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A review on effect of different bedding materials on growth, microclimatic variability and physiological indices of animals

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Abstract
Housing management of animals in the form of bedding as of paramount importance for good health and better growth. It reduces the stress on the animals caused due to adverse climatic conditions. Decrease in stress conditions by increasing animal comfort by providing ideal bedding substrate may results not only in improved production but also may facilities warmth, comfort, cleanliness and weight gain so flooring or bedding is one of the most important components of animal housing as far as animal health and welfare are concerned. Bedding material should be clean, inert, comfortable, and ideal particle size. It should help the animal to reduce heat loss through conduction and to cope up with adverse environment. This review article notify the important research works done in this field for better understanding and selection of proper bedding materials for animals.

Keywords: Animal comfort, bedding materials, behavior, growth, welfare

Introduction
India is the world's largest milk producing nation producing around 187 million tones of milk (BAHFS, 2019) [2]. Including Buffalo dairy animals plays a vital role in overall contributions to milk, meat, hides, and draft power for agricultural operations so as being the backbone of the Indian dairy industry healthy animals their calves are essential for the sustenance of the dairy industry. The lifetime performance of animals is adversely affected by no of biological and environmental constraints. It is associated with the type of housing, feeding, managemental practices, and weather conditions (Blood *et al*., 1994) [4]. Animals remain vulnerable to temperature fluctuations (both hot and cold) and require access to some form of shelter or shade (Panivivat *et al*., 2004; Rushen *et al*., 2008) [22, 28]. It was observed that twenty percent of animals mortality may result in a nearly 38% reduction in the profit of a livestock farm (Martin and Wiggins, 1973) [20]. However managemental factors relating to housing hasten the occurrence of mortality. In recent years efforts have been undertaken to reduce mortality in terms of improving management by providing a higher level of comfort regarding the housing environment. Housing management of aniams specially in the adverse climatic conditions as of paramount importance for good health and better growth. It reduces the stress on the animals caused due to adverse climatic conditions. Decrease in stress conditions significantly by increasing animal comfort thus results in improved production (Perissinotto *et al*., 2006; Navarini *et al*., 2009) [23, 21] and for this bedding is an important component of the housing management activities of animals**.**The type of bedding substrate used in animals rearing not only facilities warmth and comfort, but can also affect cleanliness (Panivivat *et al*., 2004) [22], weight gain, the incidence of scouring (Hill, Bateman, Aldrich & Schlotterbeck, 2011) [11], skin surface temperature (Sutherland, Stewart & Schutz,2013) [32], microclimate and behavior of animals so flooring or bedding is one of the most important components of animal housing as far as animal health and welfare are concerned. A number of organic (hay, silage, sawdust, crop residue) and inorganic (sand, rubber mattress, concrete) materials can be used as bedding as they provide more comfort to animals in adverse climatic condition and results in improved health, better growth, and productivity. It was observed that recently the trend has moved away fromorganic bedding materials, due to hygiene concerns, labor and transportation costs, which can affect the total on-farm price and use (Kartal & Yanar, 2011; Panivivat *et al*., 2004) [14, 15, 22]. Nowadays sand, rice hulls (rice husks), rubber mats, and concrete materials are more used as a source of rearing substances for animals (Hanninen, de Passille, & Rushen,

2005; Hill *et al*., 2011; Panivivat *et al.*, 2004) [9, 22]. There is scanty amount of review articles are available therefore, aim of persent study was to cover wide range of studies done on influences of different bedding materials on microclimate, growth and physiological aspect of animals.
The literature related to the present study has been reviewed under the following sub-heads:

Effect of bedding on Meteorological condition and floor surface temperature:
The ambient temperature and the floor surface temperature could be two important thermal parameters determining the stress level of animals due to adverse climatic conditions. Thermal comfort provided by the resting areas in the form of bedding is one of the factors that influence the overall comfort of the animals (Lendelova & Pogran, 2003) [17]. Animals were found to prefer straw to rubber mats in winter which may be due to the thermal properties of the bedding materials (Manninen, de Passillé, Rushen, Norring, & Saloniemi, 2002) [19]. An animal lying on a cool wet surface will results in greater conductive heat loss depending on the thermal conductance of the substrate as well as the temperature gradient and magnitude of the area of contact relative to the total surface area. Surface temperature of rubber remained hotter than the concrete floor during the daytime although it became equal by late night (Prasad *et al.* 2013) [25]. Sahu *et al.* (2018) [29] concluded that sandbed had moisture in it and hence, the surface temperature was significantly lower during peak hours of the day. They also revealed that the floor surface temperature of the covered area of the experimental shed (T_1) (having sand floor) was about 2.5 ˚C lower than that of control shed T_0 (having concrete floor).Wheat straw was found more hotter than rubber mat and compost bedding in winter by Dimov *et al.* 2017 [5]. Similarly animals were found to prefer straw to rubber mats in winter which may be due to the thermal properties of bedding material (Manninen, de Passillé, Rushen, Norring, & Saloniemi, 2002) [19]. Few other works of literature also suggest that different bedding materials improved the microenvironment and provide comfort to animals (Hogan *et al*., 1989; Bey *et al*., 2002) [12, 3] as Fraser, 1985 [7] also reported that straw bedding is as preferred bedding in winter. It was observed that maximizing comfort reduces stress in animals and thus increases production (House *et al.*, 2003) [13].

Effect of bedding on growth parameters
All the body growth parameters shows an increasing trend with the advancement of age and increases in body weight but the change also depends on the comforts and well being of animals which is directly affected by the microclimate inside the shed. On the other way, the animals in the comfort zone keep their physiological parameters in a normal range so their body energy can be used in increasing body growth whereas; stressed animals divert their body energy to maintain homeothermy. Kartal *et al*., 2011 [14, 15] revealed that upto four-month of age weight gain of the calves were not significantly influenced by the type of the floor but between four to six month of age total weight gains of calves in wooden slat and concrete pens were significantly (P<0.05) greater than other calves which were reared on the rubber mats. Keane *et al.* (2017) [16] also found higher ADG in crossbred heifers kept on straw bedded floor than the concrete slated floor similarly higher ADG was found in Karan fries calves kept on floor bedded with paddy straw as compared to rubber mat or CC floor by Madke *et al.*, 2010 [18]. Sorathiya *et al.*, 2019 [31] revealed that bedding with either paddy straw or rubber mat might have increased the comfort zone of calves, thus, better ADG was revealed in all treatment groups in comparison to CC as presented in the following table-

Table 1: Study indicating the effect of flooring on growth traits of calves (Sorathiya *et al.*, 2019) [31]

Parameter	Concrete floor (CC)	Kachcha soil floor without bedding (SOIL)	Concrete floor with paddy straw bedding (CC+PS)	Kachcha soil floor with paddy straw bedding (SOIL+PS)	Rubber mat Bedding (RM)
Initial B.W	54.40 ±7.22	46.80±1.86	47.00 ±5.52	48.80 ±2.62	51.40 ±6.10
Final B.W	71.80 ±7.35	68.00±2.61	70.60 ±5.63	73.80 ±3.27	73.40 ±6.14
ADG	294.80^{a}±13.82	359.40^{ab}±21.10	400.20^{b}±15.77	424.00^{b}±19.39	373.00^{b}±22.81
Cost/ADG	229.10^{b}	222.10^{b}	180.43^{a}	189.83^{a}	211.2^{ab}

Effect of bedding on Body measurements
All the body measurement shows an increasing trend with the advancement of age and increases in body weight but the change also depends on the comforts and wellbeing of animals which is directly affected by the microclimate inside the shed. On the other way, the animals in the thermal comfort zone keep their physiological parameters in a normal range so their body energy can be used in increasing body measurements whereas; cold-stressed animals divert their body energy to maintain homeothermy as Grewal *et al*., 1982 revealed that weekly change in heart girth, height, and body length was significantly affected by the type of floor and remained significantly lower on dirt floor as compared to the brick floor but the change in body measurement did not differ due to concentrate supplementation although Yarnar *et al.* (2010) [35] revealed that body measurements between birth and fourth month of age were not affected significantly by types of floor. They observed that there is no significant difference among body length and height of calves reared on three different floor- concrete, wheat straw, and rubber mat but there was a significant difference in chest girth in between treatments (wheat straw, rubber mat) and control (concrete floor) but results were not significant between treatment groups. Rafiuddin *et al*. (2009) studied the effect of group size on body measurements of buffalo calves in winter and revealed that average change (cm.) in body length was 1.90, 2.51, 2.85 cm, in body height 1.61, 1.88, and 2.08 also in hear girth was 2.46, 2.90 and 3.17 in different three groups having single, four and eight calves in each group.

Effect of bedding on Physiological parameters
A faulty flooring system may induce a stress condition among the calves. Animals will try to cope up with thesestressful conditionsby altering their physiological response like changing body temperature, pulse, and respiratory rate. Temperature and humidity are to a considerable extent responsible for the variation of the physiological reaction of animals and the reactions vary widely in different breed and

species. Animals do acclimatize by gradually adapting to such stressors within their natural environment (Willmer *et al.*, 2000) [33], yet the level of adaptation is not well documented in most situations. Grewal *et al.* (1982) [8] revealed that calves reared on the dirt floor had significantly ($P<0.05$) lower body temperature as compared to the brick floor. They observed that there was about 0.45 ˚F lower overall body temperature as compared to brick. Rohilla *et al.* (1990) [27] did not found any significant effect of floor types on body temperature, pulse rate, or respiration rate during the winter season. Similarly, floor types had no significant effect on physiological parameters reported by Yadav *et al.* (1990) [34]. Sahu *et al.* (2018) [29] study the effects of roof ceiling and flooring on microclimate of shed and physiological indices of crossbred jersey cows and reported that among physiological parameters morning and evening rectal temperature, pulse rate, and respiration rate were significantly ($P<0.01$) higher in cows kept at the conventional shed (having concrete floor) as compared to modified shed (having sand floor) and correlates with floor surface temperature as presented in the following table (2).

Table 2: Review study indicating the effect of bedding on calf physiological parameters (Sahu *et al.*, 2018) [29]

Parameters	Open area	
	T_0 (Having Concrete floor)	**T_1 (Having Sand floor)**
Floor surface temp. (˚C)	24.18 ± 0.96	21.10 ± 0.39
Rectal temperature (ºF)	100.63±0.05	100.51±0.03
Pulse rate /min.	63.98±0.46	63.76±0.34

Effect of bedding on Skin temperature

It is a well-known fact that environmental temperature affects skin surface temperature (Arp *et al.*, 1983) [1]. The changes in skin temperature at various sites indicate that the temperature of the skin surface not only varies with the change in the environmental temperature but it also varied in different parts of the body at a particular period of time. Surface temperature measured by an infrared thermometer at different sites of the buffalo calves body can be used as an indicator of animal welfare under different floor modification conditions. Singh and Singh (2006) [30] reported that the ST of extremities are significantly ($P<0.01$) lower than other body parts; the extremities were cooler by 4-10 ^{0}C as compared to the body trunk similar results were also found by Phulia *et al*. (2010) [24]. Sutherland *et al*., 2013) [32] revealed that when calves were reared on one of the following bedding types-pea gravel (PG), rubber chip (RC), sand (SA), or wood shavings (WS), Over the entire study period, calves reared on PG and SA had lower skin temperatures than calves reared on RC or WS, but skin temperature was similar between calves reared on PG and SA. body temperature of buffaloes was significantly ($P<0.01$) differ by different lying surfaces. The highest body temperatures were recorded with buffalo cows kept on sawdust and straw followed by hard surface and sand and least on newspaper (EI-Kaschab *et al*., 2009) [6].

Conclusion

Proper bedding play a vital role in housing management of animals as it affects their health, production and welfare. Most of the review studies revealed that straw bedding remain warmer and have good insulation property which helps the animals to cope up with adverse climatic condition and thus results into better growth and increase production as compared to other bedding materials (Rubber mat, Sand and concrete floor) in winter. Sand bedding was found less preferred for animal rearing during winter, was might be due to its cooler nature. So on the basis of following reviews it could be advised that wheat straw could be use effectively for animals rearing during winter.

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