Effects of stocking density and litter type on litter quality of native chicken

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Abstract. This study was conducted to identify the effect of stocking density and litter materials on litter quality of Native chicken. Three hundred and twenty-four unsexed native chickens were used for 12 weeks duration of this research. The day-old chickens were randomly assigned in three stocking density groups: 8, 12 and 16 chickens/m². Each stocking density group was further divided in three litter groups: rice hull, wood shaving and corn cob. Chickens in each group were randomized in to three replicates at hatch were housed in a deep litter pen (1x1 m). The data of litter temperature, pH, water holding capacity, water and ammonia content were analyzed by analysis of variance, then followed by Duncan’s Multiple Range Test. The result showed that the stocking density had significant effect on the litter temperature, litter pH, water content and ammonia. The litter materials had significant effect on litter pH, water holding capacity, water and ammonia content. It is concluded that greater stocking density of more than 8 chicken per square meter and rice hull type of litter material was degraded the litter quality. Litter materials of wood shavings and corn cobs can be used as a substitute for rice hull.

1. Introduction

The Native chicken population reached 285.5 million in 2015, then increased to 310.9 million in 2018 [1]. Increasing the population of native chickens in line with an increase in the number of farms. The number of farms increased significantly because the demand and prices of native chickens were relatively stable. The increase in intensive farming has an impact on the demand for land to build the pens. Limited land needs a solution, such as to increase the stocking density.

One of the main factors influencing litter quality is litter or bedding material and providing high litter quality. An ideal litter material should be dry with high water absorption capacity, but should also be able to release the absorbed moisture quickly [2]. Rice hulls is commonly used as poultry litter. Limited supplies, higher cost, and unavailability of suitable material have encouraged the search for alternative litter materials.

There is an important relationship between stocking density and litter quality. Especially, in high stocking density conditions, litter material had been disturbed faster than low density and higher levels of litter moisture may result in some problems [3]. Controlling the environment of the birds, particularly in-house humidity and ammonia along with litter moisture is crucial to provide good production. This research aims to identify ideal stocking density and other litter material sources as an alternative litter with abundant availability, such as wood shaving and corn cobs.
2. Materials and methods

2.1. Research material
The research used three hundred and twenty-four unsexed day-old chick (DOC) of native chicken. The feed contained rice bran, milled corn, meat bound meals, soybean meal, premix, DL-methionine and L-Lysine. They were prepared based on feeding standards of native chicken [4], with content of protein, fat, crude fiber, calcium content, phosphorus, lysine, methionine was 16.26%; 4.9%; 7.5%; 1.9%; 0.5%; 0.8%; 0.3% and content 2894.01 kcal/kg ME, respectively. The research used 27 units deep 1 m² litter pen, feeder tray, hanging feeder, drinker, thermometer, pH meter, Ammonia Smart Tester AR8500, Moisture Tester and digital scales, and 40-watt incandescent lamps for each pen as a brooder.

2.2. Methods
Three hundred and twenty-four DOC of native chickens were placed randomly into 27 pen units, consisted of 9 treatment groups (3 pen densities and 3 litter materials) with 3 replications. There were 3 densities (8, 12 and 16 chickens/m²), with litter material (rice hulls, wood shavings and corn cobs). Each pen used fresh litter material as much 12.8 kg/m² with the litter thickness 12 cm.

2.2.1. Litter temperature. The litter temperature was measured using a digital thermometer of each pen by inserting the thermometer into the litter.

2.2.2. Litter pH. The pH was recorded using an electronic meter after 30 g of macerated litter were added to 250 mL of water, agitated for 5 min, and suspended for 30 min [5].

2.2.3. Water holding capacity. Litter samples were collected at the beginning and end of the experiment from five locations within each pen (four equidistant from each corner and one central), and thoroughly mixed. Amounting 50 g of litter was placed in a 500-mL beaker; the beaker was filled with water and left to stand for 30 min; excess water was then drained for 3 min and the sample was weighed again; the percentage of water absorbed was calculated [5, 6].

2.2.4. Water content. Water content was measured using the proximate method. Petri dish was weighed (ms), litter sample was put into petri dish and weighed again (ms1), fed was also put into oven to 105 ⁰C for 1 hours. The samples were cooled and weighed (ms2).

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\text{Water content} = \frac{(ms1 - ms) - (ms2 - ms)}{(ms1 - ms)} \times 100 \% 
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2.2.5. Ammonia. Ammonia was measured with digital ammonia meter. A small chamber was placed into the pen and was allowed to stand for 5 minutes, then the smart sensor was turned on and waited until the sensor warms up and the ppm showed zero. After that, it was put into the chamber, then the number of constant ammonias showed.

2.3. Statistic
Data were analyzed by analysis of variance according to Complete Randomized Design of Factorial 3×3 Patterns. It was followed by Duncan's New Multiple Range Test (DMRT) test.

3. Results and discussion
The effect of litter type and stocking density on the final litter quality of native chicken summarized in Table 1. The stocking density and litter type had significant effect on the litter pH, water content and ammonia. Litter temperature only affected by stocking density and water holding capacity only
affected by litter material. However, there is no interaction between stocking density and type of litter material on litter quality parameters.

The increase in litter temperature in high stocking density attributed to the increasing number of excreta production. Each chicken produces more excreta per day at 6.6% of body weight [7]. Increasing the amount of excreta increases the activity of litter microorganisms and speeds up the bacterial fermentation process that can produce the heat. High litter water content will spur the fermentation process which will increase heat production thereby increasing the litter temperature [8].

**Table 1. Effect of stocking density and litter material on litter quality**

| Treatments                        | Litter temperature (°C) | pH   | Water holding capacity (%) | Water content (%) | Ammonia (ppm) |
|-----------------------------------|-------------------------|------|---------------------------|------------------|---------------|
| Stocking density (chicks/m²)      |                         |      |                           |                  |               |
| 8                                 | 31.6±0.77а              | 8.02±0.23а | 78.17±1.03               | 23.17±2.54а     | 8.6±3.4а     |
| 12                                | 34.11±1.94а            | 8.20±0.11аб | 78.14±0.97               | 25.74±2.44аб    | 12.3±3.3аб   |
| 16                                | 37.00±2.31е            | 8.25±0.27е   | 77.76±1.11               | 27.97±2.90е     | 15.9±4.9е    |
| Litter type                        |                         |      |                           |                  |               |
| Rice hull (RH)                    | 34.51±3.61а            | 8.34±0.22а   | 77.41±0.67а              | 23.90±2.36а     | 15.6±5.5а    |
| Wood shaving (WS)                 | 33.66±2.48а            | 8.06±0.19а   | 77.79±1.08а              | 25.10±2.79а     | 9.7±3.4а     |
| Corncob (CC)                      | 34.60±2.45а            | 8.07±0.18а   | 78.85±0.69а              | 27.88±3.33а     | 11.5±3.8а    |
| Stocking density × Litter type    |                         |      |                           |                  |               |
| 8 × RH                            | 31.67±0.76а            | 8.27±0.04а   | 77.43±0.78а              | 22.03±2.20а     | 11.8±3.3а    |
| 8 × WS                            | 31.43±0.86а            | 7.90±0.23а   | 78.29±1.09а              | 22.40±1.35а     | 7.0±3.4а     |
| 8 × CC                            | 31.87±0.94а            | 7.89±0.11а   | 78.78±1.03а              | 25.07±2.92а     | 7.0±1.0а     |
| 12 × RH                           | 34.00±2.91а            | 8.32±0.07а   | 77.48±0.92а              | 23.90±1.90а     | 14.0±2.6а    |
| 12 × WS                           | 33.17±1.81а            | 8.13±0.09a   | 77.87±0.55а              | 25.40±1.59а     | 10.5±2.6а    |
| 12 × CC                           | 35.17±0.55а            | 8.15±0.08а   | 79.06±0.81а              | 27.93±2.29а     | 12.4±1.0а    |
| 16 × RH                           | 37.87±3.71а            | 8.44±0.39а   | 77.33±0.57а              | 25.77±1.85а     | 21.2±3.3а    |
| 16 × WS                           | 36.37±1.30а            | 8.16±0.17а   | 77.24±1.54а              | 27.50±2.17а     | 11.5±3.1а    |
| 16 × CC                           | 36.77±2.03а            | 8.16±0.19а   | 78.72±2.09а              | 30.63±2.70а     | 15.2±2.5а    |

**ANOVA**

|                        | Stocking density | Litter type | Stocking density × Litter type |
|------------------------|------------------|-------------|-------------------------------|
| Stocking density      | < 0.05          | n.s         | n.s                           |
| Litter type           | n.s             | < 0.05      | n.s                           |
| Stocking density × Litter type | n.s | n.s         | n.s                           |

а, b, c Mean within columns with different superscripts are significantly different (P<0.05, P<0.01), n.s: not significant.

Litter pH was influenced by the differences in stocking density and type of litter material used. High pen density increased the excreta production leading to increase in litter pH [9]. Excreta production stimulated microbial fermentation activity in litter, which affects litter pH. Litter pH was influenced by the presence of substrate produced by a microbial activity because of the fermentation process [10]. Different types of litter material made a difference in litter pH [11]. Increasing pen density from 8 to 16 increased litter water content, because the higher stocking density increase excreta production. The water content of excreta is 76% [12, 13]. The litter of milled corncobs has higher water content because it has smaller particle sizes, wider area surface resulting in higher absorbency.

Stocking density level did not affect the litter water holding capacity because the absorption depends on the type and particle size of the litter material used. The largest water holding capacity was indicated by milled corncobs because the corncobs litter has a wider surface area than the surface area of rice hulls. Therefore, the absorption of water by corncobs litter is higher than rice hulls. The water holding capacity of litter increases along with the increase of the litter material surface area [14].

Ammonia litter levels was affected by stocking density and types of litter material, although no interaction occurs between them. Ammonia levels increased in high stocking density because there
were more excreta accumulates in each pen due to increasing density in the pen. Excreta that accumulates, dead bacteria and water content emit the ammonia gas. One of the factors that influencing the process of degradation of metabolic waste into ammonia is the density of livestock and air circulation in the pen. The higher stocking density increased of ammonia content [15]. Levels of ammonia in different types of litter material influenced by pH level on each litter material. Rice hulls litter has the highest ammonia content due to its higher pH than wood shavings litter and corn cob litter. The higher pH increased ammonia production. Litter pH under 7 depressed ammonia production, while pH upper 7 would increase ammonia gas production.

4. Conclusion
The high stocking density more than 8 chickens per square meter and rice hull litter material degraded the litter quality. Wood shavings and corn cobs can substitute the rice hull litter because it provides a better indicator of litter quality.

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