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Prevalence of Mould Found in Buildings with Moisture Problem in Port Harcourt, River State of Nigeria

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Abstract: In order to determine the moulds that were prevalent in houses with moisture problem, 288 sampling sessions were carried out in 12 living houses in Port Harcourt area of Rivers State. The houses were identified to have moisture problem as a result of constant flooding and leakages. Air samples were collected once a month for 24 months as well as temperature and relative humidity readings. Flooding and leakage incidence were also recorded. Samples were processed using potassium hydroxide for direct microscopy and cultured on sabouraud dextrose agar medium containing chloramphenicol. Microscopic examination of culture was done using lactophenol cotton blue mounting technique. All study sites yielded mould isolates. Sixteen different species of mould were isolated from the sampling sites *Trichophyton rubrum* and *Mucor* sp. were the most prevalent moulds with a total occurrence of 288 (13.8%) followed by *Microsporum audouinii* with 201 (9.6%), *Trichophyton mentagrophytes* 176 (8.4%), *Penicillium* sp. 175 (8.4%), *Aspergillus flavus* 165 (7.9%), *Aspergillus fumigatus* 148 (7.1%) and *Microsporum ferrugineum* 109 (5.2%). The lowest percentage occurrence was from *Trichophyton schoenleinii* 26 (1.2%). Buildings with consistent moisture problem and relative humidity above 60% will always provide a conducive and fertile ground for the growth of moulds.

Key words: Moulds, moisture problem, living houses, prevalence, port harcourt, *Aspergillus flavus*

INTRODUCTION

Mould is a term used to describe any fungus whose vegetative growth consists of filaments or hyphae interwoven to form a mat-like mycelium. Madigan and Martinko (2005) described moulds as members of the fungi kingdom, they include all species of microscopic fungi that grow in the form of multicellular filaments called hyphae. There are thousands of known species of moulds that exist everywhere in the natural environment and they include opportunistic pathogens, saprotrophs, aquatic species, calders and thermophiles (Ryan and Ray, 2004). Like all fungi, moulds derive energy not through photosynthesis but from the organic matter inside of which they live and as such play a major role in causing decomposition of organic material. Moisture problem in buildings results from water incursion either from internal sources (e.g., leaking pipes) or external sources (e.g., rainwater) thereby causing dampness. This becomes a problem when various materials in the building (e.g., rugs, walls, ceiling tiles, wooden frames) become wet for extended period of time. Excessive moisture in the air (i.e., high relative humidity) that is not properly controlled can also lead to excessive dampness. Flooding from within or without the building also causes dampness. Dampness is a problem in buildings because it not only provides the much needed moisture that supports the growth of moulds but it also causes illness as a result of exposure to the moulds in the damp or water damaged building.

Water damaged buildings are generally referred to as sick-buildings because not only are the buildings prone to the prolific growth of moulds, they have been related to illness of their occupants (Dales *et al*., 1991; Koskinen *et al*., 1999; Brunekreef *et al*., 1989). Much study has been done on moulds and their effect on people of different age groups, area of infection and even geographic regions (Emmy-Egbe *et al*., 2006;

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Rudy, 1999; Gargoom *et al*., 2000; Mohamed and Zenab, 2001) but little research has been made into the prevalent moulds found in the homes and to the best of the knowledge, none has been done in Nigeria. This study was therefore aimed at identifying the prevailing moulds found in buildings with moisture problem in Rivers state of Nigeria.

MATERIALS AND METHODS

A total of 12 buildings located at areas that were known for perpetual flooding incidences, visible leakages, poor drainage systems and buildings at water front areas were used for this study. Sampling was done once a month in all the rooms of each building for 2 years, thereby giving a total of 288 sampling sessions. During each sampling, the atmospheric temperature of the house was recorded. Every flooding incident resulting from rainfall, overflowing of drainages and seepages from the ground was recorded as well as leakages from walls, sinks, pipes, roofs, etc. The type of buildings used were living homes with families.

Sample collection: Air samples were collected by allowing freshly prepared sabouraud dextrose agar with chloramphenicol to stand open for 1 h then covered, sealed with masking tape and taken to the laboratory for incubation at room temperature for 3-4 weeks (Malloch, 1997). The psychrometer (dry and wet bulb thermometer) was used in measuring the air temperature of the various sites. Only the dry bulb readings were considered as the air temperature according to meteorological rules while the relative humidity of the sampling sites was measured by subtracting the reading of the wet bulb column from that of the dry bulb column. This gave the depression value which was read off from the hygrometric tables by locating the dry bulb value and the depression value given by the hygrometer. The reading at the intersection of the two columns, gave the percentage relative humidity that was used.

Sample processing: A daily inspection of the incubated air samples in sabouraud dextrose agar was made and the resultant culture was processed by observing the colonial morphology of the growths such as the colour, texture, margins, shape, etc. Tease mount method (Murray *et al*., 2005).

- A drop of lactophenol cotton blue mounting fluid was placed on a clean glass slide
- A portion of mycelium is transferred to the lactophenol cotton blue stain and teased out using a 22-gauge nichrome needle to separate the filaments
- A cover slip is placed over the preparation and gentle pressure applied
- This was examined using 10 and 40x objectives of the microscope

Each isolate was tested for the ability to ferment and/or assimilate carbon sources, ability to utilize HNO_3 as the sole nitrogen source, produce Urease and also grow at 37°C. The dermatophytes were identified using gross and microscopic morphology based on the criteria enumerated by Rebell and Taplin (1979) and Frey *et al*. (1979).

RESULTS AND DISCUSSION

Air samples collected from the 288 sampling sessions all gave positive isolation of moulds from all the study sites. Table 1 shows the indoor parameter values for air temperature, relative humidity, flooding incidence and leakages for each of the study sites throughout the 24 months. This revealed the constant hot and humid atmosphere of these sites. Table 2 shows all the moulds isolated from each study site and reveals that 16 different species of mould were isolated from the sampling sites during this research.

Table 3 shows the total number of times each mould occurred or was isolated out of the 288 samplings done and the percentage occurrence of each mould. *Mucor* sp.

Table 1: Temperature, relative humidity, leakages and flooding values of the study sites

Site	Location	Average temperature (°C)	Average relative humidity (%)	Total no. of leakages incidence	Total no. of flooding incidence
1	Akwa street	32.1	80.6	52	108
2	Sangana street	30.2	78.2	43	108
3	Nembe water front	31.9	80.2	58	138
4	Marine base water front	31.0	78.6	50	128
5	Njemanse street	30.4	80.6	15	84
6	Mile three road	30.0	76.2	10	102
7	Iloabuchi road	30.9	72.4	18	82
8	Rumuigbo/pshsycaitric road	28.2	74.6	26	96
9	Rumuokwuta/ngbuoba road	28.2	72.8	14	112
10	Rumuokoro/choba Rd One man village	29.6	67.6	20	154
11	Mile one road	30.0	70.0	27	92
12	Eastern by-pass (sand filled)	28.4	76.0	10	106

Table 2: Types of mould isolated from each study sites

Site	Name	Fungi isolated
1	Akwa street	*A. flavus*, *A. fumigatus*, *Penicillium* sp., *Mucor* sp., *T. rubrum*, *M. audouinii*, *M. ferrugineum*, *T. mentagrophytes*, *M. ferrugineum*, *Rhizopus* sp., *E. floccosum*, *Alternaria alternata*
2	Sangana street	*A. flavus*, *A. fumigatus*, *Penicillium* sp., *Mucor* sp., *T. rubrum*, *M. audouinii*, *M. ferrugineum*, *T. mentagrophytes*, *M. ferrugineum*, *Rhizopus* sp., *E. floccosum*, *Alternaria alternata*
3	Nembe water front	*A. flavus*, *A. fumigatus*, *Penicillium* sp., *Mucor* sp., *T. rubrum*, *M. audouinii*, *M. ferrugineum*, *T. mentagrophytes*, *M. ferrugineum*, *Rhizopus* sp., *E. floccosum*, *Alternaria alternata*, *S. schenckii*, *A. niger*, *T. schoenleinii*, *Fusarium solani*
4	Marine base water front	*A. flavus*, *A. fumigatus*, *Penicillium* sp., *Mucor* sp., *T rubrum*, *M. audouinii*, *M. ferrugineum*, *T. mentagrophytes*, *M. ferrugineum*, *Rhizopus* sp., *E. floccosum*, *Alternaria alternata*, *S. schenckii*, *A. niger*, *T. schoenleinii*, *Fusarium solani*
5	Njemanse street	*A. flavus*, *A. fumigatus*, *Penicillium* sp., *Mucor* sp., *T. rubrum*, *M. audouinii*, *M. ferrugineum*, *T. mentagrophytes*, *M. ferrugineum*, *Rhizopus* sp.
6	Mile three road	*A. flavus*, *A. fumigatus*, *Penicillium* sp., *Mucor* sp., *T. rubrum*, *M. audouinii*, *M. ferrugineum*, *T. mentagrophytes*, *M. ferrugineum*, *Rhizopus* sp., *E. floccosum*, *Alternaria alternata*
7	Iloabuchi road	*A. flavus*, *A. fumigatus*, *Penicillium* sp., *Mucor* sp., *T. rubrum*, *M. audouinii*, *M. ferrugineum*, *T. mentagrophytes*, *M. ferrugineum*, *Rhizopus* sp., *Scopulariopsis* sp.
8	Rumuigbo/pshsycaitric road	*A. flavus*, *A. fumigatus*, *Penicillium* sp., *Mucor* sp., *T rubrum*, *M. audouinii*, *M. ferrugineum*, *T. mentagrophytes*, *M. ferrugineum*, *Rhizopus* sp.
9	Rumuokwuta/ngbuoba road	*A. flavus*, *A. fumigatus*, *Penicillium* sp., *Mucor* sp., *T. rubrum*, *M. audouinii*, *M. ferrugineum*, *T. mentagrophytes*, *M. ferrugineum*, *Rhizopus* sp., *E. floccosum*, *Alternaria alternata*, *S. schenckii*, *A. niger*
10	Rumuokoro/choba Rd One Man Village	*A. flavus*, *A. fumigatus*, *Penicillium* sp., *Mucor* sp., T. rubrum,*M. audouinii*,*M.ferrugineum*, *T. mentagrophytes*, *M. ferrugineum*, *Rhizopus* sp., *E. floccosum*, *Alternaria alternata*, *S. schenckii*, *A. niger*
11	Mile one road	*A. flavus*, *A. fumigatus*, *Penicillium* sp., *Mucor* sp., *T. rubrum*, *M. audouinii*, *M. ferrugineum*, *T. mentagrophytes*, *M. ferrugineum*, *Rhizopus* sp., *Scopulariopsis* sp.
12	Eastern by-pass (sand filled area)	*A. flavus*, *A. fumigatus*, *Penicillium* sp., *Mucor* sp., *T. rubrum*, *M. audouinii*, *M. ferrugineum*, *T. mentagrophytes*, *M. ferrugineum*, *Rhizopus* sp., *E. floccosum*, *Alternaria alternata*

Table 3: Total occurrence of isolated mould

Isolated fungi	Total occurrence	Occurrence (%)
Aspergillus flavus	165	7.9
Aspergillus fumigatus	148	7.1
Aspergillus niger	66	3.2
Penicillium sp.	175	8.4
Rhizopus sp.	131	6.3
Mucor sp.	288	13.8
Scopulariopsis sp.	36	1.7
Alternaria alternata	95	4.5
Trichophyton rubrum	288	13.8
Sporotrix schenckii	56	2.7
Epidermophyton floccosum	98	4.7
Microsporum audouinii	201	9.6
Microsporum ferrugineum	109	5.2
Trichophyton mentagrophytes	176	8.4
Trichophyton schoenleinii	26	1.2
Fusarium solani	32	1.5
Total	2090	100.0

Table 4: Mould isolates in groups

Groups	Species	Occurrence	Occurrence (%)
Dermatophytes	*Trichophyton rubrum* *Trichophyton mentagrophytes* *Trichophyton schoenleinii* *Microsporium audouinii* *Microsporium ferrugineum* *Epidermophyton floccosum*	898	43.2
Non-dermatophytic mould	*Aspergillus flavus* *Aspergillus fumigatus* *Aspergillus niger* *Scopulariopsis* sp. *Sporothricum schenckii* *Fusarium* sp. *Mucor* sp. *Rhizopus* sp. *Penicillium* sp.	1192	56.8
Total		2090	100.0

and *Trichophyton rubrum* had the highest percentage occurrence of 13.8% as they were isolated from all the sampling done, while *Trichophyton schoenleinii* had the least occurrence of 1.2% from the entire study (Table 4). Seven dermatophytes with a total percentage occurrence of 43.2% were isolated from the study, while nine non-dermatophytic moulds were isolated with a total percentage occurrence of 56.8%.

The results of this research has revealed that buildings with higher frequency of flooding and leakages have more isolates of mould as typified by sites 1-4, 6, 9, 10 and 12 which recorded between 12 and 16 different mould isolates compared to the buildings with less flooding and leakage incidence which recorded between 10 and 11 different mould isolates in them (sites 5, 7, 8 and 11). This result could translate to mean that the more the constant presence of moisture within the building the more the perfect condition is provided for the growth of moulds. Although, no building is completely free of mould spores, even where there is no mould related problem (Kemp *et al*., 2002; Hicks *et al*., 2005), nevertheless where there is constant moisture and conducive relative humidity (>60%) there will be more moulds. The high occurrence of *Mucor* sp. in this study could be attributed to their fast and easy growth rate due to their ability to thrive in the least available nutrient condition of moisture and mould food which could be any material of plant or animal origin. *Trichophyton rubrum* which has man, domestic animals and rodents as reservoir and is mainly found on bath mats, swimming-baths and showers (Rhode and Hartmann, 1980) can therefore attribute its high prevalence to the location of these study sites which are in swampy areas and have poor drainage systems which is also a plaque of most cities in the southern part of Nigeria.

The study sites being living houses with families and all the activates that is associated with people living together may have also contributed to the type of moulds isolated from them, especially the dermatophytes which have been extensively proofed to be the major cause of most skin infections (Oyeka, 1990; Mbata and Nwajagu, 2007).

The high percentage occurrence of other non-dermatophytes (56.8%) in this study may be due to the ubiquitous nature of their spores in the environment and because they are also carried transiently on healthy skin (Oyeka and Ugwu, 2002). *Penicillium* sp. are among the greatest spoilers of food items and have proved to be very common indoors (air, house dust, plants) even when the environment is considered clean (Burge, 1986; Miller *et al*., 1988). The *Aspergillus* sp. are ubiquitous saprophytes which are found in soil, plants and man (Rhode and Hartmann, 1980). It is therefore not surprising to have them among the prevailing moulds where constant moisture is involved and an abundance of wet material to decay.

CONCLUSION

In this study, moulds can grow on any material as long as it is damp and is of plant or animal origin. All houses with one form of moisture problem or the other be it leakages (especially in the kitchen or bathroom) or/and flooding will always provide a fertile ground for the growth of moulds. *Aspergillus flavus*, *Aspergillus fumigatus*, *Penicillium* sp., *Mucor* sp., *Trichophyton rubrum*, *Microsporum audouinii*, *Microsporum ferrugineum* and *Trichophyton mentagrophytes* had over 50% occurrence (that is up to 144 occurrences out of 288 samplings) in the study and as such are said to be the moulds prevalent in the houses with moisture problem in Port Harcourt of Rivers state.

REFERENCES

Brunekreef, B., D.W. Dockery, F.E. Speizer, J.H. Ware, J.D. Spengler and B.J. Ferris, 1989. Home dampness and respiratory morbidity in children. Am. Rev. Respiratory Dis., 140: 1363-1367.

Burge, H.A., 1986. Toxigenic potential of indoor microbial aerosols. Fifth Symposium on the Application of Short-Term Bioassays in the Analysis of Complex Environmental Mixtures. Sheraton University Center, Durham, NC.

Dales, R.E., R. Burnett and H. Zwanenburg, 1991. Adverse health effects in adults exposed to home dampness and molds. Am. Rev. Respiratory Dis., 143: 505-509.

Emmy-Egbe, O.I., S.N. Ibeh, F. Opara and C.N. Umeaku, 2006. Prevalence of fungal organisms associated with skin infections in Ihiala local government area of Anambra state, Nigeria. Int. J. Nat. Applied Sci., 2: 210-213.

Frey, D., R.J. Oldfield and R.C.A. Bridger, 1979. Colour Atlas of Pathogenic Fungi. Wolfe Medical Publications Ltd., London.

Gargoom, A.M., M.B. Elyazachi, S.M. Al-Ani and G.A. Duweb, 2000. Tinea capitis in Benghazi, Libya. Int. J. Dermatol., 39: 263-265.

Hicks, J.B., E.T. Lu, R. De Guzman and M. Weingart, 2005. Fungal types and concentrations from settled dust in normal residences. J. Occupat. Environ. Hygiene, 2: 481-492.

Kemp, P.C., H.G. Neumeister-Kemp, C. Koch, G. Lysek and F. Murray, 2002. Determining the growth and vitality of micro-organisms in carpets and mattresses in non-problem dwellings by measuring CO_2 released during respiration. Indoor Built Environ., 11: 214-220.

Koskinen, O.M., T.M. Husman, T.M. Meklin and A.I. Nevalainen, 1999. The relationship between moisture or mould observations in houses and the state of health of their occupants. Eur. Respir. J., 14: 1363-1367.

Madigan, M. and J. Martinko, 2005. Brock Biology of Microorganisms. Prentice Hall, New York, USA.

Malloch, D., 1997. Isolation, Cultivation and Identification of Moulds. University of Toronto Press, Toronto, pp: 312.

Mbata, T.I. and C.C. Nwajagu, 2007. Dermatophytes and other fungi associated with hair-scalp of nursery and primary school children in Awka, Nigeria. Internet J. Dermatol.

Miller, J.D., A.M. LaFlamme, Y. Sobol, P. Lafontaine and R. Greenhalgh, 1988. Fungi and fungal products in some Canadian homes. Intern. Biodeterioration, 24: 103-120.

Mohamed, S.E. and M.K. Zenab, 2001. Dermatophytes and other fungi associated with skin mycoses in tripoli, Libya. Ann. Saudi Med., 21: 193-195.

Murray, P.R., K.S. Rosenthal, G.S. Kobayashi and M.A. Pfaller, 2005. Medical Microbiology. 5th Edn., Mosby Inc., St. Louis MO. USA., pp: 291-296.

Oyeka, C.A. and I.O. Ugwu, 2002. Fungal flora of human toe webs. Mycoses, 45: 488-491.

Oyeka, C.A., 1990. Tinea capitis in awka local governmnet area for Anambra state. West Afr. J. Med., 9: 120-123.

Rebell, G. and D. Taplin, 1979. Dermatophytes: Their Recognition and Identification, Coral Gables. University of Miami Press, Florida, USA.

Rhode, B. and G. Hartmann, 1980. Introducing Mycology by Examples. Schering Aktiengesell Schalt Press, Hambury, pp: 84-121.

Rudy, S.J., 1999. Superficial fungal infections in children and adolescents. Nurse Pract. Forum., 10: 56-66.

Ryan, K.J. and C.S. Ray, 2004. Sherris Medical Microbiology. 4th Edn., McGraw Hill, New York.