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Microbial Deterioration of Painted Wall Surfaces in Wukari, Taraba State, Nigeria

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Abstract

Bacterial and fungal biodeteriogens of painted wall surfaces in Wukari, Taraba State were investigated. Two (02) samples were randomly collected each from nine (09) buildings at different locations, totaling eighteen (18) samples from Wukari and the Federal University Wukari campus. These buildings were observed for visible discoloration, viscous loss and foul smell. The samples were collected by scraping the biodeteriorated painted walls using a new razor blade and the scraps were aseptically transferred into sterile sampling bottles, and immediately transferred to the laboratory for further analysis. Samples from the conical flask were serially diluted and isolation and identification of bacteria and fungi were done subsequently using standard techniques. The bacterial count at the various sampling sites ranged from $1.64\times10^{8} – 2.89\times10^{7}$ cfu/g. The predominant bacterial species associated with the deterioration of the painted walls were *Bacillus* species. The fungal species isolated were *Aspergillus* species (66.67%), *Penicillium* species (16.67%) and *Mucor circinelloides* (16.67%). It is likely that the biocides incorporated in the paints were no longer active after sometime. There is the need for building owners to periodically repaint the surfaces since some of the organisms isolated are potential pathogens and their build-up in the deteriorated surfaces may pose public health hazards to the community.

1. Introduction

In ancients' times, clays and chalks were mixed with animal fats and were used as paints to depict hunts on the cave walls [17]. However, contemporary household paints consist of a binder (which aid sticking to surfaces), pigments (giving colours and opacity), and solvents (making it spreadable) with some peculiar chemical constituents such as polyamides, epoxy resins, chlorides, organic solvents and water [17]. Some bacterial and fungal deteriogens use these constituents as carbon source [10, 17]. However, the raw material sources, manufacturing plant process units and packaging materials were also linked to microbial contaminations of paints [10].

Although paints are meant to protect the surfaces from biodeterioration, corrosion, oxidation, environmental weathering or other types of deterioration, the action of

biological deteriogens tend to defeat this aim [1, 4]. The deteriogens biodeteriorate the paint constituents and reduces its economic value, durability adhesive and decorative finish [1, 4, 7].

Several investigations from different location, isolated bacterial species in deteriorated painted wall surfaces. The genus *Aspergillus* is one of the most frequently isolated fungi from biodeteriorated painted walls [1, 14, 18]. Other research reported that fungi associated with deterioration of paints include *Rhizopus arrhinus, A. niger, A. ustus, A. flavus, Penicillium citrinum, Alternaria altanata, Chaetomium globosum, Alternaria altanata* [2, 11]. In their investigation, [12], reportedly isolated *Acremonium*, *Aspergillus*, *Cladosporium*, *Fusarium* and other imperfect fungal genera among which several melanized *Mycelia sterilia*. While [9], isolated *Penicililum* species*, A. niger, Rhizopus oryzae, Mucor, Trichophyton, Alternaria alternate* and *Epidermophyton floccosum.* The bacterial species commonly isolated were *Bacillus* species*, Pseudomonas* species*, Enterobacter* species*, Proteus* species*, Escherichia coli, Micrococcus, Serratia, Aeromonas* [14]. A wide range of anaerobic bacteria including *Bacteroides*, *Clostridium*, *Desulphovibrio* and *Bifidobacterium* were also been isolated in painted surfaces [16, 20, 13]. However, bacterial and fungal species associated with deteriorated painted surfaces in wukari areas have not been investigated. Therefore, this study evaluated bacterial and fungal deteriogens associated with the deterioration of the administrative complex, students' hostels in Federal Univesity-Wukari and in some houses of Wukari town of Taraba state, Nigeria.

2. Materials and Methods

2.1. Sample Collection

A total of eighteen (18) samples were collected randomly during morning hours (10:00am) on nine (09) different buildings (02 samples each) from the different locations of the Federal University Wukari campus (Administrative block, Female Hostel, Male hostel) and different buildings in Wukari town (Old Bakery Bread, Government Residential Area, Wapan Ngaku, Mammara school, Mammara street and Dikko street). These buildings were observed for visible discoloration, viscous loss, foul smell and degradation. The samples were collected by scraping of the biodeteriorated painted walls using a new razor blade and aseptically passing the scraps into a sterile sampling bottle and labeling was done accordingly. These samples were immediately transported to the laboratory for further analysis.

2.2. Sample Preparation and Analysis for Bacteria

One gram (1g) of each sample from the different study site was dissolved in 10 ml of sterile distilled water in a conical flask. Serial dilution of the fresh sample and the digested slurry sample were carried out up to 10^{-6} tubes. Exactly 0.1ml was obtained using sterile syringe from the 10^{-6} test tube and inoculated onto already prepared nutrient agar plates by spread plate and pour plate methods of inoculation. The inoculated plates were incubated at 37°C for 24h. Bacterial colonies that emerged on the plates were counted and recorded as colony forming units per gram (cfu/g) of the sample. The colonies were also sub-cultured repeatedly on fresh plates to obtain pure isolates. The pure bacterial isolates were Gram-stained and subjected to different biochemical tests. The bacterial pure isolates were identified by comparing their characteristics with those of known taxa using the schemes of [6] and by the conventional bacteriological test methods and by reference to the keys outlined by [5].

2.3. Isolation of Fungi

An aliquot (0.1ml) was obtained using sterile syringe from the 10^{6} tube and inoculated onto already prepared Potato Dextrose Agar (PDA) and was kept at a room temperature in the dark for about 4 to 10 days. After which distinct growth colonies were sub-cultured by spot inoculation on fresh sterile PDA plates to obtain pure culture. These were incubated at room temperature for another 4 to 10 days. Identification was done based on the colonial and morphological characteristics and with reference to the methods of [3, 15] (the lactophenol cotton blue and slide cultures techniques) and as described by previous workers [8, 19].

3. Results and Discussion

Table 1. *Showing Mean bacterial count from each sampling site.*

Sampling site (s)	Mean Bacterial load (CFU/g)
A1	1.89×10^{7}
A2	2.68×10^{9}
B1	2.24×10^{7}
B2	2.89×10^{7}
C1	2.64×10^{8}
C2	1.64×10^{8}
D1	NVG
D2	NVG

NVG= No Visible Growth
A1 &A2= Samples collected from Administrative block,
B1 & B2 = Samples collected from Female Hostel and
C1 & C2= Samples collected from Male hostel of the FUW.
D1 & D2 = Samples collected from

Table 2. *Showing bacteria species isolated from different sampling site.*

Sampling site(s)	Bacteria Isolated
A1	*Bacillus* species
A2	*Bacillus* species
B1	*Bacillus* species
B2	*Bacillus* species
C1	*Bacillus* species
C2	*Bacillus* species

A1 &A2= Administrative block,
B1 & B2 = Female Hostel and
C1 & C2= Male hostel of the FUW.

Table 3. *Showing the Fungal species isolated.*

S/NO.	SAMPLING SITE	ORGANISM ISOLATED
1	WN	*Penicillium* species
	WN	*Aspergillus niger*
2	OBB	*Aspergillus flavus*
	OBB	*Mucor circinelloides*
3	GRA	*Aspergillus niger*
	GRA	*Aspergillus fumigatus*
4	MS	*Penicillium* species
	MS	*Aspergillus niger*
5	DS	*Aspergillus flavus*
	DS	*Mucor circinelloides*
6	MST	*Aspergillus niger*
	MST	*Aspergillus fumigatus*
7	FAB	*Aspergillus niger*
	FAB	*Aspergillus fumigatus*
8	FMH	*Aspergillus niger*
	FMH	*Aspergillus flavus*
9	FFH	*Mucor circinelloides*
	FFH	*Penicillium* species

WN= Wapan Nghaku Area, OBB= Olb Bakery Bread Area, GRA= Government Residential Area, MS= Marmmara School, DS= Dikko Street, MST= Mammara Street, FAB= Federal University Wukari, Administrative block, FMH= Federal University Wukari, Male Hostel, FFH= Federal University Wukari, Female Hostel

Table 4. *Showing the frequency of the fungal isolates.*

ORGANISM ISOLATED	FREQUENCY	PERCENTAGE (%)
Aspergillus species	12	66.67
Penicilium species	3	16.67
Mucor circinelloides	3	16.67

Table 1 shows the bacterial load of the various sample. There was no visible bacterial growth from the samples collected from GRA, Old BB and Wapan Ngaku. The bacterial count from Mammara School, Mammara Street, Dikko Street and the Federal University Wukari campus (Administrative block, Female Hostel and Male hostel) ranged between 2.10×10^7 to 2.67×10^9 cfu/g.

The bacteria species isolated from the various samples and their frequency include *Bacillus* species (Table 2).

Table 3 presented the bacterial and fungal species isolated from the various samples which were *Aspergillus flavus, Aspergillus fumigatus, Penicillium* species, *Mucor* species and *Cephalosporium* species.

Table 4 also showed the frequency of the bacterial fungal isolates from each sampling site.

4. Discussion

The bacterial species isolated from this study were *Bacillus* species. Earlier studies isolated *Bacillus* species, *Pseudomonas* species, *Enterobacter* species, *Proteus* species, *Escherichia coli, Micrococcus, Serratia, Aeromonas* from deteriorated painted surfaces [14]. A wide range of anaerobic bacteria including *Bacteroides*, *Clostridium*, *Desulphovibrio* and *Bifidobacterium* were also isolated in painted surfaces [13, 16, 20]. The isolation of *Bacillus* species from both studies can be related to the close association of the same with paint deterioration despite the location and time of study.

The fungal species isolated were *Aspergillus* species (66.67%), *Penicillium* species (16.67%) and *Mucor circinelloides* (16.67%). This study agrees with the assertion by several researchers which reported that the genus *Aspergillus* are the predominantly isolated fungi from biodeteriorated painted walls [1, 14 18]. It also falls in alignment with the studies of [12] and [9]. However, [11] isolated *Rhizopus arrhinus, Aspergillus niger, Penicillium citrinum, Chaetomium globosum, Alternaria altanata*. The isolation of *Aspergillus* species and *Penicillium* species from both studies can be related to the close association of the fungi with paint deterioration despite the location and time of study.

5. Conclusion

Though some bacterial and fungal species are essential for global ecology, they may also pose threat to public health especially to building occupants. It is likely that the biocides incorporated in the paints were no longer active after sometime. Therefore, there is the need for building owners to routinely repaint their wall surfaces. This is because some of the organisms isolated are potential pathogens and their build-up in the deteriorated surfaces may pose public health hazards to the community. To the stakeholders in paint manufacturing industries, the incorporation of potent biocides while observing critical control points in the other chemical composition of paints, is advocated. This will enhance quality and durability of paints and discountenance the potential public health hazard which may be likely posed by the potential pathogens.

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