Jr. and P.W. Waldroup, 1978. The effects of supplementation of drinking water with zinc, molybdenum and copper on skin fatty acids and dermatitis in broilers. Poultry Sci. 57: 1174 (Abstract).

Norris, L.C. and A.T. Ringrose, 1930. The occurrence of a pellagrous-like syndrome in chicks. Science 71: 643.

Patrick, H., R.V. Boucher, R.A. Autcher and H.C. Knandel, 1942. Oxy-biotin metabolism in the chick; Oxy-biotin and biotin balance studies. J. Biol. Chem. 176: 1327-1331.

Pavcheck, P.L. and G.M. Shull, 1942. Inactivation of biotin by rancid fats. J. Biol. Chem. 146: 351-355.

Roland, D.A. and H.M. Edwards Jr., 1971. Effect of essential fatty acid deficiency and type of dietary fat supplementation on biotin deficient chicks. J. Nutr. 101: 811-818.

Roush, W.B., 1979. Evaluation and improvement of the nutritional quality of feed grains for poultry. Ph.D. Thesis, Oregon State University, Corvallis, OR.

Scott, M.L., 1981. Importance of biotin for chickens and turkeys. Feedstuffs, Feb. 23, pp. 59-67.

Scott, M.L., M.C. Nesheim and R.J. Young, 1976. Nutrition of the Chicken. 2nd ed. M.L. Scott and Associates, Pub., Ithaca, New York. 555 pp.

Titus, H.W. and J.C. Fritz, 1971. The Scientific Feeding of Chickens. 5th ed. The Interstate, Pub., Danville, IL.

Whitehead, C.C., 1977. The use of biotin in poultry nutrition. World's Poultry Sci. J., August, pp. 140-154. 336 pp.

A Cage-Related Foot Pad Dermatitis in Dwarf and Normal-Sized Single-Comb White Leghorn Layers[1]

R.A. Burger and G.H. Arscott
Department of Poultry Science
Oregon State University
Corvallis, OR 97331-3402

Key Words: Dermatitis, Perches, Plastic Flooring, Dwarf Layers, Normal-Sized Layers
Section Preference: Environment and Health

ABSTRACT

Studies were conducted to determine if wire cage floors were involved in producing a foot pad dermatitis in dwarf and normal-sized single-comb White Leghorn layers. Dermatitis scores were found to be higher for dwarf birds raised in cages versus litter floors. The use of plastic-coated cage floor inserts and wooden perches reduced the incidence of dermatitis in caged dwarf birds. Normal-sized layers exhibited a lower incidence of dermatitis than did dwarf hens.

INTRODUCTION AND LITERATURE REVIEW

A chance observation of dermatitis was noted by Roush (1979) on the feet of Oregon State University Agricultural Experiment Station dwarf and normal-sized single-comb White Leghorn (SCWL) layers in their sixth 28-day period of egg production. The lesions resembled those observed on biotin-deficient hens by McElroy and Jukes (1940), Frigg (1976), and Whitehead (19770. Research on this problem by Atuahene (1979) revealed that an increase of dietary biotin did not reduce the incidence of this particular dermatitis. Burger and Arscott (1982) also noted that dietary supplements of various trace minerals, meat and bone meal, fish meal and safflower oil were without effect.

Factors other than nutrition have been related to foot pad dermatitis. Abbott et al. (1960) and Harms and Simpson (1977) noted significant increases in foot pad dermatitis with turkey poults raised on damp or contaminated litter. Simonsen et al. (1980), after

comparing wire-raised versus litter-raised birds, concluded that integumental lesions in SCWL hens were more pronounced in birds on wire floors. Hill (1975) studied the effects of increased bird density in wire cages on the incidence of foot pad dermatitis. His results indicate that 1) increased numbers of birds per cage cause a higher level of foot irritation and 2) the incidence of sore feet can vary from year to year. Murillo and Jensen (1976) suggested that a dermatitis in turkey poults was caused by physical contact of the birds with wire in brooder cages.

An incidence of severe foot pad dermatitis has been demonstrated in broiler breeder chickens raised in wire cages. Fuquay and Renden (1980) isolated Staphylococcus aureus from swollen hock joints of caged broiler breeders. They also noted severe foot lesions and suggested that these may provide a portal of entry for Staphylococcus bacteria.

This study was undertaken to determine the extent to which wire cage floors of the type commonly used in commercial laying operations are involved in contributing to foot pad dermatitis in dwarf and normal-sized SCWL layers.

MATERIALS AND METHODS

Exp. 1: Dwarf SCWL pullets were obtained from a

mating of Shaver Starcross 288 females[2] and pure Oregon State University Agricultural Experiment Station dwarf SCWL males from a previous generation. Normal-sized SCWL pullets used were Shaver Starcross 288 birds[3]. Dwarf chicks were provided 1841 cm^2 of floor space per bird for the first 24 weeks of age, in 4.9 m X 4.9 m floor pens. Seventy-two dwarf and 72 normal-sized pullets were then transferred to individual 20.3 cm X 35.6 cm wire cages with 2.5 cm X 5.1 cm mesh floors. The cages were arranged 24 per row within a 49 m X 12 m building provided with positive pressure ventilation. One hundred twenty dwarf and 120 normal-sized pullets were transferred to open front, 3.6 m X 3.6 m pens, 40 per pen, with wood shavings as litter.

All birds received 14 hours continuous lighting per day throughout the ten 28-day periods of the study. Feed was supplied ad libitum. The rations used are cited elsewhere (Burger and Arscott, 1982). Water was provided to caged birds during eight fifteen-minute periods each day. Birds in floor pens were provided with a continuous water supply.

All birds were scored for the incidence of dermatitis on foot pads at the beginning, middle and end of the study. The following scoring system was used:

[2,3]Birds were provided as chicks by Lamont's Featherland Farms, Inc., Coburg, OR 97401.

1 = no dermatitis; 2 = slight dermatitis; 3 = moderate dermatitis; 4 = considerable dermatitis; and 5 = severe dermatitis.

Egg production and mortality were recorded daily and feed consumption was measured at the end of each 28-day period. Individual body weights were taken at the start of the study and during the second, fifth and tenth periods. Percent hen-day egg production and feed consumption values were calculated for each 28-day period by dividing the total number of eggs produced and feed consumed by the number of hen-days. Values from the ten periods were then averaged. Feed per dozen eggs was calculated for each period and an average for ten periods obtained.

Exp. 2: Dwarf layers in this study were the progeny of normal-sized SCWL females obtained as described above, mated to Oregon State University Agricultural Experiment Station SCWL dwarf males. Normal-sized pullets available were of the Dekalb XL strain[4]. Caged housing, management conditions, dermatitis scoring procedure, study length and methods for collection of production data were the same as described in Experiment 1.

Two methods were used to restrict foot contact with cage floors. Cages were fitted with either plastic-

[4]Layers were provided as chicks by Lamont's Featherland Farms, Inc., Coburg, OR 97401.

coated wire floor inserts or with 2.5 cm wide, lath-type wooden perches. Floor inserts were made from wire mesh cage material dipped in a plasticized coating mixture purchased locally. This provided a 1-2 mm layer of soft plastic over the wire surface. The wooden perches were installed across the width of the cages approximately 7 cm above the floor.

Data from Experiment 1 and Experiment 2 of this study were analyzed using the analysis of variance (McClave and Dietrich, 1979).

RESULTS

Exp. 1: The results of the dermatitis scores for dwarf and normal-sized layers are shown in Table 8. These values represent the average scores from birds during their 40th week of egg production. The dermatitis became apparent as early as 20 weeks of production but did not become commonplace in the dwarfs until the 21st week.

The caged dwarfs showed a significantly ($P < .05$) higher incidence of dermatitis than the caged normal-sized pullets. No dermatitis was observed for either type of bird reared in floor pens. The incidence of dermatitis in the caged normal-sized birds was only slightly ($P < .05$) higher than that found in the floor-reared normals. Dwarf layers reared in cages had a significantly higher incidence of dermatitis than did dwarfs reared in floor

pens ($P < .05$).

The performance parameters for cage- versus floor-raised birds are presented in Table 9. The figures for egg production, feed consumption and feed/dozen eggs are forty-week averages. Mortality is cumulative and body weights are those measured at the 40th week. The parameters are quite similar between cage-reared and floor-reared dwarfs, as is also the case when comparing cage- to floor-reared normals. Egg production, feed consumption and body weight are significantly ($P < .05$) lower for dwarfs than for normals. Dwarfs had a significantly ($P < .05$) better feed conversion (feed/dozen eggs) than did normals.

Exp. 2: The results of the dermatitis scores for dwarf and normal-sized layers are shown in Table 10. By the 40th week of production, dwarf layers again developed a significantly ($P < .05$) higher incidence of dermatitis than did normal-sized hens.
Dwarfs on plastic floors and perches showed significantly ($P < .05$) less dermatitis than those on control wire floors. Dwarfs with perches showed a slightly lower ($P > .05$) incidence of dermatitis than those on plastic floors.

Throughout the experiment, birds were observed to lay eggs while standing on the perches. The result of this behavior was a 1% increase in the incidence of cracked eggs for both dwarf and normal-sized layers.

The performance parameters for Experiment 2 are presented in Table 11. Values were calculated as described in Experiment 1. Parameters for normal-sized birds on plastic floors and perches are similar to the normal control. Those parameters for dwarfs on plastic floors and perches are similar to the dwarf control. Egg production, feed consumption and body weight are significantly ($P < .05$) lower for dwarfs than for normals. Dwarfs had a significantly ($P < .05$) better feed conversion (feed/dozen eggs) than did normals.

DISCUSSION AND CONCLUSIONS

From the results of this study it appears that this particular SCWL dwarf layer is susceptible to a foot pad dermatitis caused by constant contact with wire floors in cages. Providing a means to limit foot contact with the wire floor significantly ($P < .05$) reduced the incidence, but not to a level comparable with normal-sized hens. Plastic floors or perches within cages allowed some relief from contact with wire floors and did result in a lower incidence of dermatitis.

It might be noted that the wire of the plastic-coated floors was covered with only a thin coat of rubberized plastic. The wire, although now smooth and less abrasive, retained its thin diameter. The entire weight of the bird was still exerted on only the few points which contacted the wire at any given time. Any

means for increasing the diameter of the wire and at the same time reducing abrasiveness might help to redistribute the weight over a larger area and eliminate the dermatitis altogether. A commercially available plastic flooring similar to that described by Gayner (1981) may offer a solution to this problem.

There remains the hypothesis that some stress factors other than wire floors might be involved in producing the observed dermatitis. However, the similarity between the cage- and floor-reared production parameters is a reasonable indication of the lack of such factors.

TABLE 8: Mean Dermatitis Scores From Cage- Versus Floor-Raised SCWL Dwarf and Normal-Sized Layers at Forty Weeks of Egg Production

	Mean Score	
Bird Size	Cage	Floor
Dwarf	2.6^{a}	1.0^{b}
Normal	1.2^{b}	1.0^{b}

Values with differing superscripts are significantly different ($P < .05$).

TABLE 9: Performance of Cage- Versus Floor-Reared Dwarf and Normal-Sized SCWL Layers

	Hen-Day Egg Prod.[a] (%)	Daily Feed Cons.[a] (g)	Feed/Doz. Eggs[a] (Kg)	Body Weight[b] (Kg)	Mortality Cumulative (%)
			Normal[c,d]		
Cage	75.6	118	1.90	1.81	5.5
Floor	78.6	126	1.91	1.86	4.2
			Dwarf[c,d]		
Cage	68.1	88	1.59	1.36	2.8
Floor	68.8	94	1.64	1.32	2.5

[a]Averages of forty weeks of egg production.

[b]At forty weeks.

[c]No significant differences ($P > .05$) were observed within these groups.

[d]Except for mortality, values for normal-sized birds differ significantly ($P < .05$) from dwarf birds.

TABLE 10: Mean Dermatitis Scores from SCWL Layers Raised on Plastic Floors and Perches at Forty Weeks of Egg Production

	Normal		Dwarf	
Conditions	Mean Score	Range	Mean Score	Range
Control	1.1[a]	1-2	2.6[b]	1-5
Perches	1.1[a]	1-2	1.4[c]	1-5
Plastic floors	1.1[a]	1-2	1.5[c]	1-5

Values with differing superscripts are significantly different ($P < .05$).

TABLE 11: Performance of Dwarf and Normal-Sized Layers on Perches and Plastic-Coated Floors During Forty Weeks of Egg Production

	Hen-Day Egg Prod.[a] (%)	Daily Feed Cons.[a] (g)	Feed/Doz. Eggs[a] (Kg)	Body Weight[b] (Kg)	Mortality Cumulative (%)
			Normal[c,d]		
Control	77.3	108	1.72	1.86	2.8
Perches	74.6	108	1.72	1.81	5.6
Plastic Floors	75.0	110	1.75	1.91	4.2
			Dwarf[c,d]		
Control	61.5	84	1.64	1.45	5.6
Perches	62.3	85	1.62	1.50	4.2
Plastic Floors	66.0	86	1.61	1.36	6.9

[a] Averages of forty weeks of egg production.

[b] At forty weeks.

[c] No significant differences ($P > .05$) were observed within these groups.

[d] Except for mortality, values for normal birds differ significantly ($P < .05$) from dwarf birds.

REFERENCES

Abbott, W.W., J.R. Couch and R.L. Atkinson, 1960. The incidence of foot pad dermatitis in young turkeys fed high levels of soybean meal. Poultry Sci. 48: 2106-2188.

Atuahene, Yaw, 1979. Biotin supplementation of corn- and wheat-based rations and its influence on dermatitis and hatchability in dwarf and normal-sized single-comb white Leghorns. Master's Thesis, Oregon State University, Corvallis, OR.

Burger, R.A. and G.H. Arscott, 1982. Nutritional factors affecting foot pad dermatitis in dwarf and normal-sized single-comb white Leghorn pullets. Poultry Sci. (To be submitted for publication.)

Frigg, M., 1976. Bioavailability of biotin in cereals. Poultry Sci. 55: 2310-2318.

Fuquay, J.I. and J.A. Renden, 1980. Reproductive performance of broiler breeders maintained in cages or on floors through fifty-nine weeks of age. Poultry Sci. 59: 2525-2531.

Gayner, R.M., 1981. Plastic-coated suspended floors for rearing broilers. Alabama Agricultural Experiment Station, 28(2): 4.

Harms, R.H. and C.F. Simpson, 1977. Influence of wet litter and supplemental biotin on foot pad dermatitis in turkey poults. Poultry Sci. 56: 2009-2012.

Hill, A.T., 1975. Foot sore incidence among de-clawed leghorn-type layers, as affected by strain, density and birds per cage. Can. J. Anim. Sci. 55: 165-166.

McClave, J.T. and F.H. Dietrich II, 1979. Statistics. Dellen Publishing Co., San Francisco, CA. 681 pp.

McElroy, L.W. and T.N. Jukes, 1940. Biotin deficiency in growing chicks. Proc. Exp. Biol. Med. 45: 296 (Abstract).

Murillo, M.G. and L.S. Jensen, 1976. Sulfur amino acid requirements and foot pad dermatitis in turkey poults. Poultry Sci. 55: 554-562.

Roush, W.B., 1979. Evaluation, utilization and improvement of the nutritional quality of feed grains for poultry. Ph.D. Thesis, Oregon State University, Corvallis, OR.

Simonsen, H.B., K. Veslergaard and P. Willeberg, 1980. Effect of floor type and density on the integument of egg-layers. Poultry Sci. 59: 2202-2206.

Whitehead, C.C., 1977. The use of biotin in poultry nutrition. World's Poultry Science Journal, August, pp. 140-154.

BIBLIOGRAPHY

Abbott, W.W., J.R. Couch and R.L. Atkinson, 1960. The incidence of foot pad dermatitis in young turkeys fed high levels of soybean meal. Poultry Sci. 48: 2106-2188.

Atuahene, Yaw, 1979. Biotin supplementation of corn- and wheat-based rations and its influence on dermatitis and hatchability in dwarf and normal-size single-comb white Leghorns. Master's Thesis, Oregon State University, Corvallis, OR.

Bernier, Paul E. and G.H. Arscott, 1972. Fifteen years of observations on the dwarf gene in the domestic fowl. Ann. Genet. Sel. Anim. 4(2): 183-215.

Burger, R.A. and G.H. Arscott, 1982. A cage-related foot pad dermatitis in dwarf and normal-sized single-comb white Leghorn pullets. Poultry Sci. (To be submitted for publication.)

Burger, R.A. and G.H. Arscott, 1982. Nutritional factors affecting foot pad dermatitis in dwarf and normal-sized single-comb white Leghorn pullets. Poultry Sci. (To be submitted for publication.)

Chaiet, L. and F.J. Wolf, 1964. Properties of strept-avidin, a biotin-binding protein produced by Streptomycetes. Arch. Biochem. and Biophys. 106: 1-5.

Chavez, E. and F.H. Kratzer, 1972. Prevention of foot pad dermatitis in poults with methionine. Poultry

Sci. 51: 1545-1548.

Frigg, M., 1976. Bioavailability of biotin in cereals. Poultry Sci. 55: 2310-2318.

Fuquay, J.I. and J.A. Renden, 1980. Reproductive performance of broiler breeders maintained in cages or on floors through fifty-nine weeks of age. Poultry Sci. 59: 2525-2531.

Gayner, R.M., 1981. Plastic-coated suspended floors for rearing broilers. Alabama Agricultural Experiment Station, 28(2): 4.

Harms, R.H. and C.F. Simpson, 1977. Influence of wet litter and supplemental biotin on foot pad dermatitis in turkey poults. Poultry Sci. 56: 2009-2012.

Hill, A.T., 1975. Foot sore incidence among de-clawed leghorn-type layers, as affected by strain, density and birds per cage. Can. J. Anim. Sci. 55: 165-166.

McClave, J.T. and F.H. Dietrich II, 1979. Statistics. Dellen Pub. Co., San Francisco, CA. 681 pp.

McElroy, L.W. and T.N. Jukes, 1940. Biotin deficiency in growing chicks. Proc. Exp. Biol. Med. 45: 296 (Abstract).

Murillo, M.G. and L.S. Jensen, 1976. Sulfur amino acid requirements and foot pad dermatitis in turkey poults. Poultry Sci. 55: 554-562.

Musbah, M.G., C. Harris Jr. and P.W. Waldroup, 1978. The effects of supplementation of drinking water with zinc, molybdenum and copper on skin fatty acids and

dermatitis in broilers. Poultry Sci. 57: 1174 (Abstract).

Norris, L.C. and A.T. Ringrose, 1930. The occurrence of a pellagrous-like syndrome in chicks. Science 71: 643.

Patrick, H., R.V. Boucher, R.A. Autcher and H.C. Knandel, 1942. Oxy-biotin metabolism in the chick; Oxy-biotin and biotin balance studies. J. Biol. Chem. 176: 1327-1331.

Pavcheck, P.L. and G.M. Shull, 1942. Inactivation of biotin by rancid fats. J. Biol. Chem. 146: 351-355.

Roland, D.A. and H.M. Edwards Jr., 1971. Effect of essential fatty acid deficiency and type of dietary fat supplementation on biotin deficient chicks. J. Nutr. 101: 811-818.

Roush, W.B., 1979. Evaluation and improvement of the nutritional quality of feed grains for poultry. Ph.D. Thesis, Oregon State University, Corvallis, OR.

Scott, M.L., 1981. Importance of biotin for chickens and turkeys. Feedstuffs, February 23, pp. 59-67.

Scott, M.L., M.C. Nesheim and R.J. Young, 1976. Nutrition of the Chicken. 2nd ed. M.L. Scott and Associates, Pub., Ithaca, New York. 555 pp.

Simonsen, H.B., K. Veslergaard and P. Willeberg, 1980. Effect of floor type and density on the integument of egg-layers. Poultry Sci. 59: 2202-2206.

Titus, H.W. and J.C. Fritz, 1971. The Scientific

Feeding of Chickens. 5th ed. The Interstate, Pub., Danville, IL.

Whitehead, C.C., 1977. The use of biotin in poultry nutrition. World's Poultry Science J., August, pp. 140-154. 336 pp.

Appendix I

ANALYSIS OF VARIANCE (ANOVA) TABLES

(Values with (*) are significant; P < .05)

ANOVA: Table 3, Page 12

Dermatitis v. Trace Minerals and Meat and Bone Meal

Source	DF	MS	F
Bird	1	7.48	16.77*
Diet	4	0.54	1.21
Interaction	4	0.95	2.13
Error	20	0.45	

ANOVA: Table 4, Page 13

Dermatitis v. Fish Meal and Safflower Oil

Source	DF	MS	F
Bird	1	2.89	9.36*
Diet	2	.63	2.03
Interaction	2	.50	1.63
Error	12	0.31	

ANOVA: Production Parameters v. Diets
Tables 6 and 7, Pages 14 and 15

		Egg Production		Feed Consumption	
Source	DF	MS	F	MS	F
Bird	1	2981.67	35.70*	0.30	1691.69*
Diet	7	24.58	0.29	0.00	0.40
Interaction	7	23.52	0.28	0.00	2.08
Error	464	83.52		0.00	

		Feed Conversion		Body Weight	
Source	DF	MS	F	MS	F
Bird	1	39.81	141.48*	20.45	442.41*
Diet	7	0.178	0.63	0.09	1.89
Interaction	7	0.074	0.26	0.06	1.29
Error	464	0.281		0.05	

ANOVA: Production Parameters v. Diets (con.)

Mortality

Source	DF	MS	F
Bird	1	8.73	3.01
Diet	7	2.12	0.73
Interaction	7	3.97	1.37
Error	32	2.90	

ANOVA: Table 8, Page 28

Cage v. Floor

Source	DF	MS	F
Bird	1	7.23	14.68*
Pen type	1	4.02	8.17
Interaction	1	0.48	0.97
Error	32	0.49	

*Pen type is defined as floor or cage.

ANOVA: Floor v. Cage
Table 9, Page 29

Egg Production

Source	DF	MS	F
Bird	1	248.76	4.06*
Pen type	1	145.21	2.37
Interaction	1	69.24	1.13
Error	116	61.27	

Feed Consumption

Source	DF	MS	F
Bird	1	223.43	8.63*
Pen type	1	98.90	3.82
Interaction	1	16.57	0.64
Error	116	25.89	

ANOVA: Floor v. Cage (con.)

Feed Conversion

Source	DF	MS	F
Bird	1	18.71	3.95*
Pen type	1	0.60	0.17
Interaction	1	3.73	1.05
Error	116	3.55	

Body Weight

Source	DF	MS	F
Bird	1	12.11	4.71*
Pen type	1	1.36	0.53
Interaction	1	2.49	0.97
Error	32	2.57	

Mortality

Source	DF	MS	F
Bird	1	2.17	1.12
Pen type	1	1.88	0.97
Interaction	1	1.28	0.66
Error	9	1.94	

ANOVA: Table 10, Page 30

Dermatitis v. Perches and Plastic Floors

Source	DF	MS	F
Bird	1	1.38	10.07*
Floor type	2	1.16	8.47*
Interaction	2	0.36	2.63
Error	12	0.14	

ANOVA: Production Parameters v. Perches and Plastic Floors
Table 11, Page 31

Egg Production

Source	DF	MS	F
Bird	1	387.39	8.76*
Floor type	2	52.62	1.19
Interaction	2	43.33	0.98
Error	174	44.22	

ANOVA: Production Parameters v. Perches and Plastic Floors (con.)

Feed Consumption

Source	DF	MS	F
Bird	1	357.01	6.31*
Floor	2	54.88	0.97
Interaction	2	80.34	1.42
Error	174	56.58	

Feed Conversion

Source	DF	MS	F
Bird	1	23.48	14.78*
Floor	2	2.99	1.88
Interaction	2	0.02	0.01
Error	174	1.59	

Body Weight

Source	DF	MS	F
Bird	1	14.09	7.61*
Floor	2	1.59	0.86
Interaction	2	3.02	1.63
Error	48	1.85	

Mortality

Source	DF	MS	F
Bird	1	2.87	3.73
Floor	2	1.33	1.72
Interaction	2	0.56	0.73
Error	12	0.77	

Appendix II

A complete record of data collected in both the nutrition and management studies are on file at the Oregon State University Agricultural Experiment Station, Department of Poultry Science. Reference should be made to projects 15-79-11 and 15-80-8.