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Effect of various deep litter systems on the performance and profitability in egg laying birds

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Abstract
The aim of this study was to determine the selection of bedding material used in poultry birds during the rearing period. Total 72 chicks (Rhode Island Red, Punjab Red and Kadaknath) were used on a completely randomized design in four treatments of deep litter materials *i.e.* wheat straw, rice husk, mustard stalk and sand. This study includes four treatments along with three replicates and each replicate consists of 18 birds. Standard feeding and management practices were followed during the experimental period. Differences in body weight of adults, feed intake and egg production and weight of chicks reared on wheat straw, rice husk and mustard stalk were significantly higher than those of sand. There was a similarity in egg length, egg width, and egg shape index among the different litter materials. The moisture content increased from 8.15 to 40.4% in wheat straw, 11.4 to 45.3% in rice husk, 7.80 to 38.7% in mustard stalk and 2.2 to 17.4% in sand during the study. The cost of litter for rearing one bird in deep litter system was Rs. 1.90, 0.95, 0.85 and 0.80 for sand, mustard stalk, rice straw and wheat straw respectively. It was concluded that any of these three bedding materials (wheat straw, rice husk and mustard stalk) may be used and these are cheap and locally available to the poultry entrepreneurs. Overall rice husk gives excellent results as they have the ability to absorb the moisture and remain dry which is the basic requirement of deep litter system. The manure quality of rice husk is very excellent as compare to other materials. Birds as well as health is more vigour in rice husk as compared to other materials.

Keywords: Deep litter, feed intake, litter materials, moisture content

1. Introduction
Poultry is the most organised sector in animal production system. The growth is 6-8% in layers and 10-12% in broilers per year against the growth of agriculture as a whole which is around 2.5%. Within a span of 25 years, the egg production has gone up to 70 billion from few millions and the broiler production has gone to 3.8 million tonne from nowhere. India is the third-largest egg producer after China and USA and the fourth-largest chicken producer after China, Brazil and USA. The per capita eggs consumption has gone up from 30 to 68 and the chicken from 400 gm to 2.5 kg.

To obtain maximum egg and meat production, management in the poultry house is very essential. One of the managemental practices is the proper maintenance of poultry litter commonly named as deep litter system of management. The litter material is used in a poultry farm to give more comfort to the birds for best profitable outcomes. The quality of litter material significantly influences the overall performances of the broilers as well as the chickens. A good litter serves as an insulator to maintain uniform temperature round the year and also acts as a blotter through absorbing the extra moisture of the feces & urine by increasing surface area of the floor which prevents fungal contamination. The quality of litter significantly influences the overall performance and ultimately the profit. Litter plays a vital role in absorbing the fecal moisture, promotes drying by increasing surface area of the house floor, insulates chick from cooling effects of the ground and provide a protected cushion. Litter material helps to conserve heat by insulation and provide supplemental heat through fermentation by feacal microorganisms. It receives droppings and absorbs moisture from faeces and respiratory processes. It provides a warm, soft and spongy surface for optimum comfort of the birds.

A variety of litter material including paper products (Lien *et al.* 1992) [9], gypsum (Grimes *et al.* 2007), hardwood bark (Brake *et al.* 1992), peanut hulls (Lien *et al.* 1998), sand (Shields *et al* 2005) [15], rice and wheat straw (Sreehari and Sharma, 2010) [16], ground corn cob and soybean straw (De Avila *et al* 2008) [2] have been used as substitute bedding materials with various level of success. Particle size, absence of dust, bulk density, thermal conductivity, drying rate and compressibility make pine shavings an ideal bedding material for broilers & layer birds.

Therefore, the first aim of the present research was to assess the selection by rearing egg laying birds in different types of materials widely used as litter in the poultry industry (wheat straw, rice husk, mustard stalk (*Phulk*) and sand). The second objective of this study was to determine the predominant behaviours on each of these materials. Moreover, the characteristics of the materials used as egg laying birds substrate must be taken into account, because some substrates may enrich the environment and support important behaviours of the birds (Gunnarson *et al.* 2000) [6], as well as determine chickens' skin condition (Mendes *et al.* 2011) [10]. Thus, providing a good litter would be an effective way to increase broiler activity (Shields *et al* 2005) [15] and to reduce locomotion problems (Almeida Paz *et al.* 2010) [1].

2. Materials and Methods

2.1 Experiment details

The experiment was conducted at Poultry Unit of *Krishi Vigyan Kendra* (KVK), Bathinda (Punjab, India) during 2017-18. Four (12 m × 10 m) broiler houses were internally divided in four pens each. For the present study, up to one year of layer chicks of Rhode Island Red, Punjab Red and Kadaknath were reared. There were four treatments of litter material *i.e.* wheat straw, rice husk, mustard stalk (*Phulk*) and sand and each treatment was then replicated three times of 18 chicks each in Completely Randomized Design (CRD). The chicks were routinely vaccinated and reared under strict hygienic conditions maintaining all standard managemental practices including brooding, proper lighting, raking of litter, cleaning of feeders and drinkers etc. The birds belonging to all the experimental groups were closely observed throughout the experiment, starting from day old till the end of experiment *i.e.* one year of egg laying period (52 weeks of egg production).

2.2 Data recording

The gain in body weight for each bird was recorded on weekly basis by subtracting the initial body weight from the weight recorded at the end of each week. The feed and water was offered as per feeding standard and the leftover feed was recorded at next morning. Feed consumption was calculated for each group by subtracting the leftover feed from the feed offered. At the end of the experiment, the birds were kept fasting for 5-6 hours and no feed was offered during this withdrawal period to keep the crop of the bird empty at slaughtering time. Three birds were randomly selected from each replicate, weighed and immediately slaughtered. Samples of litter were taken in plastic bags from each replicate on weekly basis to determine the amount of moisture. Water absorbing or holding capacity was determined according to procedure described by Davasgaium and Boodoo (2000) [4]. Economics of each litter material was calculated according to prevailing market prices at the time of the trial. Five eggs were selected at random from each replicate. They were weighed and the following quality parameters were determined: egg weight, egg length, egg width and Egg Shape Index.

Egg weight (g): The Egg Weight (EW) was measured with an electronic balance to the nearest 0.01 g.

Egg Shape Index: The shape index was calculated using the following formula (Anderson *et al* 2004):

$$SI = \times \frac{W}{L} 100$$

Where, W = Width of egg

L = Length of egg

2.3 Data analysis

The data were statistically analyzed with the standard procedures of Analysis of Variance (ANOVA), using Completely Randomized Design, as described by Steel and Torrie (1981) [17]. The means were compared for significance of difference with the Duncan's Multiple Range Test for variables. The statistical package (SAS, 2000) [13] was used to perform the above analysis.

3. Results and Discussion

3.1 Growth performance of birds

Data pertaining to the body weight of birds on different deep litter materials shows that body weight of birds of all three breeds *i.e.* Rhode Island Red (RIR), Punjab Red and Kadaknath were significantly higher on rice husk, wheat straw and mustard stalk than sand (Table 1). Significantly ($P < 0.05$) higher body weight of birds of all three breeds were observed on rice husk as compared to other litter materials but there was no significant difference between wheat straw and mustard stalk for body weight of birds of all three breeds. Similarly, feed intake by birds on rice husk, wheat straw and mustard stalk were significantly higher than sand. Birds of RIR and Punjab Red lays significantly higher eggs on rice husk than other deep litter materials, while Kadaknath results in lays similar amount of eggs on wheat straw and rice husk and significantly higher than mustard stalk followed by sand. This is in agreement with the findings of Davasgaium and Boodoo (2000) [4].

3.2 Egg quality

Data pertaining to the quality of eggs of birds of different breeds such as Rhode Island Red (RIR), Punjab Red and Kadaknath on different deep litter materials was shown in Table 2. The egg weight in rice husk, wheat straw and mustard stalk were significantly higher than those of sand. There was non-significant effect on egg weight among rice husk, wheat straw and mustard stalk. There was a similarity in egg length, egg width, and egg shape index

Table 1: Performance of birds reared on four types of litters

Types of litter	Body weight of adults at 20 weeks (g)			Feed intake (g/bird/day)			Egg production (no/year)		
	RIR	Punjab Red	Kadaknath	RIR	Punjab Red	Kadaknath	RIR	Punjab Red	Kadaknath
Wheat straw	1.85 ^{b}	2.20 ^{b}	2.20 ^{b}	129 ^{a}	134 ^{a}	138 ^{b}	180 ^{b}	160 ^{b}	190 ^{a}
Rice husk	1.90 ^{a}	2.20 ^{a}	2.25 ^{a}	130 ^{a}	135 ^{a}	139 ^{a}	190 ^{a}	170 ^{a}	190 ^{a}
Mustard stalk	1.85 ^{b}	2.15 ^{b}	2.20 ^{b}	129 ^{a}	134 ^{a}	135 ^{b}	170 ^{c}	150 ^{c}	185 ^{b}
Sand	1.80 ^{d}	2.10 ^{c}	2.15 ^{c}	125 ^{b}	130 ^{b}	132 ^{c}	175 ^{d}	150 ^{c}	180 ^{c}

Means in the column with similar superscripts are not significantly different at $P<0.05$

Table 2: Quality of eggs of birds reared on four types of litters

Types of litter	Egg weight (g)			Egg length (cm)			Egg width (cm)			Egg shape index		
	RIR	PR	KN	RIR	PR	KN	RIR	PR	KN	RIR	PR	KN
Wheat straw	57.8 [b]	59.5 [a]	60.1 [a]	5.07	5.20	5.22	3.96	4.08	4.10	0.78	0.78	0.79
Rice husk	57.7 [b]	59.0 [a]	58.9 [a]	5.09	5.13	5.16	3.98	4.04	3.94	0.78	0.79	0.76
Mustard stalk	58.2 [a]	59.2 [a]	58.5 [a]	5.16	5.10	5.15	4.05	3.98	3.95	0.78	0.78	0.77
Sand	56.2 [c]	57.4 [b]	55.5 [b]	5.11	5.12	5.17	3.96	4.01	3.99	0.77	0.78	0.77

Means in the column with similar superscripts are not significantly different at $P<0.05$
Abbreviations: RIR-Rhode Island Red; PR-Punjab Red; KN-Kadaknath

among the different litter materials. This observation conforms to the findings of Sekeroglu *et al*. (2010) [14]. The higher egg weight of birds reared in rice husk, wheat straw and mustard stalk might be due to the nutrients obtained from the crop straw which enhanced albumen deposition as Penz and Jensen (1991) [12] reported that albumen deposition is greatly affected by the level of dietary protein. The dressing percentage and quality of meat was excellent on rice husk bedding material as compared to others. The bone strength and vigour of chicks was more also in the rice husk.

3.3 Manureal value of different litter materials (N, P and K content)

Rice husk contained the highest percentage of moisture followed by wheat straw, mustard stalk and sand (Table 3). The significant difference was found for nitrogen, phosphorus and potassium content among different types of used litter. The maximum values of nitrogen, phosphorus and potassium content were recorded in rice husk. Similar results were also found earlier by Monira *et al*. (2003) [11]. In this study used rice husk appeared to be best manure in respect of nitrogen, phosphorus and potassium content.

Table 3: Manureal value of different litter materials

Parameters		Types of litter			
		Wheat straw	Rice husk	Mustard stalk	Sand
Moisture content (%)	Week 1	8.15 [b]	11.4 [a]	7.80 [b]	2.2 [c]
	Week 8	40.4 [b]	45.3 [a]	38.7 [b]	17.4 [c]
Nitrogen (%)		2.20 [b]	3.40 [a]	1.80 [c]	1.53 [d]
Phosphorus (%)		0.98 [b]	1.35 [a]	0.85 [b]	0.78 [c]
Potassium (%)		0.25 [b]	0.32 [a]	0.23 [b]	0.18 [c]

Means in the column with similar superscripts are not significantly different at $P<0.05$

3.4 Economics of different litter materials

Economics of the four different bedding materials was calculated on the basis of market prices at the time of trial. Keeping the standard floor space of one square foot per broiler, prices of different litter materials were calculated. The cost of wheat straw, rice husk, mustard stalk and sand was Rs. 1680, 1450, 1530 and 1740, respectively for rearing 1000 broiler chicks (Table 4). The rice husk had an edge on wheat straw, mustard cake and sand due to its very high moisture absorbing ability, rice husk is also better than wheat straw, mustard cake and sand in respect of availability and economics.

Table 4: Economics of different litter materials

Types of litter	Amount required/ft^2 (kg)	Price/kg (Rs)	Price/ft^2 (Rs)	Price/1000 ft^2 (Rs)
Wheat straw	0.7	2.4	1.68	1680
Rice husk	0.5	2.9	1.45	1450
Mustard stalk	0.9	1.7	1.53	1530
Sand	2.9	0.6	1.74	1740

4. Conclusion

It was concluded that any of these three bedding materials (wheat straw, rice husk and mustard stalk) may be used and these are cheap and locally available to the poultry entrepreneurs. Overall rice husk gives excellent results as they have the ability to absorb the moisture and remain dry which is the basic requirement of deep litter system. The manure quality of rice husk is very excellent as compare to other materials. Egg production performance of birds was excellent in rice husk as compared to other bedding materials. Meat quality of chicks was better in rice husk.

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