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Impact of ultra-hydrophobic contact surfaces on micro environmental management of goat shed

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Abstract

Total 30 adult goats were distributed into five different compartments on concrete floor as Control, T₁, T₂, T₃, & T₄ treatment groups for 106 days. Contact floors of all treatment groups except Control were modified by application of ultra-hydrophobic layers. Three different Improved cleaning methods ICT-A, ICT-B & ICT-C were implemented in T₂, T₃ and T₄ respectively, Traditional cleaning resulted in least reduction of 18.81% MCS, 11.58% BCS, 30.42% PCS with 14.80 min. of TS. Non-significant difference was noted in TCS. About 38.48% reductions in MCS recorded in T₄ with 31.61% reduced BCS, 74.20% reduction in PCS. TS was 11.02 min. with 4.91 min for TICT. T₁ showed 32.84%, 19.77%, 35.46% reduction in respectively with 11.55 min. for TS & 11.09 for TICT. Treatment T₂ resulted with reduced MCS, BCS & PCS by 28.92, 22.71 & 33.59% and consumed 11.02 & 7.47 min for TS & TICT respectively. 31.91, 25.63 & 50.71% reduction in MCS, BCS & PCS with 11.03 & 3.79 min for TS & TICT respectively. TCS for all treatments found increased by 3.74, 3.35, 3.95, 3.57 & 3.49% in Control, T₁, T₂, T₃ & T₄ respectively. Average gradation score reported 43.12, 50.00, 69.22, 74.10 & 89.44% observed cleanliness in Control, T₁, T₂, T₃ & T₄ respectively. It was concluded that, scientific management of micro-environment of goat floor can be enriched by means of ultra-hydrophobic coating of contact surfaces with the ICTs.

Keywords: Ultra-hydrophobic, Super hydrophobic, Micro-environment, Goat shed, Management

Introduction

Nanotechnology is not just about the size of very small things, it is the revolutionary science and the art of manipulating matter at the atomic or molecular scale. Super-hydrophobic surfaces have evoked great interest. Super-hydrophobic surfaces (SHS) exhibit extremely high water repellency, in addition to high contact angles, super hydrophobic surfaces exhibit very low water contact angle hysteresis CAH (<10) leads to the rolling and bouncing of the water droplets, leading to a self-cleaning property of super hydrophobic surfaces. The physical reason of self-cleaning is the joint action of small adhesion of dust particles to the surface and high capillary force acting on the dust particles at water drop-air interface. Besides water repellency and self-cleaning, other properties have also been incorporated in super-hydrophobic surfaces such as transparency and color, anisotropy, reversibility, flexibility, non-toxic, anti-microbial and breathability (Moisture vapor transfer).

Goats are stall fed either on concrete floor or on traditional kattcha soil floor. Both the surfaces have their advantages and disadvantages. But the dampness, wetting of floor, staining of floor with urine and droppings, foul odorous air, stagnation of stagnation at corners, drainage channel, trapping of dirt in cracks and crevices are very common problems with flooring of goat shed.

These problems collectively gives rise to growth and multiplication of different bacteria, fungi and parasites in the contact surfaces of goat shed that results into respiratory distress, pneumonia, foot-rot, neonatal kid's mortality particularly in goat management. The microbial load of contact surfaces in intensive management of animals plays very crucial role in health status of herd. Hence in present investigation major emphasis was employed for structural modification of contact surfaces of animal shed to reduce moisture level with layering of ultra-hydrophobic material.

Materials & Methods: Total 30 adult goats were distributed into five different compartments with concrete floor as Control, T₁, T₂, T₃, & T₄ treatment groups for 106 days to Study qualitative and quantitative effects of ultra-hydrophobic contact surfaces with different improved cleaning methods on micro-environmental management of goat housing. All the experimental goats from all treatment and control group were dewormed 15 days prior to the commencement of the actual research work.

Contact floors of all treatment groups except Control were modified by application of ultra-hydrophobic layers. Floor and drainage channel of all above experimental groups were restructured with fine layer of concrete with a slope with an inclination angle of 8°. Three different Improved cleaning methods ICT-A, ICT-B & ICT-C were designed & implemented in T₂, T₃, T₄ respectively, however T₁ was treated with Traditional swiping by stick broom only.

Table 1: Experimental Design

Sr. No	Treatment group	Number of Experimental Goats	Details of treatment
01	Control	06	Traditional cleaning of floor by using stick broom.
02	T ₁	06	Swiping by stick broom only without any improved cleaning treatment.
03	T ₂	06	Daily swiping by using SSD garden broom and prescribed ICT-A i.e. Cleaning of contact surfaces with pressure water pump, 1.0 Hp (240-260V)
04	T ₃	06	Daily swiping by using SSD garden broom and prescribed ICT-B i.e. Cleaning of contact surfaces with power air blower, 820W (240-260V)
05	T ₄	06	Daily swiping by using SSD garden broom and ICT-C as Cleaning of contact surfaces with multi-purpose vacuum cleaner, 1000 W (240-260 V)

Table 2: Prescribed Treatment Schedule.

Sr. No.	Time Phase (Days)	Scheduled Treatment Frequency Interval							
		Control	T ₁	T ₂		T ₃		T ₄	
		Swiping	Swiping	Swiping	ICT-A	Swiping	ICT-B	Swiping	ICT-C
1.	0-7	Daily	Daily	Daily	---	Daily	---	Daily	---
2.	08-16	Daily	Daily	Daily	Daily	Daily	Daily	Daily	Daily
3.	17-34	Daily	Daily	Daily	Every 3 rd day	Daily	Every 3 rd day	Daily	Every 3 rd day
4.	35-64	Daily	Daily	Daily	Every 5 th day	Daily	Every 5 th day	Daily	Every 5 th day
5.	65-106	Daily	Daily	Daily	weekly	Daily	weekly	Daily	weekly

Before and after the application of treatments as showed in Table No. 1& 2, floor temperature and moisture along with samples of loose soil or dust from floor surface for microbial analysis were collected aseptically.

- **Moisture content of contact surfaces (MCS)** of experimental groups was recorded by using Concrete floor Moisture Meter, Pin Type with Digital LCD display at 4 corners and at center of the floor to calculate average observation.
- **Floor temperature of contact surfaces (TCS)** of experimental groups was measured by using Non-Contact Infrared Thermometer Digital Temperature Gun with Laser Functional Range -26 to 716 Degree Fahrenheit (-32 to 380 Degrees Celsius) at 4 corners and at center of the floor to calculate average observation.
- **Bacterial Count of contact surfaces (BCS):** Dust/loose soil collected from the contact floors from each experimental compartment aseptically in sample bottles. The collected material will be smeared after dilution on agar media in Petri dishes and incubated for 36 hours to observe bacterial growth. The bacterial growth will be observed microscopically for estimation of bacterial colony count.
- **Parasitic Count of contact surfaces (PCS):** Dust/loose soil collected from the contact floors from each experimental compartment aseptically in sample bottles and analyzed with modified Cobb's Decanting and Sieving Method¹⁸ and modified Baermann method to estimate parasitic egg/larvae count present in it.

Results & discussion: The mean initial moisture contents of contact floor surfaces were 26.00, 15.00, 14.00, 13.60 &

15.40% and before traditional swiping during the first 8 days of the study were 62.03, 32.35, 29.08, 28.85 & 28.43 while after traditional swiping were observed as 50.40, 20.33, 25.60, 24.95 & 24.26% for Control, T₁, T₂, T₃ and T₄ treatments respectively. Average Daily Moisture (%) content of experimental contact floors of treatment compartments before cleaning of experimental compartments of all the treatment groups during 9th to 16th days of the study were 62.03, 32.35, 28.43, 28.85 & 29.08 and 50.40, 20.80, 19.48, 19.70 & 19.45% after cleaning with different ICT for Control, T₁, T₂, T₃ and T₄ treatments respectively. There were 8.83, 9.56, 8.95, 9.70 & 10.10% reduction as 14.23, 29.55, 31.48, 32.49 & 34.73% percentile reduction in the moisture level of Control, T₁, T₂, T₃ and T₄ treatments were respectively and on every 3rd day before the cleaning of experimental compartments of all the treatment groups between 19th to 34th days of the study were 65.13, 32.13, 32.50, 29.77 & 26.60 and 53.20, 22.57, 22.40, 20.07 & 17.11 after the cleaning for Control, T₁, T₂, T₃ and T₄ treatments respectively. Average Moisture (%) content of experimental contact floors of treatment compartments on every 5th day were 61.37, 31.90, 31.47, 30.33 & 32.77 and 48.33, 21.53, 20.83, 19.50 & 15.63 before and after the cleaning of experimental compartments of all the treatment groups between 39th to 64th days of the study were for Control, T₁, T₂, T₃ and T₄ treatments respectively. Average weekly Moisture (%) content of experimental contact floors of treatment compartments before the cleaning of experimental compartments of all the treatment groups between 71st to 106th days of the study were 59.10, 45.73, 31.03, 33.50 & 32.77 and 46.53, 32.10, 21.73, 19.97 & 15.63 after the cleaning for Control, T₁, T₂, T₃ and T₄ treatments respectively.

The mean initial surface temperature of the contact floor were 88.92, 93.04, 92.28, 93.32 & 93.14 °F ; before traditional swiping during the first 8 days of the study were 89.56, 88.63, 87.94, 88.19 & 88.79 °F and after traditional swiping for Control, T₁, T₂, T₃ and T₄ treatments were observed as 91.83, 92.06, 91.25, 91.16 & 91.38 °F respectively.

Average Daily surface temperature during 9th to 16th days of the study were 88.63, 88.91, 88.16, 88.46 & 88.36 °F ; after cleaning with different ICT along with traditional swiping were observed as 91.40, 92.48, 91.77, 91.96 & 91.80 °F for Control, T₁, T₂, T₃ and T₄ treatments respectively. on every 3rd day before the cleaning of experimental compartments of all the treatment groups between 19th to 34th days of the study were 88.77, 88.07, 87.69, 88.05 & 88.33 °F & after the cleaning of experimental compartments between 19th to 34th days of the study were 92.45, 90.92, 90.99, 90.73 & 91.78 °F for Control, T₁, T₂, T₃ and T₄ treatments respectively. Every 5th day before the cleaning were 88.56, 88.55, 87.52, 87.84 & 88.25 °F and after the cleaning of experimental compartments of all the treatment groups between 39th to 64th days of the study were 92.33, 90.84, 90.94, 91.03 & 91.14 °F for Control, T₁, T₂, T₃ and T₄ treatments respectively. Average weekly 71st to 106th days of the study were 88.44, 88.25, 87.61, 87.88 & 88.13 °F and after the cleaning of experimental compartments were 92.56, 90.93, 91.29, 91.27 & 91.19 °F for Control, T₁, T₂, T₃ and T₄ treatments respectively.

The mean initial bacterial count of the contact floor were 195.67, 148.67, 165.33, 110.33 & 124.54 (N×10⁶ CFU) for Control, T₁, T₂, T₃ and T₄ treatments respectively. Average Daily bacterial count before traditional swiping during the first 8 days were 192.33, 195.42, 174.42, 176.25 & 180.00 after traditional swiping for Control, T₁, T₂, T₃ and T₄ treatments were observed as 170.71, 153.42, 135.71, 136.67 & 141.79 (N×10⁶ CFU), for Control, T₁, T₂, T₃ and T₄ treatments respectively. Average Daily Bacterial load during 9th to 16th days of the study were 174.33, 176.44, 183.63, 187.54 & 174.33 (N×10⁶ CFU) for Control, T₁, T₂, T₃ and T₄ treatments respectively. During the second phase of data collection between 9th to 16th days of the present investigation, Average Bacterial load after cleaning with different ICT along with traditional swiping were observed as 153.00, 137.17, 134.08, 128.20 & 97.56 (N×10⁶ CFU) for Control, T₁, T₂, T₃ and T₄ treatments respectively. On every 3rd day before the cleaning between 19th to 34th days were 191.17, 184.86, 175.50, 179.17 & 185.28 & after the cleaning were 170.28, 146.67, 132.28, 128.00 & 123.50 (N×10⁶ CFU) for Control, T₁, T₂, T₃ and T₄ treatments respectively. Every 5th day before the cleaning of experimental compartments of all the treatment groups between 39th to 64th days of the study were 181.56, 184.94, 179.89, 177.94 & 180.83 & after were 159.94, 149.94, 139.00, 134.17 & 123.17 for Control, T₁, T₂, T₃ and T₄ treatments respectively. Average weekly Bacterial load were 180.17, 182.80, 182.82, 175.20 & 174.70 & 158.61, 154.45, 151.67, 139.42 & 126.16 (N×10⁶ CFU) before and after cleaning of Control, T₁, T₂, T₃ and T₄ treatments respectively. The principles of reducing CFU are in close agreement with the reports of Yea-Ling Ong *et al.*, (1999) [12] Behzad Rezaei *et al.*, (2006) [3], Siti Hajar Othman *et al.*, (2014) [9], Lauren R. Freshcauf *et al.* (2012) [14], Hongyan Gao *et al* (2019) [15] Xiaoxue Zhang *et al* (2013) [11]

Average Daily parasitic load of experimental contact floors before traditional swiping during the first 8 days were 9.63, 10.13, 9.50, 9.75, & 8.50 (N×100/cm²) however after traditional swiping for Control, T₁, T₂, T₃ and T₄ treatments were observed as 6.25, 6.13, 6.38, 4.75 & 2.50 (N×100/cm²) respectively & during 9th to 16th days were 10.50, 10.25, 9.75, 10.13 & 8.00 (N×100/cm²) for Control, T₁, T₂, T₃ and T₄ treatments respectively. During the second phase Average Parasitic load were observed as 7.75, 6.63, 6.50, 5.50 & 2.13 & before the cleaning of experimental compartments of all the treatment groups between 19th to 34th days of the study were 11.17, 10.00, 9.17, 10.00 & 9.50 ((N×100/cm²) for Control, T₁, T₂, T₃ and T₄ treatments respectively. On every 3rd day after and before the cleaning of experimental compartments of all the treatment groups between 19th to 34th days of the study were 7.67, 6.67, 6.50, 5.50 & 2.50 & were 10.33, 9.50, 10.33, 10.17 & 9.00 (N×100/cm²) for Control, T₁, T₂, T₃ and T₄ treatments respectively with every 5th day after & before the cleaning between 39th to 64th days of the study were 7.67, 6.50, 6.67, 3.50 & 2.33 & (N×100/cm²) and Average weekly Parasitic load of experimental contact floors of treatment compartments before and after the cleaning of experimental compartments of all the treatment groups between 71st to 106th days of the study were 10.83, 9.83, 10.50, 9.50 & 9.83 & were 7.67, 6.17, 6.67, 5.17 & 2.33 (N×100/cm²) for Control, T₁, T₂, T₃ and T₄ treatments respectively. Hassan *et al.*, (2011) [11], Bob Storey (2015) [4]

Conclusion

Under conventional goat housing, surface modification of rough concrete floor by means of application of ultra-hydrophobic layer ensures healthy management of micro-environmental factors of contact surface. Incidences of bacterial infections, parasitic infestations, neonatal mortality etc. in goat shed can be minimised effectively with the ultra-hydrophobic contact floor and any of the Improved Cleaning Treatment (ICT). Hence it is concluded that, as the future prospect of micro-environmental management of goat shed to harvest best results in conventional housing, modifying the contact surfaces of goat shed with ultra-hydrophobic coating with any of the Improved Cleaning methods will be definitely answered.

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