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A study on the effect of different floor types on the physiological responses, haematology and blood-biochemical parameters and stress tolerance in Nellore brown ram lambs

Pandu R, Sarat Chandra A, Harikrishna CH, Venkateswarlu M and Vidya B

Abstract
The present study was undertaken at sheep unit of Livestock Farm Complex (LFC), College of Veterinary Science, Rajendranagar, Hyderabad-30. 24 Nellore brown ram lambs with average body weight of 15.32±0.39 kg and aged 3-6 months were procured from Livestock Research Station, Mamnoor. These lambs were then allotted randomly to 3 treatment groups (eight lambs in each group) i.e., on mud floor (control, T1), on concrete floor (T2) and on the elevated plastic slatted floor (T3) in completely randomized design under intensive system. Floor type did not have significant effect on rectal temperature, pulse rate and respiration rate, RBC, WBC, Hb, PCV, MCV, MCH, MCHC, total protein, albumin, globulin, glucose and Cortisol among three treatment groups. The values of all leucocyte indices were statistically non-significant among the three treatment groups except for monocytes at the end of the experiment where higher monocytes were recorded in T3.

Keywords: Nellore brown ram lambs, physiological responses, haematology, blood-biochemical, stress tolerance

1. Introduction
Small ruminants play an important role in Indian economy, contribute greatly to the agrarian economy, especially in areas where crop and dairy farming are not economical, and play an important role in the livelihood of a large proportion of small and marginal farmers and landless labour (NAP, DAHD, GOI, 2012). The prevailing food shortage and malnutrition problems of third world countries could be lessened by encouraging the sheep rearing practices. Sheep has got special importance among all other livestock species due to their multifaceted utility (Prabhu *et al*., 2009) [10]. As per the 20th Livestock Census (2019) the sheep population in India is 74.26 million and contributes 13.87% of the total livestock population. As per the 20th Livestock Census, Telangana ranked first in sheep population with 19.1 million and contributing 25.72% of the total sheep population in India (D.A.H., GOI, 2019). Nellore breed of sheep is one of the most popular mutton breeds in the country and as per Breed survey 2013, the population of Nellore breed is about 1,17,45,867 and accounts for 19% of the total sheep in our country.

Livestock entrepreneurs are evincing keen interest in intensive system of rearing small ruminants owing to scarcity of grazing land and poor pasture quality. Elevated slatted floor housing for small ruminants is becoming popular by the day owing to various advantages associated with such housing. Research on alternative flooring solutions in sheep production are limited, probably mainly because of the higher initial cost of raised floor in sheep houses. In the conventional slatted floor house where bamboo and wood are commonly used, frequent recurring expenses, leg stuck problems etc are encountered. To overcome these disadvantages, plastic slatted floor materials are being used widely due to better durability, anti-skid nature and better animal comfort. Though plastic slatted floor manufacturers are aggressively marketing, the scientific reports on its effect on the production performance and welfare are not available in the literature. Limited studies have been carried out using slatted/raised flooring, which were not conclusive. Keeping in view the importance of flooring the present study was planned to study the effect of different floor types on the performance of stall fed Nellore brown ram lambs in intensive system.

2. Materials and Methods

2.1 Physiological Responses

Stress in animals, if any due to rearing on different floor types was recorded by observing and recording different physiological parameters *viz*., pulse rate, respiration rate and rectal temperature at fortnight intervals throughout the experimental period.

2.1.1 Pulse Rate

Pulse rate (PR) of each lamb was measured using the femoral artery on the inside of the rear leg roughly 1/3 of the way down with minimum disturbance to the animals at fortnight interval.

2.1.2 Respiration Rate

Respiration rate (RR) was measured by counting flank movement with the aid of a stop watch.

2.1.3 Rectal Temperature

Rectal temperature (˚F) was recorded at fortnight intervals in each group by inserting a digital thermometer in to the rectum of lamb, kept for 1 minute and observations were recorded in degrees of Fahrenheit for individual animals.

2.2 Haematology and Blood – bio chemical Parameters

2.2.1 Blood Collection

Blood was collected from the jugular vein of the lambs at the beginning and at the end of the experiment. The animals were restrained and then the area was first sterilized by using surgical spirit and about 5 ml of blood was collected from all the experimental lambs by using hypodermic needles in the morning (before feeding) in a clean, dry, sterilized test tube with ethylene diamine tetra acetate (EDTA) as anti-coagulant under aseptic conditions. These test tubes were labelled and brought to the laboratory for further analysis. Whole blood (5 ml) was collected into separate test tube without adding the anticoagulant and centrifuged at 3000 rpm for 15 min to separate serum, and then transferred into a sterilized small plastic Eppendorf tubes (2 ml) and stored at – 20 ˚C for further analysis. Clean glassware and analytical grade chemicals were used in the study.

2.2.2 Hematological Constituents

Blood samples were analyzed for various hematological parameters *viz*. Red blood count (RBC), Hemoglobin (HB), Packed Cell Volume (PCV), White blood count (WBC), Differential Leucocyte Count (DLC), Mean Corpuscular Volume (MCV), Mean Corpuscular Hemoglobin (MCH) and Mean Corpuscular Hemoglobin Concentration (MCHC). Blood samples were analysed with the help of haemoanalyser (ABX-MICROS-60).

2.2.3 Bio-chemical Constituents

Blood serum metabolites like glucose, albumin, and total protein were analysed to find out the changes if any deviations from normal range due to effect of different floor types. The blood biochemical parameters were analyzed using commercial kits (Coral Clinical Systems) on auto analyzer (Model: Erba-chem 7, India) and spectrophotometer (Thermo).

2.2.3.1 Stress Tolerance (Cortisol Estimation)

The blood samples were collected and analyzed for serum cortisol hormone using AccuDiag™ Cortisol ELISA Kit (Cat# 6101- 15).

3. Results

The data recorded during the experiment was tabulated, statistically analysed and interpreted.

3.1 Physiological Responses

3.1.1 Fortnightly Rectal Temperature

Effect of different floor types on fortnightly changes in rectal temperature (°F) is presented in Table 1

Statistical analysis of the data on rectal temperature showed that there was no significant difference in rectal temperature among three treatment groups.

Table 1: Mean ± SE values of fortnightly rectal temperature (°F) of Nellore brown ram lambs under different floor types

Floor Type	Fortnightly Rectal Temperature (°F)							
	1	2	3	4	5	6	7	8
T1	101.46 ± 0.37	103.11 ± 0.51	102.56 ± 0.20	102.31 ± 0.29	101.37 ± 0.41	101.60 ± 0.18	101.11 ± 0.40	101.69 ± 0.24
T2	102.28 ± 0.42	102.73 ± 0.34	102.15 ± 0.19	102.74 ± 0.26	101.48 ± 0.36	101.59 ± 0.17	101.01 ± 0.48	101.68 ± 0.28
T3	101.75 ± 0.38	102.51 ± 0.28	102.43 ± 0.16	102.00 ± 0.31	101.31 ± 0.28	101.75 ± 0.13	101.25 ± 0.15	101.65 ± 0.23
N	08	08	08	08	08	08	08	08
SEM	0.228	0.215	0.106	0.172	0.191	0.090	0.205	0.139
P value	0.354	0.545	0.292	0.204	0.943	0.726	0.898	0.995

T1: Conventional gravel (Mud)floor
T2: Concrete Floor
T3: Elevated plastic slatted floor
N: No. of animals in each treatment
SEM: Standard Error Mean
P Value: Probability Value

3.1.2 Fortnightly Pulse Rate

Effect of different floor types on fortnightly changes in pulse rate (beats/min) is presented in Table 2.

Statistical analysis of the data on pulse rate showed that there was no significant difference in pulse rate among three treatment groups.

Table 2: Mean ± SE values of fortnightly pulse rate (beats/min) of Nellore brown ram lambs under different floor types

Floor Type	Fortnightly Pulse Rate (beats/min)							
	1	2	3	4	5	6	7	8
T1	63.00 ± 0.88	72.14 ± 1.71	72.57 ± 1.29	62.43 ± 0.81	62.14 ± 0.70	64.00 ± 0.20	62.29 ± 0.68	62.43 ± 0.72
T2	62.50 ± 0.85	72.63 ± 1.22	72.88 ± 1.19	62.38 ± 0.73	62.25 ± 0.67	63.50 ± 1.09	62.75 ± 0.65	62.13 ± 0.58
T3	62.38 ± 0.68	72.13 ± 1.03	71.88 ± 1.13	62.88 ± 0.79	62.00 ± 0.57	63.13 ± 1.17	62.00 ± 0.65	62.25 ± 0.59
N	08	08	08	08	08	08	08	08
SEM	0.443	0.726	0.665	0.430	0.357	0.638	0.370	0.346
P value	0.850	0.954	0.828	0.880	0.962	0.869	0.714	0.944

3.1.3 Fortnightly Respiratory Rate

Effect of different floor types on fortnightly changes in respiration rate (breaths/min) is presented in Table 3.

The fortnightly respiration rate (breaths/min) was non-significant among the three treatment groups.

Table 3: Mean ± SE values of fortnightly respiration rate (breaths/min) of Nellore brown ram lambs under different floor types

Floor Type	Fortnightly Respiration Rate (breaths/min)							
	1	2	3	4	5	6	7	8
T1	24.00 ± 1.57	30.86 ± 1.68	33.71 ± 2.45	22.57 ± 1.56	21.71 ± 1.13	21.71 ± 1.02	27.29 ± 1.29	27.43 ± 1.27
T2	22.63 ± 1.57	29.63 ± 1.63	33.50 ± 1.91	21.63 ± 0.94	22.13 ± 1.57	21.50 ± 0.91	27.00 ± 1.12	27.25 ± 1.22
T3	22.50 ± 1.18	30.00 ± 1.36	32.25 ± 1.24	23.25 ± 0.10	21.50 ± 1.18	21.25 ± 0.65	26.13 ± 0.86	27.50 ± 1.25
N	08	08	08	08	08	08	08	08
SEM	0.808	0.863	1.043	0.656	0.733	0.474	0.603	0.682
P value	0.732	0.854	0.837	0.606	0.942	0.931	0.734	0.989

3.2 Haematology and Blood-biochemical Parameters

3.2.1 Haematological Constituents

The Mean ± SE values of haematological values (RBC, WBC, HB, PCV and erythrocyte indices) of Nellore brown ram lambs under different floor types is presented in Table 4 and Table 5.

No significant effect was found among three floor types on RBC, WBC, Hb, PCV, MCV, MCH and MCHC in lambs.

Table 4: Mean ± SE values of haematological parameters of Nellore brown ram lambs under different floor types

Floor Type	RBC (mil/cu mm)		WBC (10^3/ cu mm)		Hb (grams %)		PCV (%)	
	Before	After	Before	After	Before	After	Before	After
T1	10.46±0.51	9.23±0.45	8.46±0.51	8.40±0.26	11.03 ± 0.16	11.23 ± 0.21	27.57±0.52	27.76± 0.49
T2	9.67±0.42	8.80±0.26	8.29±0.59	8.56±0.36	11.18 ± 0.21	11.33 ± 0.16	27.90±0.32	27.85 ± 0.47
T3	9.65±0.34	9.41±0.46	8.15±0.36	8.36±0.38	11.19 ± 0.19	11.40 ± 0.11	27.86±0.35	27.94 ± 0.52
N	08	08	08	08	08	08	08	08
SEM	0.245	0.227	0.274	0.190	0.107	0.089	0.221	0.271
P value	0.350	0.532	0.911	0.907	0.820	0.758	0.824	0.968

Table 5: Mean ± SE values of haematological parameters (erythrocyte indices) of Nellore brown ram lambs under different floor types

Floor Type	MCV (fl)		MCH (picograms)		MCHC (%)	
	Before	After	Before	After	Before	After
T1	27.67± 1.66	27.17± 1.24	9.51± 0.47	9.09± 0.35	34.53± 0.61	33.50± 0.46
T2	26.40± 0.53	28.33± 0.76	9.23± 0.18	9.40± 0.29	35.00± 0.35	33.20± 0.38
T3	26.64± 0.79	29.76± 1.00	9.14± 0.32	9.83± 0.29	34.36± 0.64	33.04± 0.22
N	08	08	08	08	08	08
SEM	0.584	0.595	0.187	0.182	0.306	0.199
P value	0.673	0.217	0.720	0.266	0.688	0.662

Table 6: Mean ± SE values of leucocyte indices of Nellore brown ram lambs under different floor types

Floor Type	Lymphocytes (%)		Neutrophils (%)		Eosinophils (%)		Monocytes (%)		Basophils (%)	
	Before	After	Before	After	Before	After	Before	After	Before	After
T1	56.90± 2.85	49.37± 3.60	38.31± 2.80	44.19± 3.72	3.09±0.24	4.13±0.44	1.70±0.16	2.31 ± 0.14^{b}	0	0
T2	49.99± 3.94	51.28± 3.44	44.96± 3.62	42.78± 3.41	3.39±0.50	3.85±0.37	1.66±0.28	2.10 ± 0.17^{b}	0	0
T3	53.16± 3.05	54.29± 2.95	40.35± 2.88	38.06± 3.16	4.23±0.35	4.73±0.42	2.26±0.33	2.93 ± 0.24^{a}	0	0
N	08	08	08	08	08	08	08	08	0	0
SEM	1.943	1.880	1.834	1.962	0.237	0.241	0.162	0.130	0	0
P value	0.375	0.586	0.334	0.429	0.126	0.316	0.238	0.016	0	0

The perusal of results from the Table 6 indicated that the values of all leucocyte indices were statistically non-significant among the three treatment groups except for monocytes at the end of the experiment where higher monocytes (%) were recorded in T3.

3.2.2 Blood- biochemical Parameters

The blood-biochemical constituents like total protein (gm/dl), albumin(gm/dl), globulin (gm/dl) and blood glucose (gm/dl) in Nellore brown ram lambs reared on different floor types are presented in Table 7.

Statistical analysis of the data revealed non-significant difference in total protein, albumin, globulin and glucose concentrations among three floor types after the experiment.

Table 7: Mean ± SE values of blood-biochemical parameters of Nellore brown ram lambs under different floor types

Floor Type	Total protein (gm/dl)		Albumin (gm/dl)		Globulin (gm/dl)		Glucose (gm/dl)	
	Before	After	Before	After	Before	After	Before	After
T1	6.88 ± 0.10	7.30±0.18	3.80 ± 0.08	3.88±0.09	3.08 ± 0.15	3.43±0.20	8.50 ± 0.18	8.55 ± 0.06
T2	6.55 ± 0.27	6.98 ± 0.11	3.80 ± 0.04	3.88 ± 0.06	2.75 ± 0.26	3.10 ± 0.16	8.58 ± 0.10	8.60 ± 0.12
T3	7.13 ± 0.30	7.33 ± 0.18	3.98 ± 0.05	3.95 ± 0.05	3.15 ± 0.32	3.38 ± 0.14	8.78 ± 0.15	8.65 ± 0.12
N	08	08	08	08	08	08	08	08
SEM	0.145	0.097	0.040	0.037	0.143	0.098	0.084	0.056
P value	0.291	0.281	0.108	0.676	0.525	0.384	0.426	0.803

3.2.3 Stress Tolerance
3.2.3.1 Cortisol (stress hormone)
The Mean ± SE values of cortisol (stress hormone) values of Nellore brown ram lambs under different floor types is presented in Table 8.

Statistical analysis of the data at the end of the experiment revealed a non-significant difference for Cortisol (stress hormone) among three floor types.

Table 8: Mean ± SE values of cortisol levels (µg/dl) of Nellore brown ram lambs under different floor types

Floor Type	Cortisol (µg/dl)	
	Before	after
T1	1.10 ± 0.17	1.59 ± 0.29
T2	0.60 ± 0.11	1.08 ± 0.12
T3	0.97 ± 0.25	1.33 ± 0.26
N	08	08
SEM	0.115	0.137
P value	0.190	0.343

4. Discussion
4.1 Physiological Responses
4.1.1 Fortnightly Rectal Temperature
Statistical analysis of the data on rectal temperature showed that there was no significant difference in rectal temperature among three treatment groups. The results are in agreement with the findings of Kulkarni *et al.* (2000), Thiruvenkadan *et al.* (2009) [16], Divate (2014) [4], Deshmukh (2017) [3], Mohit *et al.* (2019c) [8] and Ramachandran *et al.* (2020) [12] who had reported that the rectal temperature was not significant in different floors. The results are dissimilar with the findings of Rahman *et al.* (2013) [11] and Tharun tej *et al.* (2020) [14-15] who had reported that the rectal temperature was significant in different floors.

4.1.2 Fortnightly Pulse Rate
There was no significant difference among the three treatment groups. The results are in agreement with the findings of Kulkarni *et al.* (2000), Thiruvenkadan *et al.* (2009) [16], Divate (2014) [4], Deshmukh (2017) [3], Mohit *et al.* (2019c) [8] and Ramachandran *et al.* (2020) [12] who had reported that the pulse rate was not significant in different floors. The results are dissimilar with the findings of Rahman *et al.* (2013) [11] who had reported that the pulse rate was significant in different floors.

4.1.3 Fortnightly Respiratory Rate
The fortnightly respiration rate (breaths/min) was non-significant among the three treatment groups. The results are in agreement with the findings of Kulkarni *et al.* (2000) [6], Thiruvenkadan *et al.* (2009) [16], Divate (2014) [4], Deshmukh (2017) [3], Mohit *et al.* (2019c) [8] and Tharun tej *et al.* (2020) [14-15] who had reported that the respiration rate was not significant in different floors. The results are dissimilar with the findings of Rahman *et al.* (2013) [11] and Ramachandran *et al.* (2020) [12] who had reported that the respiration rate was significant in different floors.

4.2 Haematology and Blood-biochemical Parameters
4.2.1 Hematological Constituents
No significant effect was found among three floor types on RBC in lambs. These results are comparable with Mohit *et al.* (2019c) [8] and Tharun tej *et al.* (2020) [14-15] who observed that there was no significant difference between the groups in RBC values with different types of bedding.

No significant effect was found among three floor types on WBC in lambs. These results are comparable with Mohit *et al.* (2019c) [8] and Tharun tej *et al.* (2020) who observed that, there was no significant difference between the groups in WBC values with different types of bedding.

No significant effect was found among three different floor types on Hb (%) in lambs. The results obtained in the present study are similar to the findings of Thiruvenkadan *et al.* (2009) [16], Kumari *et al.* (2013), Divate *et al.* (2014) [4], Deshmukh (2017) [3] and Tharun tej *et al.* (2020) [14-15] who had observed that different floors had non-significant effect on Hb(%).

The PCV (%) values were similar among the three treatment groups at the end of the experiment. The results obtained in the present study are similar to the findings of Thiruvenkadan et al. (2009) [16] who had observed that different floors had non-significant effect on PCV (%). The results obtained in the present study are not in agreement to the findings of Tharun tej *et al.* (2020) [14-15] who had observed that different floors had significant effect on PCV (%).

The MCV (fl), MCH (pg) and MCHC (%) values were similar among the three treatment groups at the end of the experiment. The present findings were supported by Mohit *et al.* (2019c) [12] and Tharun tej *et al.* (2020) [14-15] who found that there was no significant difference between the groups in MCV, MCH and MCHC values animals on different type of floors.

The values of all leucocyte indices were statistically non-significant among the three treatment groups except for monocytes at the end of the experiment where higher monocytes (%) were recorded in T3. The present findings are dissimilar to the findings of Mohit *et al.* (2019c) [8] and Tharun tej *et al.* (2020) [14-15] who found that there was no significant difference between the groups and floor type on DLC.

4.2.2 Blood- biochemical Parameters

4.2.2.1 Total Protein

The observed total protein concentration (gm/dl) was similar among three different floor types after the experiment. Similar findings were reported by Singh *et al.* (2017), Chikwanda and Muchenje (2017) [1], Mohit *et al.* (2019c) [8] and Tharun tej *et al.* (2020) [14-15].

4.2.2.2 Albumin

Statistical analysis of the data at the end of the experiment revealed a non-significant difference for albumin among different floor types. Similar findings were reported by Singh *et al.* (2017), Chikwanda and Muchenje (2017) [1], Mohit *et al.* (2019c) [8] and Tharun tej *et al.* (2020) [14-15].

4.2.2.3 Globulin

Statistical analysis of the data at the end of the experiment revealed a non-significant difference for globulin among three floor types. The present findings are in agreement with Chikwanda and Muchenje (2017) [1], Mohit *et al.* (2019c) [8] and Tharun tej *et al.* (2020) [14-15] who reported that type of flooring did not influence serum concentrations of biochemical variables.

4.2.2.4 Glucose

Statistical analysis of the data at the end of the experiment revealed a non-significant difference for glucose among three floor types. The glucose concentration obtained in the present study was similar to the findings of Chikwanda and Muchenje (2017) [1] and Tharun tej *et al.* (2020) [14-15] who reported that type of flooring did not influence serum glucose concentrations. This finding was not in agreement with Mohit *et al.* (2019c) [8] who stated significant difference in serum glucose values in kids reared under different bedding materials and recorded significant increase in serum glucose.

4.2.3 Stress Tolerance

Statistical analysis of the data at the end of the experiment revealed a non-significant difference for Cortisol (stress hormone) among three floor types, the levels being lower in elevated plastic slatted house, probably indicative of reduced stress as result of environment enrichment. However, Hussein *et al*. (2018) [5] has observed a significant effect of different flooring materials on cortisol levels in contradiction to the present findings.

5. Conclusion

1. The physiological responses were similar among the three different floors.
2. Haematological constituents were similar among the three different floors except for monocytes. Higher monocytes were recorded in the T3 group at the end of the experiment. Blood-biochemical parameters were similar among the three different floors.
3. Stress tolerance was similar among the three different floors.

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