



Effect of plastic slatted flooring on growth and welfare of stall-fed kids

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ABSTRACT

Male kids (36) at 6 months age, 12 each of Jamunapari, Jakhrana, Barbari breed were equally divided and allotted randomly in plastic and soil floor and reared up to 12 of age through April to September months, fed *ad lib.* roughage, green fodder and concentrate to meet nutrient requirements for optimum growth. Body weight was recorded fortnightly, physiological responses were recorded twice and blood sampling at 60th and 120th day of trial. The weight gain and ADG on plastic floor was similar as compared to soil floor. Kids were equally comfortable on both floors except RR; however, increased RR on plastic floor did not affect the weight gain in kids. Plasma AST and ALT enzymes, total protein, albumin, total cholesterol, triglycerides level differed non-significantly in kids reared on both plastic and soil floor indicating the suitability of plastic floor in goat shelters in semi-arid conditions.

Keywords: Blood biochemical parameters, Growth, Plastic slatted floor, Semi-arid weather, Stallfed kids

The importance of shelter for profitable goat rearing plays an inevitable role in large scale commercial goat enterprise especially on intensive rearing system. The modern goat shelters address the two foremost component of shelters, i.e. floor and roof that affects comfort and goat productivity. Sutherland *et al.* (2017) reported that goats prefer to use different flooring types depending on the behaviour they are performing, hence, multiple flooring options may be better to meet their needs in commercial systems. Research on alternative flooring solutions in goat production are limited, probably mainly because of the higher initial cost of raised floor in goat houses. Limited studies had been carried out using slatted/raised flooring, which were not conclusive. Some studies (Kumari *et al.* 2013, Bharambe and Shinde 2014) had reported improved performance (Bhagat and Nagpaul 2009, Tahir *et al.* 2011, Bharambe and Shinde 2014), while others (Graunke *et al.* 2011, Tiruvenkadan *et al.* 2009, Jaborek *et al.* 2016) have not demonstrated any benefits of slatted floor. The study on wooden slatted floor on growth, welfare and worm load in kids revealed that the growth and comfort level were similar between kids of wooden slatted and soil floor with significant reduction of coccidial oocysts (Ramachandran *et al.* 2017, Singh *et al.* 2017, Ramachandran and Singh 2017). However, significantly lower milk yield was recorded in lactating goats on raised floor (Ramachandran *et al.* 2019). The conventional slatted floor using bamboo and wood demands frequent recurring expenses, leg stuck

problems etc. To overcome these disadvantages, plastic slatted floor materials shall be tried due to its long life. Few studies on flooring preferences indicated that plastic slats may be acceptable options in addition to straw bedded floors (Boe *et al.* 2007, Muir *et al.* 2013, Sutherland *et al.* 2017). 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. Therefore, the present study aimed to assess the effect of plastic slatted floor in goat shelter on growth, physiological responses and blood biochemical parameters in kids.

MATERIALS AND METHODS

Location and weather conditions: The present experiment was conducted at the Experimental farm of the Animal Physiology and Reproduction Division of Central Institute for Research on Goats, Makhdoom (27°10'N latitude, 78°02'E longitude, 169 m above sea level altitude), Farah, Mathura, Uttar Pradesh, India which falls under semi-arid region of India. The mean maximum, minimum, daily temperature, dry and wet bulb temperature, relative humidity, vapor pressure, total rainfall, total sunshine and THI during experimental period (Apr–Sept. 2017) were 39.51, 25.85, 32.68, 33.55, 35.11°C, 58.42%, 20.62 mmHg, 191.88 mm, 1320.50 h and 83.81, respectively.

Experimental animals, housing, feeding and management: Thirty six male kids of Jamunapari, Barbari and Sirohi breed (12 each) with mean body weight and age of 19.20±1.92, 14.46±0.83, 16.92±0.65 kg and 243.25,

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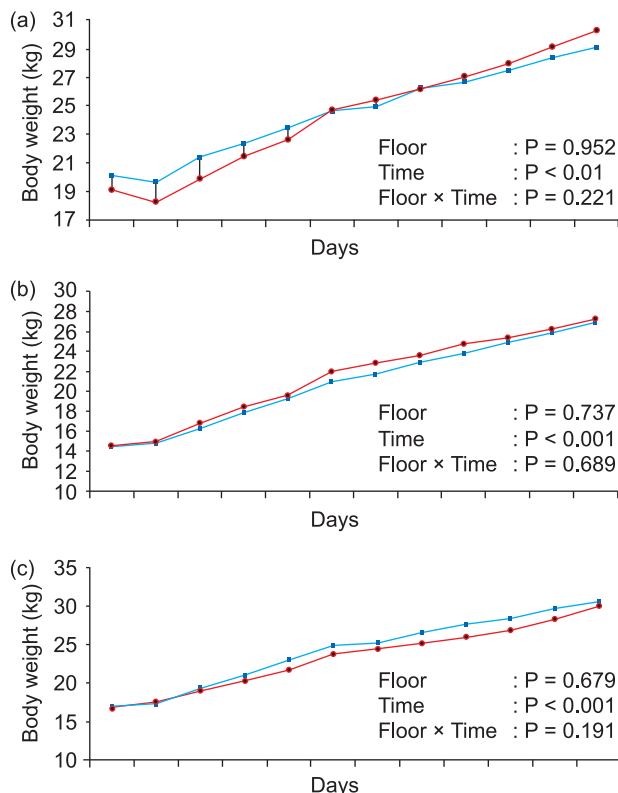


Fig. 1. Body weight trend of (a) Jamunapari, (b) Barbari, and (c) Jakhrana kids on two floors.

205.00, 192.46 days, respectively, were selected for the study. The kids of each breed were randomly divided into 2 groups of 6 each after adjusting for age, body weight, type of birth and assigned to pen having either plastic slatted floor (PSLF) or soil floor (SOF) in goat shelters. Slatted/raised floor (4.26 m × 6.09 m size) was constructed at height of 1.14 m from ground as per Ramachandran *et al.* (2014) except floor material and the supporting structures. The plastic floor was installed using perforated plastic slatted material having dimensions of 0.6 m × 0.3 m size, grade-A quality (M/S Murthy Agro Traders, Villupuram DT, Tamil Nadu, India) with 47 mm thickness and 16 mm space between the slats. The supporting structures were installed using 25.4 mm PVC pipe filled with concrete mixture. The kids of three breeds in each group were reared separately in enclosures with the floor area of 28 m² under *ad lib.* feeding and uniform management conditions up to 1 year age. Kids were offered *ad lib.* roughage (gram straw-*Cicer arietinum*, arhar straw-*Cajanus cajan*), concentrate pellets and green fodder (cow pea-*Vigna sinensis*, berseem-*Trifolium alexandrinum*), and drinking water available 24 h. The experimental protocol was approved by the Institute Animal Ethics Committee.

Body weight gain: Live body weight was recorded at fortnightly intervals at 08:00 AM before feeding for two consecutive days using electronic weighing scale (Digicontrols Northern Pvt. Ltd., Noida, India) to monitor body weight trend and weight gain of kids during the trial.

Measurements of physiological variables: All

measurements of physiological variables (RT, RR and HR) were done under relatively calm and quiet conditions twice (June and September) at 02:00 PM. The measurement of RT of kids was done using a digital clinical thermometer (Hicks, Hicks Thermometers India Ltd.), inserted about 3–4 cm into the rectum for about 1 min and represented in °C. The RR was measured before the HR and RT. The HR (presented as beats per minute) and RR (presented as breath per minute) were recorded using a medical stethoscope (Amex Macro Tone Stethoscope) at the fourth left intercostal space behind the animal's left elbow and above the animal's left elbow over a period of 1 min., respectively.

Blood collection and plasma separation: The blood samples from kids were collected twice at 60th and 120th day of the trial by direct jugular venepuncture. The days of blood sample collection were different from the days of recording of physiological variables to avoid possible effect of handling or human presence on the cortisol level in the blood. Plasma was separated at room temperature, which was centrifuged (600 × g for 5 min at room temperature) using table top centrifuge (R8C Remi Laboratory centrifuge, India) and samples were stored at –20°C until assayed for biochemical variables. Plasma concentrations of biochemical variables such as alanine transaminase (ALT) [IU/l; 2,4-DNPH (Reitman and Frankel method)], aspartate transaminase (AST) [IU/l; 2,4-DNPH (Reitman and Frankel method)], glucose (mg/dl; Kind and King's method), albumin (g/dl; Bromocresol Green method), total protein (g/dl; modified biuret, end point assay), total cholesterol (mg/dl; CHOD-PAP, end point assay) and triglycerides (mg/dl; GPO-PAP, end point assay) were measured using commercial kits according to the manufacturer's instructions (Arkray Healthcare Pvt Ltd, Surat, India).

Statistical analysis: The generated data were analyzed using independent sample t-test for comparison of floors between three goat breeds pairwise separately. All statistical analyses were performed using SPSS (version 16.0, SPSS Inc., Chicago, IL). Data are presented as arithmetic means ± SEM; significance, variations were assessed by probability value (P) with the following levels of significance: P < 0.05, P < 0.01, P < 0.001 and a trend was noted when 0.05 ≤ P ≤ 0.10.

RESULTS AND DISCUSSION

The goat kid rearing is fast changing from grazing system to stall-fed system with challenge feeding conditions to reduce age at slaughter for meeting the ever increasing demand of chevon among domestic consumers. Accordingly, the goat shelters are emerging with modern facilities like raised plastic floor with pillars, customised feeders and waterers for easy fixing in partitions, automatic feeding system, weighing system with RFID identification etc. The initial body weight of kids in the present study on plastic as well as soil floor was 19.13 ± 2.85 and 20.08 ± 2.75 for Jamunapari kids, 14.50 ± 1.15 and 14.43 ± 1.30 for Barbari kids, and 16.85 ± 0.93 and 16.98 ± 1.00 for Jakhrana kids, respectively. Table 1 depicts the growth performance of kids

Table 1. Growth performance of growing kids (N=36) raised on two floors

Growth trait	Breed	Floor type		Pooled mean	P value
		Plastic floor	Soil floor		
Body weight gain (kg)	Jamunapari	5.20±0.66	4.33 ^a ±0.75	4.77 ^a ±0.43	0.297
	Barbari	5.98±0.44	5.86 ^b ±0.49	5.44 ^b ±0.43	0.887
	Jakhrana	6.26±0.74	6.63 ^b ±0.30	5.99 ^b ±0.66	0.676
	Overall	5.81±0.36	5.61±0.36	5.40±0.31	0.942
Average daily gain (g)	Jamunapari	67.47±8.55	56.22 ^a ±9.72	61.85 ^a ±5.59	0.295
	Barbari	77.37±5.66	76.06 ^b ±6.34	70.53 ^b ±5.52	0.895
	Jakhrana	81.17±9.51	85.83 ^b ±3.83	77.61 ^b ±8.54	0.675
	Overall	75.34±4.60	72.71±4.85	70.00±3.96	0.936

Means with different superscripts in the column differed significantly ($P<0.05$) for each parameter.

on plastic and soil floor. The weight gain in all three breeds on both the floors differed non-significantly ($P>0.05$) in the present study which corroborates the previous findings (Day *et al.* 2006, Ramachandran *et al.* 2017). The mean weight gains in the present study are 5.81±0.36 and 5.61±0.36 kg, respectively in plastic floor and in soil floor. Similar growth performance in Barbari kids were also reported by Antil *et al.* (2019) while using plastic slats as bedding materials compared with soil and rubber mats. The mean weight gain, irrespective of the floors in Jamunapari kids was significantly lower ($P<0.05$) than weight gain in Jakhrana and Barbari kids. The weight gain in plastic floor was similar in all three breeds, however, the weight gain in Jakhrana and Barbari kids was significantly higher ($P<0.05$) than weight gain in Jamunapari kids.

The average daily gain also followed similar pattern as that of total weight gain in the present study (Table 1). The mean ADG, though it was similar on both floors, it was slightly higher in plastic floor (75.34 g) than soil floor (72.71 g). Antil *et al.* (2019) while using plastic slats as bedding materials compared with soil and rubber mats also observed ADG of 76.13 g in plastic slats as bedding materials and 75.25 g in soil floor in post weaned Barbari

kids, which were similar to the present results. However, Muñoz-Osorio *et al.* (2017) reported that fattening lambs housed in raised slatted floor cages were heavier (ADG 306.5±2.69 g) than those raised in floor pens (ADG 269.4±4 g). Among breeds, Jakhrana kids gained significantly ($P<0.05$) higher weight followed by Barbari kids and lowest in Jamunapari kids. Similarly, the growth response of Jamunapari kids to *ad lib.* feeding was lowest (56.22 g) compared to 85.83 g in Jakhrana kids and 76.06 g in Barbari kids reared on soil floor. However, the growth response of kids of three breeds reared on plastic floor was statistically similar in the present study. The body weight trend (Fig. 1) — throughout the trial also indicated the similar growth in all three breeds (Jamunapari $P=0.952$; Barbari $P=0.737$; Jakhrana= 0.679) on both the floors indicating the suitability of plastic floor in goat shelters.

The physiological responses of kids of three goat breeds reared on plastic and soil floor have been presented in Table 2. Perusal of Table 2 revealed that all the kids were equally comfortable on both floors except RR. The overall RR was significantly higher ($P<0.001$) in plastic floor as compared to soil floor (79.67±4.50 vs 65.92±2.91). This indicated that kids experienced moderate stress on plastic

Table 2. Mean physiological responses of growing kids (N=36) raised on two floors

Age group	Breed	Floor type		Pooled mean	P value
		Plastic floor	Soil floor		
RR (Breathes/min)	Jamunapari	65.17 ^a ±5.95	56.42 ^a ±4.62	60.79 ^a ±3.80	0.259
	Barbari	78.83 ^a ±7.71	69.17 ^b ±4.29	74.00 ^b ±4.43	0.250
	Jakhrana	95.00 ^b ±7.63	72.17 ^b ±5.34	83.58 ^c ±5.14	0.024
	Overall	79.67±4.50	65.92±2.91	72.79±2.78	0.001
HR (Beats/min)	Jamunapari	119.17±4.07	111.75 ^a ±2.89	115.46 ^a ±2.56	0.152
	Barbari	131.42±5.27	130.58 ^b ±4.26	131.00 ^b ±3.32	0.507
	Jakhrana	127.17±3.12	133.58 ^b ±6.42	130.38 ^b ±3.55	0.382
	Overall	125.92±2.53	125.31±3.12	125.61±2.00	0.697
RT (°C)	Jamunapari	39.41 ^{ab} ±0.13	39.44 ^a ±0.09	39.43 ^{ab} ±0.08	0.834
	Barbari	39.27 ^a ±0.09	39.35 ^a ±0.04	39.31 ^b ±0.05	0.541
	Jakhrana	39.67 ^b ±0.17	39.48 ^b ±0.05	39.57 ^a ±0.09	0.306
	Overall	39.45±0.08	39.42±0.04	39.43±0.04	0.744

Means with different superscripts in the column differed significantly ($P<0.05$) for each parameter.

Table 3. Mean plasma biochemical parameters of growing kids (N=36) raised on two floors

Age group	Breed	Floor type		Overall floor	P value
		Plastic floor	Soil floor		
AST (IU/L)	Jamunapari	57.02 ^a ±6.42	61.42±9.11	59.22±4.84	0.588
	Barbari	74.13 ^b ±10.27	64.72±8.68	69.42±6.11	0.329
	Jakhrana	60.26 ^{ab} ±5.00	65.36±6.12	62.81±2.82	0.370
	Overall	63.80±4.00	63.83±3.97	63.82±2.78	0.079
ALT (IU/L)	Jamunapari	19.80±5.88	19.00±5.28	19.40±3.04	0.511
	Barbari	9.49±4.53	10.88±4.28	10.19±2.07	0.081
	Jakhrana	16.66±5.40	12.33±5.67	14.50±2.38	0.760
	Overall	15.32±2.27	14.07±2.18	14.69±1.55	0.708
Glucose (mg/dL)	Jamunapari	72.45±2.19	76.03±4.94	74.24±2.40	0.410
	Barbari	71.14±2.79	76.60±4.00	73.87±1.59	0.124
	Jakhrana	72.58±3.01	76.34±3.12	74.46±1.99	0.247
	Overall	72.06±1.19	77.42±2.89	74.74±1.60	0.061
Albumin (g/dL)	Jamunapari	2.92 ^a ±0.10	2.93±0.10	2.93±0.04	0.958
	Barbari	3.26 ^b ±0.14	3.31±0.20	3.28±0.08	0.843
	Jakhrana	3.05±0.14	3.23±0.20	3.14±0.09	0.404
	Overall	3.08±0.06	3.15±0.08	3.12±0.05	0.273
Total Protein (g/L)	Jamunapari	7.06±0.18	6.84±0.30	6.95±0.12	0.386
	Barbari	7.32±0.23	6.61±0.16	6.97±0.16	0.002
	Jakhrana	7.09±0.42	6.57±0.19	6.83±0.21	0.179
	Overall	7.16±0.14	6.67±0.10	6.92±0.09	0.001
Total Cholesterol (mg/dL)	Jamunapari	51.16±2.52	53.05±2.27	52.11 ^a ±1.42	0.533
	Barbari	47.13±1.95	52.82±2.58	49.98 ^a ±1.61	0.044
	Jakhrana	52.93±2.38	55.22±1.44	54.08 ^b ±1.01	0.426
	Overall	50.41±1.24	53.70±0.95	52.05±0.82	0.124
Triglycerides (mg/dL)	Jamunapari	91.52 ^a ±4.93	91.82±5.79	91.67 ^a ±3.41	0.963
	Barbari	71.59 ^b ±2.75	86.65±5.57	79.12 ^b ±3.37	0.007
	Jakhrana	78.16 ^c ±3.87	82.40±5.13	80.28 ^c ±2.81	0.377
	Overall	80.42±2.84	86.96±2.78	83.69±2.04	0.126

floor during the trial which fell during hot-dry and hot-humid season of the year under semi-arid conditions. However, the increased RR on plastic floor did not affect the weight gain in kids as reflected in the growth data. The HR and RT recorded in kids were similar on both floors. On the contrary, Antil *et al.* (2019) reported that Barbari kids reared on plastic slat as bedding materials showed similar RR and lower HR as compared to soil floor. Ramachandran and Singh (2017) reported non-significant difference of physiological responses in Jakhrana kids reared on wooden slatted and soil floor.

Among breeds, Jamunapari kids had lower RR followed by Barbari and highest in Jakhrana kids. The RR of Jakhrana kids on plastic floor was 95.00±7.63 breathes/min, which is significantly higher ($P<0.05$) than on soil floor (72.17±5.34 breathes/min). This could be due to the black coat colour of Jakhrana breed which might have absorbed more heat during hot-dry and hot-humid season of the study as well as lesser distance between roof and floor surface in raised plastic floor than in soil floor.

The plasma enzymes (AST and ALT) level in kids reared on plastic and soil floor are were similar in the present study (Table 3). Among breeds, Barbari kids reared on plastic floor showed significantly ($P<0.05$) higher level of aspartate transaminase enzyme than Jakhrana and Jamunapari kids.

However, such difference could not be observed in kids of different breeds reared on soil floor. The alanine transaminase enzyme level did not differ significantly ($P>0.05$) among kids reared both in plastic and soil floor. Singh *et al.* (2009) also found similar ALT and AST level in Jakhrana kids reared on wooden slatted and soil floor. The enzyme levels estimated in the present study are well within the reference values reported for goats.

The plasma biochemical parameters like total protein, albumin, total cholesterol, triglycerides level differed non-significantly ($P>0.05$) in kids reared on both plastic and soil floor indicating the suitability of plastic floor in goat shelters in semi-arid conditions. Similar non-significant difference in biochemical parameters in kids reared on wooden slatted floor and soil floor was also reported by Singh *et al.* (2017). Though the overall level of all biochemical parameters in the present study were similar, the plasma glucose level in kids reared on plastic floor showed lower trend ($P=0.061$) compared to kids reared on soil floor.

Among breeds, the glucose and albumin level were similar in all three breeds in both the floors in the present study. However, the albumin level was significantly higher ($P<0.05$) in Barbari goats than Jakhrana and Jamunapari kids raised on plastic floor. Though the total protein, total

cholesterol and triglycerides showed similar levels in Jakhra and Jamunapari kids on both the floors, Barbari kids responded differently on plastic floor. The significantly higher total protein ($P < 0.01$) and significantly lower total cholesterol ($P < 0.05$), triglycerides ($P < 0.01$) in Barbari kids reared on plastic floor indicates the higher comfort level of smaller goat breeds on raised plastic floor as compared to larger goat breeds like Jamunapari and Jakhra (Table 3). In another study, Antil *et al.* (2019) reported that Barbari kids reared on plastic slat as bedding materials showed similar glucose, albumin, total cholesterol level, significantly higher total protein ($P < 0.01$) and significantly lower triglycerides ($P < 0.05$) as compared to soil floor, corroborates the present findings.

Overview of the results indicated that raised plastic floor shall be recommended for goat shelters in semi-arid conditions without compromising growth performance and comfort level in stall-fed goat rearing system.

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