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INFLUENCE OF QUALITY CHARACTERISTIC PARAMETERS WITH USE OF DIFFERENT LITTER MATERIAL COMBINATIONS ON PERFORMANCE OF BROILERS

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Abstract: The objective of the study was to evaluate the effect of use of different litter material combinations on performance of broiler and quality characteristics of bedding materials. Four hundred twenty day old, commercial broiler chicks (VenCobb[400] Strain) were divided into seven groups, with three replicates of 20 chicks in each water. The control A had Rice husk, while other treatment groups B, C, D, E, F and G having combinations such as soybean straw with groundnut hulls, wheat straw with soybean straw, saw dust with soybean straw, groundnut hulls with wheat straw, groundnut hulls with saw dust and saw dust with wheat straw, respectively. The highly significant effects were observed for the treatment group C (Soybean straw with wheat straw) for litter nitrogen percent, litter temperature, litter total viable count and litter total coliform count. Therefore it is concluded that the mixture of soybean straw with groundnut hulls used for bedding material of broilers was more economical and profitable.

Keywords: Broiler, groundnut hulls, rice husk, saw dust, soybean straw, wheat straw.

Introduction

The Poultry industry has emerged as the fastest growing segment of the livestock sector both globally and in India [1]. It has a high potential to generate foreign exchange earnings through export of poultry products to neighboring countries [1].In agriculture, poultry litter or broiler litter is a mixture of poultry excreta, spilled feed, feathers, and material used as bedding in poultry operations. Common bedding materials include wood shavings, sawdust, peanut hulls, shredded sugar cane, straw, and other dry, absorbent, low-cost organic materials. Litter material is any dry material used on the floor of chicken houses on which chicken dropping will fall. It is known as litter material because it combines with the droppings and undergoes a bacterial breakdown process, thus preventing a smelly and unsanitary condition [2]. Poultry litter, as an environmental factor, is an important and integral element in providing the proper environment inside the poultry facilities to achieve

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efficient productive and reproductive performance of poultry. Therefore, a characteristic optimal litter has to include some important characters like: low moisture, pH and ammonia production, firm in the hand, not wet and sticky, highly absorbent, soft and give off moisture readily and doesn't pack down easily. In addition, it has to be cheap, available and free of molds, preservatives and pesticides [3, 4, 5].

The deep litter system is the most popular system of housing in poultry production throughout the world. The quality of litter material directly affects the performance, health, carcass quality and welfare of poultry [6]. Quality of chicks, feed and water are all of great concern to broiler producers but quality of litter in broiler houses is seldom given sufficient emphasis. Low supplies, high cost, and unavailability of suitable materials have encouraged the search for alternative litter materials [7]. Burning of huge quantities of paddy straw and wheat straw leads to emission of obnoxious gases thus, causing adverse impacts on, health of human, animal and bird population. This practice can be discouraged through its utilization as an alternate litter material to commonly use rice husk which is now available at costly prices because of its use in different industries, raising the cost of broiler production. In the recent past, rice husk has become an extensively used material by many other industries due to its potential as a fuel. Similarly, the rice husk availability is also limited in certain region / area. It is therefore important to find out suitable and cheap alternate bedding materials and their combination to curtail the cost of poultry production.

In this context the use of crop residues as poultry litter seems to be promising. Hence, the present experimental design was planned to carry out studies on performance of broiler and quality characteristics of bedding material by use of different litter materials and their combination with objectives to study the effect of different litter materials combinations on bedding quality characteristic like weekly litter nitrogen percent, litter temperature, litter total viable count and litter total coliform count.

Materials and Methods

Experimental design and diet

For the present study, 420 healthy day old commercial straight run broiler chicks of Vencobb^{400}strain were procured from M/s Venkateshwara Hatcheries Private Limited, Pune having uniform body weight and the experiment was carried out for a period of 42 days (6 weeks) from 7th March to19th April 2015 in the Department of Poultry Science, College of Veterinary and Animal Sciences, MAFSU, Parbhani. The experimental design used in the present study for housing the broilers is presented in Table 1. Brooding was continued up to 1

week of age as experiment was conducted in summer. Before arrival of broiler chicks washing, disinfection and fumigation of shed was performed. The birds were housed under deep litter system with different litter materials such as rice husk, saw dust, groundnut hulls, wheat straw, soybean straw which were procured from Balsa Dairy, VNMAU, Parbhani and MIDC, Parbhani and used throughout the experiment with different 1:1 (50 %) combinations of different litter material on volume by volume basis. The experimental chicks were housed in seven different pens. Each pen was partitioned for treatment group to have 3 replications, accommodating 20 birds in each. The experimental birds were vaccinated against Ranikhet disease on 4th day, Gumboro disease/IBD on 15 day and booster dose of Gumboro /IBD was carried out on 24th day and of Ranikhet (strain) disease given on 29th day. The litter material as per the treatment group was spread in each pen and for first two days it was covered by pasting the newspaper on the floor and chicks were reared on respective litter material from 3rd day onward till the completion of experiment. No litter materials were added, removed or replaced during course of trial, although some stirring of litter material occurred. The feed ingredients used in the present experiment were purchased from local market and rations were prepared as per BIS (2007) at Feed Mixing Plant, College of Veterinary and Animal Sciences, MAFSU, Parbhani Table 2.The feed was prepared as per [8] BIS (2007) stardards. The Pre-starter ration was offered for first eight days, starter ration was offered from 9th day up to end of 21st day of age and finisher ration was offered thereafter up to 42nd day of age.

Observations recorded and test procedures

Litter nitrogen percent (%)

Nitrogen (%) content was estimated by Kjeldahl method [9]. It was processed by three steps viz. 1. Digestion 2. Distillation and 3. Titration. Litter samples were dried and samples were finely grinded into 60 mm particle size. The digestion mixture was prepared and the sample weighing 200 mg was taken into cellulose paper. The digestion mixture was taken into Kjeldahl flask and weighed sample was allowed for digestion for 3 to 4 hrs until the color changes to clear transparent. The digested part was allowed for cooling for 15 minutes. After complete digestion take 2 gm boric acid, NaOH 40 gm (40%), 5 gm sodium thiosulphate and distilled water and make volume up to 100 ml. During 1st step take 40 gm NaOH and Sodium thiosulphate 5 gm make 100 ml in volumetric flask and in 2nd step take 2 gm boric acid (2 %) and put some distilled water. Afterwards take digested sample and put up to 50 ml of distilled water in volumetric flask. Put this all in distillation assembly and methyl red indicator in the beaker. Allow for 15-20 minutes in the distillation assembly. Volume

goes up to the 70 ml in the beaker this is the end point of distillation. Titration with H_2SO_4 was to be done until pink color appears which the end point of the titration. The nitrogen % was calculated by the formula given below:

$$\text{Nitrogen \%} = \frac{\text{Corrected biurette reading x Normality of } H_2SO_4 \text{ x } 0.014 \text{ x } 5}{\text{Weight of the sample}}$$

Litter temperature

The temperature was recorded using a Hick's clinical thermometer. The weekly litter temperatures for all pens were recorded at a depth of 3 cm in five different spots in each pen (two near the lateral pen wall, two near the central aisle, and at the geometrical center of the pen). The weekly Litter temperature was recorded at the end of each week three times viz, morning, after-noon and evening and the average of it is been considered as the representative litter temperature of that particular week.

Litter total viable count

Total viable count of litter samples were estimated by serial dilution method [10, 11, 12]. Litter samples diluted (10^{-1} to 10^{-6}) using serial dilution method. The last two dilutions 10^{-5}, 10^{-6} inoculated in duplicates on the Plate Count Agar (PCA) using the pour plating method. The plates were incubated at 37°C for 24 h. After incubation, the distinct bacterial colonies were counted to determine the colony forming unit (CFU) per gram of the sample.

$$N = \frac{C}{(n\,1 + 0.1\,n\,2)d}$$

Where, N = No of bacteria per gram per ml of sample

C = Sum of colonies counted on all dishes retained

n_1 = No of dishes retained in 1st dilution

n_2 = No of dishes retained in 2nd dilution

d = dilution factor

0.1 = Inoculum

Litter total coliform count

Total coliform count of litter samples were determined using pour plating method [10,13] using Eosin methylene blue agar [EMB]. About 25 g of litter sample was collected and poured into 225 ml of sterile distilled water and further diluted serially (10^{-1} to 10^{-6}). The last two dilutions were plated out in duplicates using the pour plating method. The plates were incubated at 37°C for 24 h after which the total coliform count were determined.

$$N = \frac{C}{(n\,1 + 0.1\,n\,2)d}$$

Where, N = No of bacteria per gram per ml of sample

C = Sum of colonies counted on all dishes retained

n_1 = No of dishes retained in 1st dilution

n_2 = No of dishes retained in 2nd dilution

d = dilution factor

0.1 = Inoculum

Statistical analysis

All the data obtained were subjected to statistical analysis as per [14] using Randomized Block Design.

Results and discussion

Litter nitrogen percent (%)

The data for average weekly means for litter nitrogen percent with use of different litter materials are presented in Table 3 and in Figure 1. The analysis of variance for mean weekly litter nitrogen percent showed highly significant influence ($P<0.01$) amongst the various treatment groups Table 4.

The results in the present study clearly indicated that ammonia nitrogen concentration/percent was increased more marked in combination of soybean straw and wheat straw (Group C). This higher content of ammonia nitrogen concentration may be due to the more ability of ammonia producing bacteria to use the straw as a substrate for growth due to their greater lignin content [15], because litter moisture levels, ventilation rates and temperature were standardized across the treatment during experiment. At beginning of the experimentation litter ammonia nitrogen concentration/ percent were significantly lower may be due lower level of litter moisture % and bacterial population. The similar results were also reported by [16, 17, 7].

Litter temperature

The data for average weekly means for litter temperature degree Celsius with use of different litter materials are presented in Table 5 and depicted in Figure 2.The analysis of variance for mean weekly litter temperature degree celsius showed highly significant influence ($P< 0.01$) amongst the various treatment groups Table 6.

The treatment group A, B, E and G differed significantly from rest of the treatment groups but did not differ significantly among themselves for weekly temperature of litter. The

treatment group D differed significantly from rest of treatment groups. Significantly highest temperature ($P < 0.01$) was observed for treatment group C containing wheat straw with soybean straw as a litter material followed by F(groundnut hulls with saw dust). Significantly lowest temperature was observed for treatment group A followed by B (soybean straw with groundnut hulls), E (groundnut hulls with wheat straw) and G (Saw dust with wheat straw), respectively. The results in the present study are in accordance with [18, 17]. Litter surface temperature were significantly higher for wood shavings, rice hulls compared to sand alone as reported by [19].

Litter total viable count

The data for average weekly means for litter total viable count cfu / gm with use of different litter materials are presented in Table 7 and depicted in Figure 3.The analysis of variance for weekly mean total viable count cfu / gm showed highly significant influence ($P<0.01$) amongst the various treatment groups Table 8.

The significant ($P< 0.01$) differences were observed for treatment group A(rice husk), B(soybean straw with groundnut hulls) from rest of the treatment groups for mean viable count of litter but there were no significant differences amongst these two treatment groups. Similarly, significantly ($P < 0.01$) higher value for total viable count of litter was observed for treatment group C (soybean straw with wheat straw). It was clear that in all different litter groups with advancing age of litter, total viable count increased progressively and highest count in all litter groups were recorded at 6^{th} week of litter age.

The present study concluded that treatment group C (soybean straw with wheat straw) had significantly higher moisture content might have lead to promote the bacterial growth. This has resulted in decomposing organic material producing ammonia, a highly irritating toxic gas ultimately resulting in higher mortality in birds [20,21]. It also concluded that wet litter condition may slow down microbial and enzymatic activities due to scarcity of oxygen. The results in the present study are in accordance with the findings of [22, 23]. [23] reported that significant difference at different litter ages. The highest mean of TBC was recorded in wheat straw (4.69 log/g) followed by sugarcane baggasse (4.57 log/g) while, the lowest one was recorded for wood shavings (3.83 log/g).

Litter total coliform count

The data for average weekly means for litter total coliform count cfu / gm with use of different litter materials are presented in Table 9 and depicted in Figure 4.The analysis of

variance for mean weekly total coliform count cfu / gm showed highly significant influence ($P< 0.01$) amongst the various treatment groups Table 10.

The treatment groups A, B and G differed significantly from rest of the groups. However, the differences amongst these treatment groups were non-significant. The treatment group C differed significantly from rest of the treatment groups. There were non-significant differences amongst D, E and F for total coliform count of litter. Significantly highest mean total coliform count was observed for treatment group C (soybean straw with wheat straw).

The litter materials containing higher inorganic elements with few nutrients content, utilized by bacteria leading to lower bacterial count. In addition to this, rice husk may lack binding sites for bacteria. On other hand, straw like materials are organic containing nutrients that can be utilized by some bacterial species. [24] reported that there was increase in litter population of anaerobic bacteria and decrease in coliforms during period from 3 to 7 week after placement of broilers. These findings are in contrast to the findings in the present study. However, [16] also reported that no consistent differences in bacterial population were noted between litter sources.

Conclusion

Significantly lower values of nitrogen %, temperature, total viable count, total coliform count of litter concluded that the combination of soybean straw with groundnut hulls and saw dust with wheat straw can be replaced as a alternate litter material to that of rice husk alone, as rice husk is being costly and non-availability due to its huge demand in other agro-industrial sector.

Recommendations

It is recommended that the combination of soybean straw with groundnut hulls may be used as a superior bedding material with 50 % combination on volume basis. The combination of soybean straw with wheat straw as a litter material was having bad litter characteristics due to more nitrogen %, temperature, total viable count, total coliform count. Hence it is recommended that poultry farmers should not use the combination of soybean straw with wheat straw (Group C) as a litter material during rearing of broilers.

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Table 1. Experimental design used for housing of broilers in the present study

Group	Treatment	No. of birds/pen/ replication	No. of replication	Total number of birds
A	Control - Rice husk	20	3	60
B	50 % Soybean straw + 50 % Groundnut hulls	20	3	60
C	50 % Wheat straw + 50 % Soybean straw	20	3	60
D	50 % Saw dust + 50 % Soybean straw	20	3	60
E	50 % Groundnut hulls + 50 % Wheat straw	20	3	60
F	50 % Groundnut hulls + 50 % Saw dust	20	3	60
G	50 % Saw dust + 50 % Wheat straw	20	3	60
	Total birds		21	420

Table 2. Percent ingredient and nutrients composition of Prestarter, Starter and Finisher ration

FEED INGREDIENTS	**PRE-STARTER**	**STARTER**	**FINISHER**
Maize	53.2	54.0	58.5
Vegetable oil	3.0	4.2	4.9
Soya-bean meal	41.0	39.0	33.8
Dicalcium phosphate	1.5	1.5	1.5
Limestone powder	1.0	1.0	1.0
Salt	0.3	0.3	0.3
Total	100	100	100
SUPPLEMENTS/ADDITIVES (g/100kgs)			
Mineral mixture	300	300	300
Vitamin mixture	150	150	150
Methionine	180	190	160
Lysine	170	130	100
Cholinechloride	60	60	60
Crude protein (%)(calculated)	23.08	22.24	20.22
Metabolisable energy (Kcal/kg)(calculated)	3011.16	3100	3202.22
E:P ratio	130.46:1	139.38:1	158.37:1

Table 3. Average weekly nitrogen (percent) of litter with different combination of litter materials

Weeks	Treatment groups						
	A	B	C	D	E	F	G
I	1.467	1.843	2.274	2.065	2.174	2.179	1.867
II	1.875	1.945	2.271	2.170	2.221	2.214	1.891
III	1.956	2.223	2.378	2.318	2.349	2.358	2.116
IV	2.097	2.259	2.895	2.515	2.509	2.239	2.168
V	2.185	2.365	3.170	2.473	2.427	2.595	2.263
VI	2.349	2.454	3.240	2.523	2.466	2.758	2.463
Mean	1.989^{c}	2.181^{c}	2.704^{a}	2.344^{b}	2.357^{b}	2.390^{b}	2.128^{c}

Table 4. ANOVA for average weekly nitrogen (percent) of litter with different combination of litter materials

Sources	*df*	SS	*MSS*	*Calculated F*
Treatments	6	1.90841	0.31806	17.640**
Weeks	5	2.04299	0.40859	22.661**
Error	30	0.54091	0.01803	
Total	41	4.49232		

** Highly significant at $P < 0.01$.

Table 5. Average weekly temperature degree celsius of litter with different combination of litter materials

Weeks	Treatment groups						
	A	B	C	D	E	F	G
I	25.19	25.43	27.99	26.52	25.60	27.05	25.51
II	27.48	28.72	29.64	28.67	27.47	29.53	27.31
III	29.00	29.81	30.54	29.72	29.87	30.27	29.21
IV	29.49	29.14	30.99	29.54	29.72	29.84	30.22
V	30.05	30.29	31.88	30.12	30.11	30.17	30.62
VI	31.46	31.49	32.55	31.84	31.98	32.23	31.67
Mean	28.778^{c}	29.146^{c}	30.598^{a}	29.401^{b}	29.125^{c}	29.848^{a}	29.090^{c}

Note: Means connected with similar superscript do not differ significantly

Table 6. ANOVA for average weekly temperature degree Celsius of litter with different combination of litter materials

Sources	*df*	SS	*MSS*	*Calculated F*
Treatments	6	13.525	2.254	10.730**
Weeks	5	132.963	26.592	126.580**
Error	30	6.302	0.210	
Total	41	152.7915		

** Highly significant at $P < 0.01$.

Table 7. Average weekly total viable count (cfu / gm) of litter with different combination of litter materials

Weeks	Treatment Groups						
	A	B	C	D	E	F	G
I	2.1	2.66	3.5	2.4	2.5	3.06	3
II	2.26	2.96	3.86	2.73	2.9	3.3	3.36
III	2.5	3.23	4.23	2.9	3.13	3.43	3.6
IV	2.6	3.43	4.33	3.1	3.2	3.56	3.8
V	2.8	3.6	4.9	3.5	3.6	3.9	4.0
VI	3.4	3.9	5.4	3.8	3.9	4.0	4.2
Mean	2.61^{c}	3.29^{b}	4.37^{a}	3.07^{c}	3.20^{b}	3.54^{b}	3.66^{b}

Note: Means connected with similar superscript do not differ significantly

Table 8. ANOVA for average weekly total viable count (cfu / gm) of litter with different combination of litter materials

Sources	*df*	SS	*MSS*	*Calculated F*
Treatments	6	10.853	1.8089	118.0**
Weeks	5	8.116	1.6233	105.89**
Error	30	0.459	0.0153	
Total	41	19.429		

** Highly significant at $P < 0.01$.

Table 9. Average weekly total coliform count (cfu / gm) of litter with different combination of litter materials

Weeks	Treatment groups						
	A	B	C	D	E	F	G
I	2.0	2.3	4.46	2.53	3.03	2.9	2.36
II	2.2	2.6	4.9	2.93	3.6	3.1	2.76
III	2.3	2.96	5.1	3.1	3.73	3.1	2.9
IV	2.5	2.93	5.2	3.2	3.8	3.3	3.1
V	3.2	3.3	5.3	3.7	3.9	3.7	3.8
VI	3.4	3.8	5.5	3.9	4.1	3.9	4.0
Mean	2.60^{c}	2.98^{c}	5.07^{a}	3.22^{b}	3.69^{b}	3.34^{b}	3.15^{c}

Note: Means connected with similar superscript do not differ significantly

Table 10. ANOVA for average weekly total coliform count (cfu / gm) of litter with different combination of litter materials

Sources	*df*	SS	*MSS*	*Calculated F*
Treatments	6	22.7853	3.7975	160.29**
Weeks	5	7.6265	1.5253	64.38**
Error	30	0.7107	0.0237	
Total	41	31.1227		

** Highly significant at $P < 0.01$.

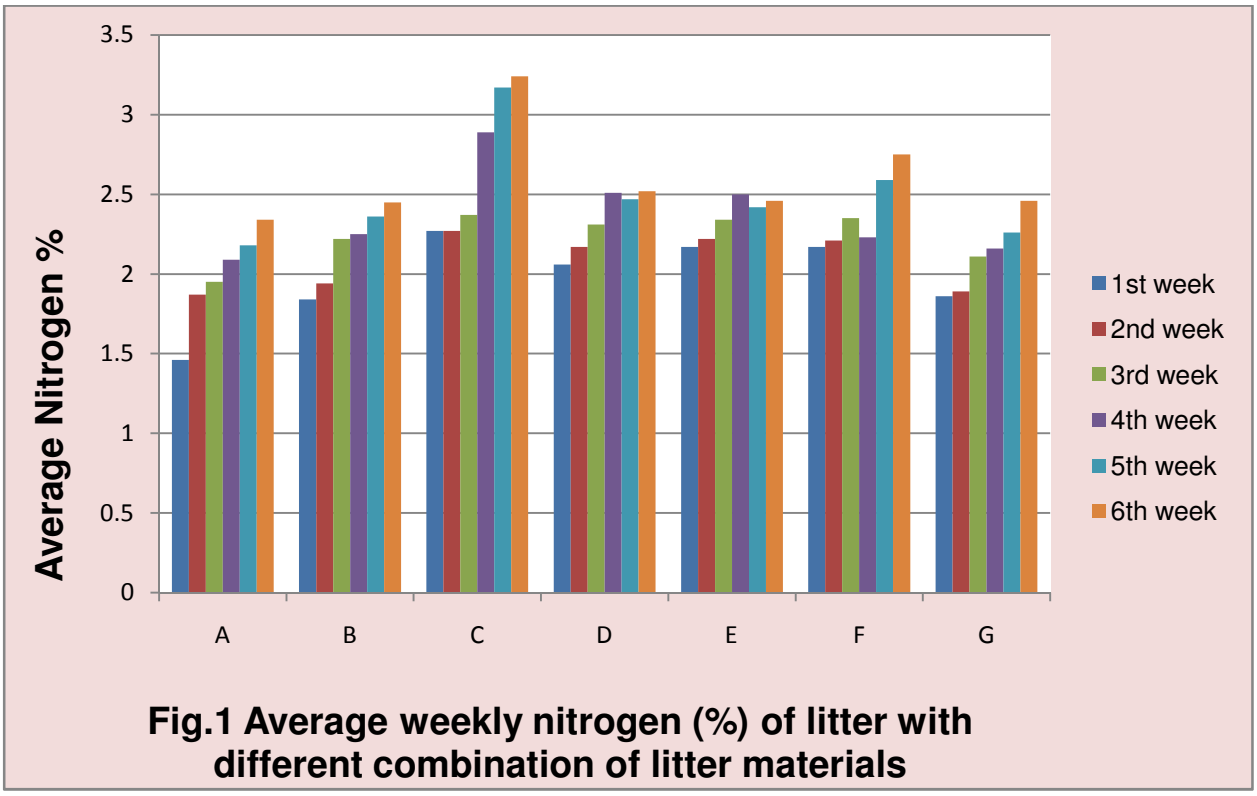

Fig.1 Average weekly nitrogen (%) of litter with different combination of litter materials

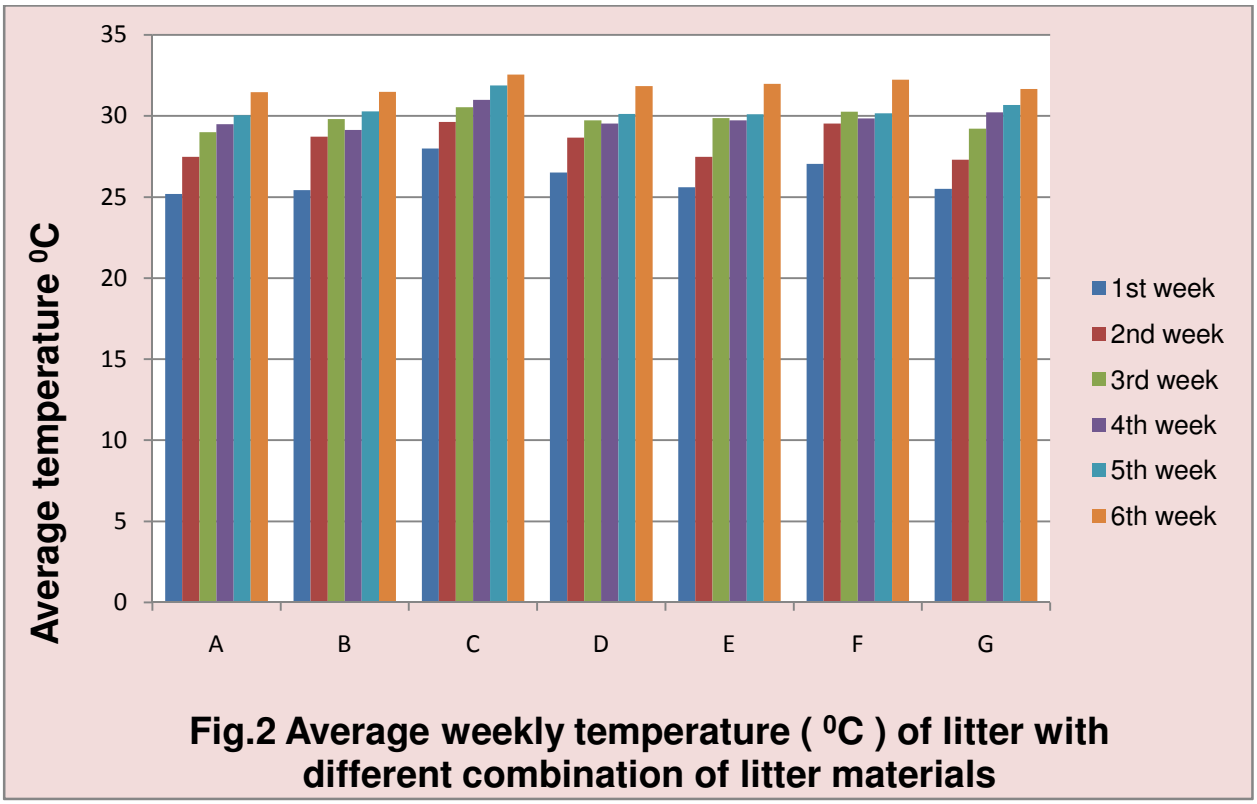

Fig.2 Average weekly temperature (^{0}C) of litter with different combination of litter materials

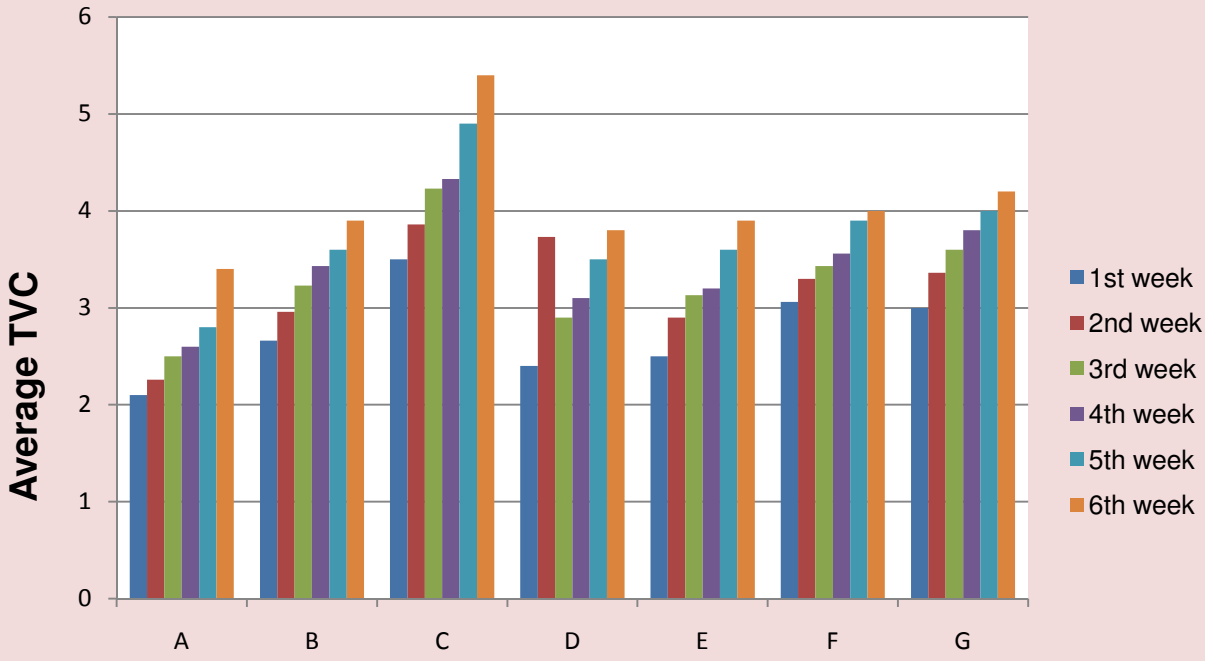

Fig.3 Average weekly total viable count (cfu/gm) of litter with different combination of litter materials

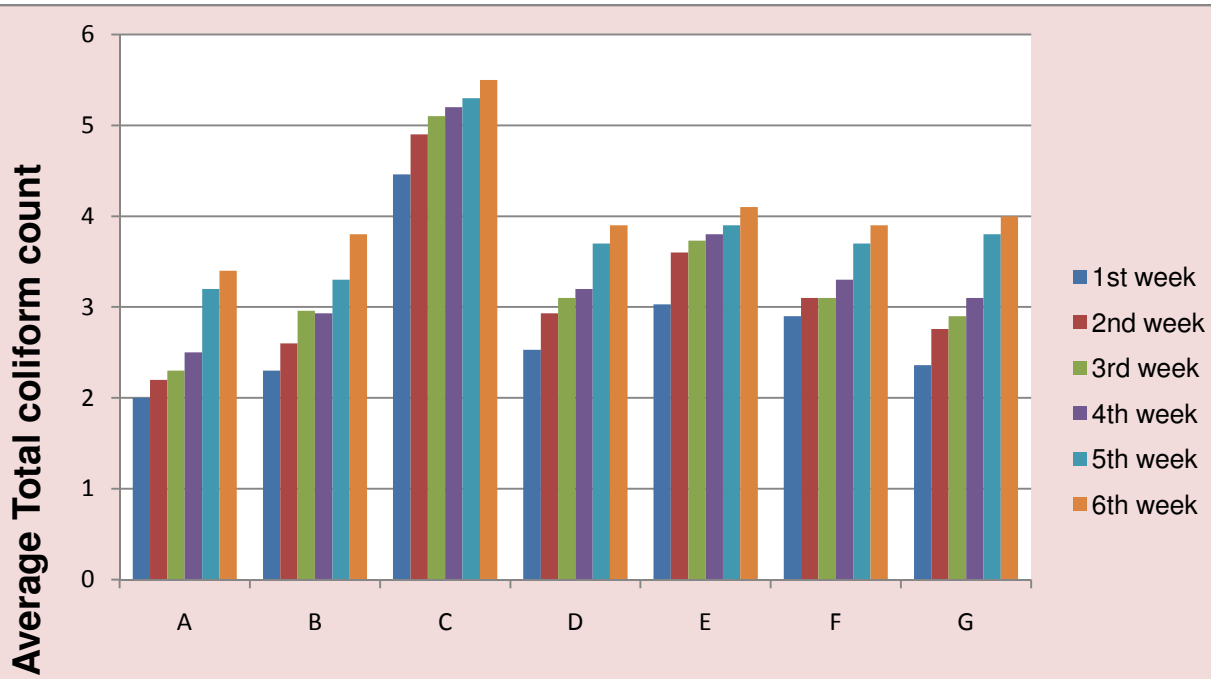

Fig.4 Average weekly total coliform count (cfu/gm) of litter with different combination of litter materials