# Effect of Composting Broiler Litter on Broiler Performance

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# EFFECT OF COMPOSTING BROILER LITTER ON BROILER PERFORMANCE

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## REVIEW OF LITERATURE

Broilers in the United States, for the most part, are reared in litter floor houses. In most instances, the litter is reused several times before a complete cleanout occurs. Molted feathers are raked from the surface, and any caked or wet litter is removed from the house before a two-inch layer of new, clean litter is spread over the top of the old litter.

Broiler growers have difficulty at times obtaining sawdust, shavings and other conventional litter materials which may be in short supply. These wood by-products have become more costly as they are used increasingly to manufacture pressed board for the building trade or to make paper or paper products.

To conserve litter and reduce costs, artificial composting of used litter by treatment with an inoculum of microorganisms was proposed using a commercially available product, Litter-Life (LL). (1). The plan was to have broilers maintain an aerobic environment for the microorganisms by scratching in the litter. The selected microorganisms would break down urea, uric acid and other nitrogenous products in the excrement. In so doing, the litter loses nitrogen, moisture and other volatile compounds and possibly would not serve as a substrate for flies (2). These investigators also indicated that the composted litter could be dusty at low humidities but retain its structure with relative humidities as high as 90 percent. Other advantages noted: improved feed efficiency for broilers grown on composted litter as compared with broilers raised on fresh shavings; higher levels of B-complex vitamins in composted litter, and an apparent reduction of disease problems in spite of inadequate management (2). Initial composting temperatures would reach 60° to 71.1°C (140° to 160°F) which would destroy most active pathogens.

To determine the benefits obtained from composted broiler litter under Oregon weather conditions, four broiler experiments were carried out through the four seasons of the year. The effects of new litter (NL), used litter (UL), used litter mixed with added moisture and Litter-Life (processed litter, PL+LL) and used litter mixed with added moisture only (PL) were determined by measuring growth rate, feed efficiency, mortality and condemnation.

## EXPERIMENTAL PROCEDURE

The building used for these trials consisted of 8 pens (3.7 meters x 2.8 meters or 10 feet x 14 feet) each separated from adjacent pens by a solid partition. Each pen had adjustable windows on one side for ventilation. The house had a wood floor.

An initial experiment consisted of 1,440 straight-run commercial broiler chicks. These chicks were distributed 180 per pen in 8 pens and the floor space allowance of 0.78 square feet (725 square centimeters). per chick. New Douglas-fir shavings were used as litter. One electric hover brooder with a rated capacity for 300 chicks was used in each pen. The temperature under the hover was 35°C (95°F) the first week and was decreased by 5°F each week down to 18.5°C (65°F). Room temperature was not controlled. The chicks were started by providing feed on flats and later 4 galvanized feed troughs 4 feet (1.2 meters) long before they were fed in 2 tube feeders per pen, each 16 inches (40 centimeters) in diameter. A portable fountain was used in each pen for the first two weeks and gradually water was provided in one continuous-flow water trough, 100 inches (250 centimeters) long providing 1.1 inches (2.8 centimeters) of drinking space per chick.

Continuous artificial light was provided by one 40 watt white incandescent bulb in the center of each pen, about 7.5 feet (2.3 meters) above the floor.

A single stage broiler ration was mixed at the Poultry Science Feed Mill with a constant formulation for all the experiments (Table 1). Free choice feed and water were provided.

After the initial test, four successive experiments were carried out in the same building with the same number of chicks and similar brooding, rearing, feeding and lighting conditions. The four experiments were started in September, December, February and May with three weeks between each experiment.

Birds for each litter treatment were grown in the same pen for each experiment. In Treatment 1, the old litter was removed after each brood and replaced with new fir shavings (NL). In Treatment 2, the caked litter and feathers plus the top 1 inch of old shavings were removed and then replaced with 2 inches of new shavings (UL). In Treatment 3, the used litter was thoroughly mixed with water and LL (1/2 pound per square foot of floor area) until the moisture in the litter reached 40 to 50 percent. The mixture was allowed to compost for 5-7 days, then stirred daily and as long as necessary until ammonia production ceased (PL+LL). Treatment 4 was handled exactly as Treatment 3 except LL was not added (PL). The litter depths for Treatments 1 and 2 and Treatments 3 and 4 were 4 inches (10 centimeters) and 6-8 inches (15-20 centimeters), respectively.

Body weights and feed consumption, obtained for each trial at 8 weeks of age, were analyzed statistically by the method of Steel and Torrie (1960). Mortality was recorded daily throughout the test and dead birds were sent to the University Veterinary Diagnostic Laboratory for autopsy. Litter was sampled and moisture determined at the beginning of Experiments 1 and 3 and at the end of Experiments 1, 2 and 4.

Litter samples were analyzed after the first and third experiments for moisture, ash, nitrogen, phosphorus, potassium, magnesium, calcium, copper, manganese, zinc and sulfur through cooperation with the Department of Agricultural Chemistry.

Data on condemnations for broilers marketed from Experiment 3 were obtained at a commercial processing plant.

RESULTS

The first experiment was started on September 22, 1972, during the onset of the winter rains in Oregon (Table 2). Mortality was higher than normal during the first 10 days of the trial. It was suspected that the chicks experienced a failure in the water supply over a weekend. The most severely affected chicks were the ones grown on the PL+LL treatment. The average body weight for these broilers grown on PL+LL had significantly smaller ($P<0.05$) body size at 8 weeks of age than the 3 other treatments. Feed conversion was not significantly different. The differentials in average body weight ranged from 0.12 to 0.21 pounds lighter. Feed conversion ranged from 0.10 to 0.22 pounds less efficient with the PL+LL than NL groups.

The litter moisture was determined on litter sampled from PL+LL and PL pens just prior to the time when the chicks were placed on the litter and immediately following their removal at 8 weeks. The litter was much wetter in the beginning than desired for these groups but no problems were apparent from this condition.

The second experiment (Table 2) was started December 5, 1972. During the first two weeks of this experiment outside temperatures were below freezing for approximately one week. The litter in the UL, PL+LL and PL groups was damp enough that it froze except for the litter area under the hover. At the end of the test the litter moisture was very high and much of the litter was caked and slicked over. Even with this severe weather, mortality was low and performance of these birds was satisfactory. Both the PL+LL and PL groups had heavier average body weights at 8 weeks of age than either the NL or the UL groups (avg. 3.88 vs. 3.71). Average feed conversion data were similar and no significant differences were evident.

Since the moisture level appeared high at the end of the second experiment for the PL+LL and PL groups, no water was added during the composting process. LL was added and the litter was thoroughly stirred. The litter did heat and dried to about 51 to 52 percent moisture.

Birds on the PL+LL and PL treatments in the third experiment did not perform as well as the birds on the NL and the UL treatments which may have been caused by the wet litter and high ammonia levels (Table 2, Experiment 3). A high level of mortality occurred in this brood when the chicks were about 5 days of age. The Veterinary Diagnostic Laboratory indicated the presence of Salmonella organisms but the origin of this disease in the baby chicks could not be ascertained. The PL+LL and the PL groups had the highest mortality but whether the mortality was related to either the wet litter or Salmonella, or a combination of the two, or perhaps other factors could not be determined. These broilers also experienced an outbreak of chronic respiratory disease which affected them the last 2 to 3 weeks; however, mortality from this condition was not high. Broilers reared on NL or UL were heavier by an average of 0.17 pounds than broilers grown on the PL+LL treatments. Broilers grown on the NL appeared to utilize feed more efficiently than the birds grown on either the UL, PL+LL or PL treatments. However, neither the average body weight nor feed conversion at 8 weeks was significantly different.

Performance of PL+LL broilers in Experiment 4 was good (Table 2, Experiment 4). The birds grown on PL+LL and PL had an average body weight at 8 weeks of age of 4.15 pounds compared to the NL and UL groups which averaged 4.03 pounds. Feed conversions were only slightly different; however, neither average body weight nor feed conversion was significantly different. The PL+LL and PL groups had slightly higher mortality for the first 10 days. Litter moisture by the end of this experiment was about 40 percent for the PL+LL and PL pens, higher than desirable but not necessarily detrimental. Litter moisture for the NL and UL groups was a desirable 27 to 28 percent.

Combined data for the four experiments are presented in Table 3. No statistical differences were observed for either average body weight or feed conversion. Mortality for the first 10 days was approximately three times higher for the PL+LL and PL groups than the NL or UL groups. These differences were attributed to the higher mortality observed in Experiments 1 and 3 (Table 2).

Table 4 provides a summary of the condemnation report at the time of slaughter for Experiment 3. The most apparent effect of treatments on the condemnation pattern was the high level of toxemia and septicemia in the PL group. This group had the highest level of early mortality (Table 2). The PL+LL group also had a fairly high level of condemnations for toxemia and septicemia plus airsacculitis.

Chemical analyses of litter samples for the PL+LL and PL were performed at the end of Experiments 1 and 3 and the data are presented in Table 5. Nitrogen levels decreased during the composting process. Most of the other elements increased either as a result of the loss of nitrogen and other volatile components during the composting process or increased in concentration because of the feed. The addition of LL increased the percent of ash but had essentially no effect on any of the elements measured in chemical analyses.

From these results, it is evident that composting of broiler litter can be satisfactorily achieved either with or without the addition of LL. It is possible that under some conditions the addition of LL might aid the composting process but that was not true under the conditions of these experiments.

The process of composting appeared to be of value when the litter could dry. However, wet litter can present a problem in open-type houses in Oregon's wet, cool winters. Perhaps a procedure of composting in the spring or late summer might prove a good litter management program. The litter apparently can be composted and reused indefinitely. It is also a valuable fertilizer.

A firm recommendation for year-around composting cannot be made at this time but it appears of most value in spring or summer. Broiler producers should try it on a small scale before using in an entire operation.

## SUMMARY

Four broiler experiments were carried out throughout one year using four litter treatments: new (NL); used without stirring (UL); used mixed with moisture and Litter Life (PL+LL); and used litter with moisture without LL (PL). Average body weights and feed conversions for the PL+LL and PL treatments were comparable to either the NL or UL, except in Experiment 1. The first 10-day mortality for the PL+LL and PL treatments was approximately 50 percent higher than the NL or UL treatments. After the first 10 days there were no differences in mortality for the treatments. There were higher percent condemnations for the PL+LL and PL groups than for the NL and UL groups. Toxemia and septicemia accounted for approximately 50 percent of the total percent condemnation.

Chemical analyses of the PL+LL and PL after the first and third experiments indicated an increase of all analyzed mineral elements except nitrogen which was lower.

Although no firm recommendation can be given, it is suggested that broiler growers should try to use this method of composting litter on a small scale before using it for their entire operation.

## REFERENCES

1. Patrick, H., 1967. Artificial Composting Best Answer Right Now, Broiler Industry, May 1967, pp. 48, 53.

2. Howes, J. R. and C. A. Rollo, 1967. The Reuse of Poultry Litter. Auburn University Poultry Litter Seminar, October 25, 26, 1967, pp 102-120.

3. Steel, R. G. D. and J. H. Torrie, 1960. Principles and Procedures of Statistics, McGraw-Hill Book Company, Inc. New York, New York.

Table 1. Composition and calculated analysis for the broiler feed used

| Ingredient | Amount % |
|---|---|
| Corn, yellow | 68.30 |
| Soybean meal, 44% protein | 17.00 |
| Herring meal, 70% protein | 5.00 |
| Meat meal with bone, 50% protein | 6.00 |
| Alfalfa meal, 20% protein | 2.00 |
| Limestone flour | 1.00 |
| Salt, iodized | 0.30 |
| Vit.-trace min. premix[1] | 0.25 |
| Methionine hydroxy analogue (90%)[2] | 0.15 |
| Zoamix (25%)[3] | + |
| | 100.00 |
| Calculated analysis | |
| Protein, % | 20.86 |
| Metabolizable energy, kcal./kg. | 3014. |
| Calcium, % | 1.24 |
| Phosphorus, % | .75 |
| Methionine + cystine, % | .82 |

1. Supplies per kg. of diet: 3300 I.U. vitamin A; 1100 I.C.U. vitamin $D_3$; 3.3 mg. riboflavin; 5.5 mg. d-pantothenic acid; 22 mg. niacin; 191 mg. choline; 5.5 mcg. vitamin $B_{12}$; 1.1 I.U. vitamin E; 0.55 mg. vitamin K; 0.22 mg. folacin; 60 mg. manganese; 20 mg. iron; 2 mg. copper; 1.2 mg. iodine; 27.5 mg. zinc and 4.4 mg. zinc bacitracin.

2. Provided gratuitously by Monsanto Chemical Co., St. Louis, Mo.

3. Provided gratuitously by Dow Chemical Co., Midland, Michigan, and supplied at level of .05%.

Table 2. Litter treatments and broiler performance when grown throughout the year

Experiment 1 (September 22 - November 16)

| Treatment | Avg.[1] body wt. | Avg.[1] feed conversion | Mortality 0-10 days | Mortality 10-56 days | Litter moisture begin | Litter moisture end |
|---|---|---|---|---|---|---|
| | lbs. | lbs./lbs. | % | % | % | % |
| New (NL) | 4.06[b] | 2.12[a] | 9.7 | 2.0 | --- | --- |
| Used (UL) | 4.08[b] | 2.04[a] | 5.8 | 3.1 | --- | 38.9 |
| LL (PL+LL) | 3.94[a] | 2.22[a] | 13.6 | 1.7 | 37.0 | 40.3 |
| No LL (PL) | 4.15[b] | 2.00[a] | 5.6 | 1.6 | 36.0 | 41.0 |

Experiment 2 (December 5 - January 29)

| Treatment | Avg.[1] body wt. | Avg.[1] feed conversion | Mortality 0-10 days | Mortality 10-56 days | Litter moisture begin | Litter moisture end |
|---|---|---|---|---|---|---|
| | lbs. | lbs./lbs. | % | % | % | % |
| New (NL) | 3.73[a] | 2.39[a] | 0.6 | 1.1 | --- | 48.9 |
| Used (UL) | 3.69[a] | 2.33[a] | 0.3 | 1.7 | --- | 46.5 |
| LL (PL+LL) | 3.89[a] | 2.33[a] | 2.5 | 1.4 | --- | 55.1 |
| No LL (PL) | 3.87[a] | 2.39[a] | 1.9 | 1.9 | --- | 52.9 |

Experiment 3 (February 15 - April 11)

| Treatment | Avg.[1] body wt. | Avg.[1] feed conversion | Mortality 0-10 days | Mortality 10-56 days | Litter moisture begin | Litter moisture end |
|---|---|---|---|---|---|---|
| | lbs. | lbs./lbs. | % | % | % | % |
| New (NL) | 4.03[a] | 2.22[a] | 2.8 | 1.7 | --- | --- |
| Used (UL) | 4.00[a] | 2.29[a] | 2.5 | 2.8 | --- | --- |
| LL (PL+LL) | 3.87[a] | 2.30[a] | 6.9 | 2.8 | 52.0 | --- |
| No LL (PL) | 3.86[a] | 2.28[a] | 18.0 | 2.0 | 51.2 | --- |

Experiment 4 (May 1-June 26)

| Treatment | Avg.[1] body wt. | Avg.[1] feed conversion | Mortality 0-10 days | Mortality 10-56 days | Litter moisture begin | Litter moisture end |
|---|---|---|---|---|---|---|
| | lbs. | lbs./lbs. | % | % | % | % |
| New (NL) | 4.05[a] | 2.28[a] | 0.9 | 1.7 | --- | 28.4 |
| Used (UL) | 4.02[a] | 2.25[a] | 0.3 | 2.0 | --- | 27.1 |
| LL (PL+LL) | 4.17[a] | 2.25[a] | 2.3 | 1.4 | --- | 38.9 |
| No LL (PL) | 4.14[a] | 2.27[a] | 2.0 | 1.2 | --- | 40.0 |

1. Values with different superscripts are significantly different at $P<0.05$

Table 3. Average of all four experiments on litter treatments

| Treatment | Avg.[1] body wt. | Avg.[1] feed conversion | Mortality 0-10 days | Mortality 10-56 days |
|---|---|---|---|---|
| | lbs. | lbs./lbs. | % | % |
| New (NL) | 3.97[a] | 2.25[a] | 3.5 | 1.6 |
| Used (UL) | 3.95[a] | 2.23[a] | 2.2 | 2.4 |
| LL (PL+LL) | 3.97[a] | 2.28[a] | 6.3 | 1.8 |
| No LL (PL) | 4.01[a] | 2.24[a] | 6.9 | 1.7 |

1. Values with different superscripts are significantly different at $P<0.05$.

Table 4. Condemnation report of Experiment 3 on litter treatments

| | New (NL) | Used (UL) | LL (PL+LL) | No LL (PL) |
|---|---|---|---|---|
| Total number of live birds | 346. | 345. | 290. | 327. |
| Percent condemned for: toxemia and septicemia | 1.45 | 0.58 | 1.03 | 2.45 |
| airsacculitis | 0 | 0 | 1.03 | 0 |
| bruises | 0 | 0 | 0 | 0.31 |
| cadavers | 0.29 | 0.29 | 0 | 0 |
| Total (%) | 1.74 | 0.87 | 2.06 | 2.76 |
| Total (number) | 6. | 3. | 6. | 9. |

Table 5. Chemical analyses of litter samples on a dry matter basis

| | Moisture | Ash | Nitrogen | Phosphorus | Potassium | Magnesium | Calcium | Copper | Manganese | Zinc | Sulfur |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | % | % | % | % | % | % | % | ppm | ppm | ppm | % |
| <u>After Experiment 1</u>: | | | | | | | | | | | |
| LL, before composting | 25.0 | 9.2 | 2.54 | 0.52 | 1.08 | 0.38 | 0.93 | 14 | 180 | 142 | 0.270 |
| No LL, before composting | 26.0 | 8.9 | 2.20 | 0.50 | 1.08 | 0.34 | 0.87 | 16 | 159 | 147 | 0.275 |
| LL, after composting | 36.2 | 16.2 | 1.67 | 0.60 | 1.29 | 0.43 | 1.04 | 13 | 194 | 143 | 0.302 |
| No LL, after composting | 37.1 | 9.8 | 1.60 | 0.60 | 1.25 | 0.38 | 0.99 | 15 | 178 | 157 | 0.315 |
| LL, change in composting | +11.2 | + 7.0 | -0.87 | +0.08 | +0.21 | +0.05 | +0.11 | - 1 | + 14 | + 1 | +0.32 |
| No LL, change in composting | +11.2 | + 0.9 | -0.60 | +0.10 | +0.25 | +0.04 | +0.12 | - 1 | + 19 | + 10 | +0.40 |
| <u>After Experiment 3</u>: | | | | | | | | | | | |
| New (used 1st trial) | 52.8 | 10.2 | 2.75 | 0.89 | * | 0.37 | * | 29 | 159 | 140 | 0.341 |
| Used (used 3rd trial) | 49.8 | 13.2 | 3.25 | 1.06 | * | 0.46 | * | 26 | 221 | 170 | 0.382 |
| LL, before composting | 52.9 | 25.5 | 2.94 | 1.39 | * | 0.59 | * | 43 | 274 | 234 | 0.532 |
| No LL, before composting | 51.0 | 16.9 | 3.47 | 1.66 | * | 0.56 | * | 46 | 267 | 229 | 0.532 |
| LL, after composting | 50.5 | 29.0 | 1.95 | 1.58 | * | 0.60 | * | 31 | * | 214 | 0.543 |
| No LL, after composting | 50.7 | 18.6 | 2.40 | 1.83 | * | 0.58 | * | 34 | * | 210 | 0.577 |
| LL, change in composting | - 2.4 | + 3.5 | -0.99 | +0.19 | * | +0.01 | * | - 12 | * | - 20 | +0.01 |
| No LL, change in composting | - 0.3 | + 1.7 | -1.07 | +0.17 | * | +0.02 | * | - 12 | * | - 19 | +0.04 |

*Figures were either not available or were of questionable accuracy.