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Mississippi Broiler Litter: Fertilizer Value and Quantity Produced

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INTRODUCTION

The Mississippi poultry industry produces more than 730 million broiler chickens each year. Poultry litter, a mixture of poultry manure and the bedding material used in a poultry house, is a valuable source of plant nutrients and is a valuable soil amendment. Poultry litter should be used at a rate that meets but does not exceed plant nutrient requirements. To properly use litter as a fertilizer or soil amendment, the nutrient value of the litter and the quantity of litter available must be known. Patterson *et. al*. (1998) reported fresh broiler litter produced in Pennsylvania contained 31% moisture and 75 pounds of nitrogen (N), 62 pounds of phosphorus (P), and 44 pounds of potassium (K) per ton; it is produced at a rate of 1.4 tons per 1,000 broilers. Fresh broiler litter in Georgia contained 66 pounds of N, 50 pounds of P, and 40 pounds of K per ton, and it is produced at a rate of 1.2 tons per 1,000 broilers (Vest *et. al*, 1994). Fresh broiler litter in Alabama contained 20% moisture and 62 pounds of N, 60 pounds of P, and 40 pounds of K per ton; it is produced at a rate of 1 to 1.4 tons per 1,000 broilers (Mitchell and Donald, 1995). Clearly, there is variation in the nutrient content and quantity of litter produced in various states. To date, no data exist describing the nutrient value and quantity of broiler litter in Mississippi. Additionally, none of the aforementioned data described the change in nutrient content and the quantity of litter produced as multiple flocks are grown on the same litter. Therefore, our objective was to determine the fertilizer value of Mississippi broiler litter and the quantity of broiler litter produced in the state as it is related to the age of the litter.

MATERIALS AND METHODS

Litter Sampling — A broiler litter sample submitted for laboratory analysis must be representative of all of the litter in a broiler house. To collect a litter sample that was representative of the entire house, 20 random samples were taken throughout each broiler house. These 20 samples were placed in a large container and thoroughly mixed together. After mixing the samples, a 1-quart subsample of the litter was collected from the container, and the sample was placed in a sealable plastic bag. The final sample was stored in a cool, dry place until it was submitted to the laboratory for determination of the nutrient value.

Litter Quantity — The quantity of broiler litter was determined by analysis of samples from three broiler farms. Each load of litter removed from a single broiler house on each farm was weighed as it was removed from the house. In addition, the ability to predict the amount of litter in each broiler house was tested. A known volume of litter was weighed and the depth of the litter was measured at 25 random locations in a broiler house. The total volume of litter in the house, in cubic feet, was determined by multiplying the length of the house by the width of the house by the average litter depth. Multiplying the total cubic feet of litter in a house by the average weight of a cubic foot of litter provided the total predicted weight of litter in the house.

Litter Fertilizer Nutrient Value — Broiler litter samples were collected from 197 broiler houses in Mississippi from 1998 through 2000. Samples were collected across a wide range of litter ages (1-28 flocks of production). All litter samples were submitted to the Mississippi State Chemical Laboratory for determination of N-P-K.

Statistical Analysis — All data were analyzed using the General Linear Models procedure of the SAS Institute (1988). The means were compared by Fisher's Protected Least Significant Difference (Steele and Torrie, 1980).

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Results and Discussion

Effect of Litter Age on Nutrient Content of Fresh Broiler Litter

The moisture content and the fertilizer nutrient content of the various ages of fresh broiler litter are presented in Table 1. The moisture content of broiler litter ranged from 17% to 22%, and there were no consistent differences in moisture content across all ages of litter. The average moisture content of all litter samples was 19%. The nitrogen content of fresh broiler litter increased from 42 pounds per ton after one flock of production to 60 pounds per ton after five flocks, and it remained constant from five to 28 flocks of production. The average nitrogen content across all ages of litter was 57 pounds per ton. The phosphate level in fresh broiler litter increased from 22 pounds per ton after one flock of production to 29 pounds per ton after three flocks of production. Phosphate level was not statistically different through 28 flocks of production, with the exception of litter that had produced eight flocks of broiler chickens. An unexplained high level of phosphate in the litter that had produced eight flocks of broilers was seen and may be attributable to sampling error. The average phosphate content across all ages of litter was 29 pounds per ton. The potash level in fresh broiler litter increased from 45 pounds per ton after one flock of production to 57 pounds per ton after four flocks of production, and it remained constant through 10 flocks of production. The potash level in litter that had produced 21-28 flocks ranged from 64-66 pounds per ton, which was significantly higher than the 57 pounds per ton in the litter produced after four flocks of production. The average potash content across all ages of litter was 59 pounds per ton.

Table 1. Effect of litter age on moisture and nutrient content of fresh Mississippi broiler litter.

Litter age	Moisture	Nitrogen (N)	Phosphate (P_2O_5)	Potash (K_2O)
	%	*lb/ton*	*lb/ton*	*lb/ton*
1 Flock	20ab	42h	22f	45g
2 Flocks	20ab	46gh	23ef	47fg
3 Flocks	21ab	51fg	29bcde	52ef
4 Flocks	20ab	52efg	24ef	57de
5 Flocks	20ab	60bcd	29bcde	59bcd
6 Flocks	21ab	57cde	33abc	61abcd
7 Flocks	21ab	57def	31bcd	64ab
8 Flocks	22a	63abc	39a	58cde
9 Flocks	20ab	63abc	35ab	63abc
10 Flocks	20ab	61bcd	33abc	63abc
21 Flocks	20ab	65ab	25def	64abc
23 Flocks	17c	65ab	28cdef	65ab
25 Flocks	20ab	64ab	32bc	66a
28 Flocks	19bc	67ab	29bcde	65ab
Average	**19**	**57**	**29**	**59**

Effect of Litter Age on Nutrient Content of Broiler Litter on a Dry-Matter Basis

The dry matter nutrient content of the various ages of broiler litter is presented in Table 2. Dry matter nitrogen in broiler litter increased from 51 pounds per ton after one flock of production to 75 pounds per ton after five flocks of production, and it remained constant after five flocks of broilers had been produced on the litter. The average dry matter nitrogen content across all ages of litter was 71 pounds per ton. Dry matter phosphate increased from 27 pounds per ton after one flock of production to 36 pounds per ton after three flocks of production. Phosphate content remained unchanged through 28 flocks of production, with the exception of eight flocks of production. As with the phosphate levels in fresh litter, there was an inexplicable high level in the litter that had produced eight flocks of broilers. This unexplained high level could be attributable to sampling error. The average dry matter phosphate content across all ages of litter was 36 pounds per ton. Dry matter potash increased from 55 pounds per ton after one flock of production to 71 pounds per ton after four flocks of production, and it remained constant through 10 flocks of production. The potash level in litter that had produced 21-28 flocks ranged from 79-83 pounds per ton, which was significantly higher than the 71 pounds per ton in the litter produced after four flocks of production. The average dry matter potash content across all ages of litter was 73 pounds per ton.

Table 2. Effect of litter age on nutrient content of Mississippi broiler litter on a dry-matter basis.

Litter age	Nitrogen (N)	Phosphate (P_2O_5)	Potash (K_2O)
	lb/ton	*lb/ton*	*lb/ton*
1 Flock	51h	27e	55e
2 Flocks	55h	27e	56e
3 Flocks	63g	36bcd	65d
4 Flocks	65fg	31de	71cd
5 Flocks	75bcde	36bcd	74bc
6 Flocks	71def	41b	76abc
7 Flocks	71efg	39bcd	80ab
8 Flocks	81abc	50a	74bc
9 Flocks	76abcde	42ab	76abc
10 Flocks	73cde	41b	77abc
21 Flocks	81abc	32cde	79ab
23 Flocks	79abcd	34bcde	79ab
25 Flocks	79abcd	40bc	83a
28 Flocks	82ab	35bcde	79ab
Average	**71**	**36**	**71**

Effect of Integrator on Nutrient Content of Fresh Broiler Litter

The moisture content and the nutrient content of the various ages of fresh broiler litter grouped by integrator are presented in Table 3. Moisture levels ranged from 18% to 21%, with no observed differences in moisture content among integrators. Litter produced by integrators 5 and 2 contained 43 pounds per ton and 50 pounds per ton of nitrogen, respectively — less nitrogen than was contained in litter produced by the other four integrators. Litter produced by integrators 3 and 4 contained 64 pounds per ton and 67 pounds per ton of nitrogen, respectively — more nitrogen than was contained in litter produced by the other four integrators. The litter collected from integrator 5 contained 21 pounds of phosphate per ton, which was less than the phosphate in litter from the other integrators. The litter from integrators 1, 2, and 5 contained 55, 56, and 51 pounds of potash per ton, respectively, which was less potash than in the litter produced by integrators 3, 4, and 6.

Table 3. Effect of integrator on moisture content and nutrient content of fresh Mississippi broiler litter.

Integrator	Moisture	Nitrogen (N)	Phosphate (P_2O_5)	Potash (K_2O)
	%	*lb/ton*	*lb/ton*	*lb/ton*
1	21a	57b	32a	55b
2	21a	50c	29a	56b
3	20a	64a	30a	64a
4	19a	67a	32a	64a
5	18a	43d	21b	51b
6	20a	57b	28a	63a

Effect of Integrator on Nutrient Content of Broiler Litter on a Dry-Matter Basis

The dry matter fertilizer nutrient content of the various ages of broiler litter is presented in Table 4. Litter collected from integrator 5 contained 52 pounds of nitrogen per ton, which was significantly lower than litter nitrogen for the remaining integrators. The litter from integrator 3 contained 80 pounds of nitrogen per ton, which was higher than litter nitrogen levels for the remaining integrators. Litter produced by integrator 5 contained 25 pounds of phosphate per ton, which was significantly lower that the phosphate level in the litter for the other integrators. Integrator 5 produced litter with the lowest potash level (61 pounds per ton), while integrators 6 and 3 produced litter with the highest potash levels — 78 pounds per ton and 80 pounds per ton, respectively.

Table 4. Effect of integrator on nutrient content of Mississippi broiler litter on a dry-matter basis.

Integrator	Nitrogen (N)	Phosphate (P_2O_5)	Potash (K_2O)
	lb/ton	*lb/ton*	*lb/ton*
1	72b	41a	70b
2	64c	35a	70b
3	80a	37a	80a
4	71b	34a	70b
5	52d	25b	61c
6	69bc	35a	78a

Quantity of Broiler Litter Produced

Litter production was measured on two broiler farms at the end of 1 year (five flocks) of production. Litter was produced at a rate of 1.6 tons per 1,000 birds placed in the house. Litter production was determined on one farm at the end of 2 years (10 flocks) of production. Litter was produced on this farm at a rate of 1 ton per 1,000 birds placed. The decrease in the amount of litter produced over time may be attributable to natural decomposition of the litter due to microbial action. Mississippi produced 739.9 million broilers in 2000. If all broiler houses in Mississippi were cleaned out on an annual basis, 1.2 million tons of broiler litter would be produced. If all broiler houses in Mississippi were cleaned out on a biannual basis, only 739,900 tons of litter would be produced.

Predicted litter production was determined on the same three farms. Broiler litter weighs 31.6 pounds per cubic foot. The average amount of litter predicted to be in a broiler house at the end of 1 year of production (five flocks) was 68% (99 tons vs. 146 tons) of the actual amount of litter in the house. The predicted amount of litter in a broiler house at the end of 2 years of production (10 flocks) was 82% (210 tons vs. 258 tons) of the actual amount of litter in the house.

Conclusion

Litter moisture was not affected by litter age or by integrator. N-P-K levels (pounds per ton) increased during the first five flocks of production, but remained relatively unchanged from five to 28 flocks of production. N-P-K levels are affected by the integrator producing the litter. The differences in litter nutrients among integrators may be attributed to differences in the feed formulation and house management used by each integrator. Litter in a broiler house is not produced in a linear fashion, as one might think. That is, there is not 10 times as much litter in a broiler house after 10 flocks of production as is in that house after one flock of production. A natural decomposition of the litter due to microbial action may be occurring in the broiler house that prevents the quantity of litter from building up in a linear fashion over time.

In addition, the moisture content, nutrient content, and quantity of fresh broiler litter produced in Mississippi are different from those values reported in other states (Table 5). Why is the composition of broiler litter different from state to state? Differences in litter composition exist from integrator to integrator (Table 3), and every broiler integrator does not operate in each of the broiler-producing states. Thus, differences in litter moisture, N-P-K, and quantity of litter produced will exist among the broiler-producing states due to variations in feed formulations and poultry house management used by the integrators operating in each state.

Table 5. Profile of fresh broiler litter produced in four states.

State	Moisture	N	P	K	Litter production[1]	Reference
	%	*lb/ton*	*lb/ton*	*lb/ton*	*tons*	
Alabama	20	62	60	40	1-1.4	Mitchell and Donald, 1995
Georgia	—	66	50	40	1.2	Vest *et. al.*, 1994
Mississippi	19	57	29	59	1-1.6	Table 1
Pennsylvania	31	75	62	44	1.4	Patterson *et. al.*, 1998

[1]Measured in tons per 1,000 birds.

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