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Fungi Associated with Leather Shoes Worn by Students of Federal University Wukari, Taraba State, Nigeria

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Abstract
A survey was carried out among sixty (60) students (thirty (30) males and thirty (30) females) in Federal University, Wukari to determine the fungi associated with leather shoes and the prevalence of the fungi. A total of fifty (50) isolates (twenty (20) from females and thirty (30) from males) were isolated using standard Microbiological techniques. These isolates belong to five (5) genera, namely: *Aspergillus, Penicillium, Fusarium*, *Trichophyton* (A dermatophyte) and lastly, *Candida*. The genus *Aspergillus* had the highest isolate with 50% and 40% for males and females respectively. The different species isolates of Aspergillus include *Aspergillus niger, Aspergillus flavus* and *Aspergillus fumigatus*. The dermatophyte known as *Trichophyton rubrum* had lower number of isolate (1) 3.3% and (0) 0% for males and females respectively. The incidence of the other isolates was as follows: Candida was (4) 13.3% and (1) 5%, *Penicillium notatum* was (8) 26.7% and (1) 5% and lastly *Fusarium oxysporum* was (2) 6.7% and (0) 0.0% for both male and female respectively. Ninety-eight percent (98%) of the students harboured the nonpathogenic fungi while only two percent (2%) harboured the pathogenic organism in their shoes. This low prevalence rate of the pathogenic organisms is due to the fact that pathogenic organisms are easier to isolate from the feet of the infected host. In conclusion, Leather shoes worn by students in Wukari harboured a number of fungi which have effect on the wearers and the shoe itself. Students and other individuals should always try to dry and clean their shoes after each use, to avoid dampness as this facilitate the growth of fungi. Those that are affected with the pathogenic fungi should try and seek for medical help immediately it is discovered. Proper methods of preserving the leather shoes including dehydration and use of antifungal agent should be developed. More studies should be conducted to determine the genetic status of the pathogenic strains which is hitherto non-pathogenic. Finally, further work should also be carried out to know the fungi associated with shoes worn at different times of the day to determine any relationship between organisms and the weather condition, that is, hot or cold weather.

1. Introduction

Fungi constitute a diverse group of microorganisms which can grow in almost any ecological habitat [1]. Fungi include mold and yeast. The yeast are unicellular organisms while the molds are multicellular filamentous organisms [2]. All fungi are chemo heterotrophs, requiring organic compounds for energy and carbon. They are aerobic or facultative anaerobic and they are eukaryotic organisms [1]. Reproductions in fungi occur by spore formation and the spores can be sexual or asexual [3]. Most of them are free living in the soil or water and obtain their energy by respiration of fermentation or soluble organic materials present in these environment [4]. The microorganism in the soil are able to gain entrance to the foot wear from where they can either attack the foot of the host or cause deterioration of the shoe component [5]. Foot wear is a general term that describes all foot protecting devices. It is not exactly known when foot protecting devices came into existence. Perhaps, it came with or after man discovered the need to cover his nakedness. Since that time, foot wear has evolved leading to different types and makes such as sandals and covered shoes made either from leather, synthetic or natural rubber or any other material [2]. Over the years, effort has been made to understand factors affecting the quality and durability of foot wear, particularly the leather foot wear. For example, production of leather shoes has witness various improvement beginning from the preparation and processing of the hides and skin to the actual production of shoes of various sizes and shapes. The organisms which thrive in the shoe environment manifest themselves in several ways. Attacks by microorganisms is a major cause of deterioration of foot wear components containing natural or regenerated cellulosic fibers, for instance linen welt thread, cotton vamp linings, bonded cellulose in sole boards and the cotton base fibers of toe-puffs [6]. The significant of microbiology deterioration was first appreciated at SATRA in connection with premature failure of linen welt thread leading to detachment of the sole. Rotting of protected cotton or rayon linings have been shown to be rapid in conditions where organisms can flourish, particularly by the cellulolytic fungi such as *Scopulariopsis bravicaulis, Verticillium laterium, Chaetomium globosum, Fusarium oxysporum*. Although the deterioration of the cellulosic foot wear material is usually attributed to fungi such as Penicillium species which exhibit different hydrolysis tendencies when acting on cellulose materials such as leather skin and hide [7]. Soil Streptomyces was found to hydrolyze vegetable tanned leather due to the enzymes it secretes [8]. Also, soil *Streptomyces wartii* was observed to degrade collagen isolated from bovine Achilles tendons, calf skin, human placenta, carp swim bladder, it also degrades hides and vegetable tanned leather [9].

The deterioration in wear of some materials is thought to be primarily due to chemical interactions with absorbed matter rather than to microbiological effects. Breakdown of chrome tanned upper leather is partly attributed to solubilization of chromium by lactate in cold aqueous extracts of damaged leather from shoes [6]. Fungi impact a characteristic moldy fragrance to shoes [10]. Shoe materials are susceptible to mold growth under adverse conditions other than those me in wear. Mold attack on partially or fully completed shoes could occur in processing and storage [11]. It has been observed that vegetable tanned leather is more susceptible to growth of mold than chrome tanned leather [12]. The degree of resistance possessed by chrome tanned leather have been attributed to the fact that it is usually heavily impregnated with oils waxes, greases etc and hence the fibers are not readily wet [3]. Vegetable tanned shoes are susceptible to mold growth because it is finished with a small amount of glucose and magnesium sulphate [13]. Furthermore, it was found that mildew acts on vegetable strap leather by removal of grease with resultant loss in strength of the leather material [14]. Studies at the national bureau of standards of vegetable tanned strap leather indicated that considerable tensile strength was lost when a heavy growth of mildew was supported on its surface [15]. The mechanism of this loss in strength has been shown to be associated with the action of fungi. Thin leathers were found to loss more strength than thick leathers. Studies shows that the hide substance in the leather was only slightly affected [15], it is apparent that the fungi used the oil and grease has nutrient. Vegetable tanned shoes were observed to have fungicidal effect on *Trichophyton metagrophytes, T. gypseum*, the causative agent of “athletic foot” whereas chrome tanned leather had no such effect [15]. It was attributed to the activity of the vegetable tannins which was able to show similar effect with tannic acid on the same organism [15]. Other airborne fungi such as phycomycetes were not affected by either leather found in sheep and cattle which play a role in fiber digestion of leather shoes. Leather shoes have been affected by red spot which occur as a result of the growth of fungi from the genera Penicillium and paecilomyces which are tolerant to the chromium compound used in tanning and they exhibit different hydrolysis tendencies when acting on cellulose materials of leather [2]. The mode of action of fungi on shoes resulting in deterioration is due to the fact that they produce enzymes which are able to split the fat present in the shoes, resulting in the release of fatty acid which is further destroyed by bacteria [16]. A further important aspect of the abundant growth of fungi in leather shoes is likely direct effect on the foot. The most well-known example of fungal attack is “athletes foot”. Foot wear create the necessary condition of moisture and warmth between the toes and communal activity permits the spread of infection [17]. The susceptibility of the individual wearer seems to be more relevant than the presence of the organisms. The complaint is often found among fastidious foot-washers and it has been polluted that too frequent washing may render wearers prone to attack as a result of

open to conjecture. But theories include the susceptibility of water swollen or hydrated skin and the loss of fungistatic effect of skin soluble removed by washing [10]. Another less known harmful organism is the fungi *Scopulanopsis bravicaulis*. This is not only an avid devourer of cellulose insole boards but it has been known to attack toe nails. The fungus can also provide crack or opening in the skin that may allow easier access for bacterial infections of the feet [17]. It has been reported that foot wears (leather shoes) could cause foot allergy which can result in chronic foot dermatitis that can be disabling, a view that was not at variance with the report of [18] who associated foot wears with contact dermatitis. This research is therefore aim at isolating and identifying fungi associated with leather shoes worn by university students in Wukari and to determine their prevalence.

2. Materials and Method

2.1. Sources and Collection of Samples from Leather Shoe

Samples used for this study were swab samples of different leather shoes worn by student of Federal University, Wukari, Taraba State, Nigeria. A total of 60 swab samples were collected from shoes of students. The samples were collected with sterile swab stick which was partly wetted with sterile peptone water and was later used to swab the inner surface of the leather shoes. The samples collected were then taken to the laboratory immediately for analysis with minimal delay. Out of the 60 samples collected 30 were from males and the other 30 from females.

2.2. Media Preparation

The medium used (Sabouraud dextrose agar) was prepared from dehydrated commercial products and was made strictly according to manufacturer's instructions, 65g of the sabouraud dextrose agar was dissolved in 1 liter of distilled water and was sterilized by autoclaving at 12°C for 15 minutes. After sterilization, chloramphenicol was added to the medium. The chloramphenicol (250mg) was dissolved in ethanol before adding to the medium. The medium was then allowed to cool to about 48°C before dispensing into appropriate sterile petri dishes.

2.3. Isolation Identification of Fungi

The specimen was inoculated on the already solidified medium and this was done aseptically. It was then incubated at room temperature for 5-10 days. For fungal identification, a mash of hypha of the test organism were made on slides containing Lacto phenol cotton blue, covered with a cover slip and observed in X 40 microscope.

3. Results

Fungal isolate was recorded in both males and females. The occurrence rates were 30 and 20 respectively. The total isolate obtained is shown in table 1. Table 2 shown the cultural characteristics of the various fungi isolated. The different morphological characteristics of the isolates of fungi is shown in table 3 why the frequency of occurrence of fungi isolates from both male and female is in table 4.

Table 1. *Total number of fungal isolates from male and female student leather shoes.*

Fungi Isolates	Number Isolated		
	Male	Female	Total
Candida species	4	1	5
Aspergillus funmigatus	3	1	4
Aspergillus flavus	1	3	4
Aspergillus niger	11	4	15
Penicillium notatum	8	1	9
Fusarium oxysporum	2	0	2
Trichophyton rubrum	1	0	1
Total Isolates	30	20	50

Table 2. *Cultural characteristics of the Fungal Isolates.*

Sample	Microscopic growth forms	Colour	Isolates
1	Large circular colonies to gram's react.	Cream	*Candida*
2	Velvety to flaky	Blue green	*Aspergillus fumigatus*
3	Velvety to flaky	Yellow	*Aspergillus flavus*
4	Velvety to flaky	Black	*Aspergillus niger*
5	Powdery to velvety surface	Blue green	*Penicillium notatum*
6	Woody fiber with compact act work growth hyphae	White	*Fusariun oxysporum*
7	Granular to powdery	White with red reverse	*Trichophyton rubrum*

Table 3. *Morphological Characteristics of the Isolates.*

Sample	Hyphae	Spores	Probable identification
1	Pseudomycellium	Short chain, ova and elongated in shape	*Candida spp*
2	Septate	Non-septate conidiophores borne in chains laterally on hyphae, sterigma in chain	*Aspergillus fumigatus*
3	Septate	Non-septate conidia	*Aspergillus flavus*
4	Septate	Non-septate conidiophores. Lateral on hyphae, conidia borne in chains on sterigma.	*Aspergillus niger*
5	Septate	Conidia borne on conidiophores in multiple linked chains conidiophores rise vertically from the hyphae	*Penicillium notatun*
6	Septate	Sickled-shaped septate, conidia	*Fusarium oxysporum*
7	Septate	Conidia borne on conidiophores	*Trichophyton rubrum*

Table 4. *Frequency of occurrence of Fungi from both male and female student Leather shoes.*

Fungi isolate	Male	Female	Total
Candida species	13.3%	5.0%	10.0%
Aspergillus fumigatus	10.0%	5.0%	8.0%
Aspergillus flavus	3.3%	15.0%	8.0%
Aspergillus niger	36.7%	20.0%	30.0%
Penicillium notatum	26.7%	5.0%	18.0%
Fusarium oxysporum	6.7%	0.0%	4.0%
Trichophyton rubrum	3.3%	0.0%	2.0%

4. Discussion

Foot wears has been known to can carry microorganisms, hence foot wears are not allowed beyond certain limits in hospitals and animal houses. In this study fungi belonging to five genera were isolated. These fungi isolated except *Candida* have earlier been reported by other workers [8; 7]. The *Candida* species isolated in this study may be due to the fact that yeast was observed to be a normal flora of the animal skin [16]. From the overall result, the males had the highest number of isolate (60.0%) compared to that of the females which was 40.0%. in males, it was observed that the incidence of *Aspergillus niger* (36.7%) is greater than (>) *Penicillium notatum* (26.7%) > Candida species (13.3%) > *Aspergillus fumigatus* (10.0%) > *Fusarium oxysporum* (6.7%) > *Aspergillus flavus* (3.3%) and *Trichophyton rubrum* (3.3%). In females, *Aspergillus niger* (20.0%) > *Aspergillus flavus* (15.0%) > *Candida* species (5.0%) > *Penicillium notatum* (5.0%) and *Aspergillus fumigatus* (5.0%). There was no growth of *Fusarium oxysporum* and *Trichophyton rubrum.* The fungi isolated in this study are those that thrive on hides and skins [7]. The implication of their occurrence shows the ability to survive the effect of different types of polish and other shoe treatment [9]. The variation is the number of fungi isolated from foot wears suggested that fungi are able to tolerate the conditions and treatments in shoes, and possible higher ability to carry out metabolic activities in leather [3]. In addition, increased acidity and salinity resulting from sweat in feet may support growth of fungi [1]. Some of the fungi isolated were soil organisms thus indicating that soil is the source of spread. The conditions encountered within the normal shoe which favours the growth of fungi is temperature of 32^{o}C and relative humidity of 80-90% [6]. The fungal species Candida, Aspergillus and Trichophyton isolated in this study are opportunistic pathogen commonly colonizing human mucosal surfaces as a component of the normal microflora. However, when host defenses are weakened or when there is a disruption in the host environment, these opportunistic organisms can proliferate, causing an array of infections ranging from mucosal to systemic that are often life threatening. Of all the organisms that were isolated, it was only *Trichophyton rubrum* that was reported pathogens by [2]. The percentage was just 2.0% compared to the nonpathogenic organisms which were 98.0%. This pathogenic organism is known to cause "athletes foot", a dermatologic infection of men and animal [19]. If it is not well treated in man, it can lead to secondary bacterial infection in the affected areas and reaction on hands and face (a rare skin rash). Also, the organisms recovered in this study are capable of producing stains in the footwear during metabolic activities, leading to discoloration and loss of beauty. These can cause deterioration of foot wear by metablilising and decomposing the components of the leather foot wear. The presence of these fungi may also produce stench from the foot wear which could result from their metabolic activities. The fungi activities could lead to loss of the tensile strength and elasticity of the footwear leading to tear and wear [14].

5. Conclusion

Leather shoes worn by students of Federal University, Wukari, harboured a number of fungi. These fungi have effect on the wearers and the shoe itself. This corresponds with the result obtained from previous researched work. Students and other individuals should always try to dry and clean their shoes after each use, to avoid dampness as this facilitate the growth of these pathogenic fungi reported in this study. Those affected with the pathogenic fungi should seek for medical help immediately it is discovered. Proper methods of preserving the leather shoes including dehydration and use of antifungal agent should be developed. More studies should be conducted to determine the genetic status of the pathogenic strains which is hitherto non-pathogenic. Finally, work should also be carried out to know the various pathogenic organisms associated with shoes worn at different times of the day to determine any relationship between organisms and the weather condition, that is, hot or cold weather.

References

[1] Roger, Y. S, Edward, A. A. and John, L. I. (2006): The Fungi General Microbiology, 4th Ed. Prentice Hill Inc. Englewood Clifss, New Jersy, U. S. A. Pp. 105-114.

[2] Gerard, J. T., Rerdell, R. F. and Christain, L. C. (2002): Fungi, Algae, Protozoans and Multicellular Parasites. Introduction to Microbiology 4th Ed Benjamin/Cumming Publishing Company Inc. Rodwood City, California. Pp. 296-305.

[3] Wolfgang, K. Joklik, Willet, H. P., Bernard, D. A. and Welfet, C. M. (2010): Medical Mycology. Zinsser Microbiology. 19th Ed. Appleton and Lange, California. Pp. 879-929.

[4] Lorone, D. H. (2006): Medically Important Fungi: A Guide to Identification. Harper and Rio Publisher Inc. Maryland. 156 Pp.

[5] Sivaparvathi, M. and Nandy, S. C. (2014): Hydrolysis of Vegetable Tanned Leather by a Soil Actinomycete. *Leather Sc.* 31(9): 236.

[6] Petit, D. (2004): The Relationship between Loss of Chrome and Absorption of Perspiration Ingredient in Full Chrome Upper Leather During Practical Wear Tests. Leather Research Institute, 97.

[7] Van, WYK – JPH, and Botha, A. C. (2010): Hydrolysis of Cellulose Materials during Successive Treatment Celluleses from Penicillium Species. *Biotes. Lett*. 19 (7): 687–689.

[8] Thorstense, T. C. and Dubost, C. (2015): Studies on Chemical Unhairing Systems. *Journal of Amer. Leath. Chem. Assn*. 80: 647-652.

[9] Mukhopadhyay, R. P. and Chandra, A. L. (2006): A Collagenolytic Streptomycetes. Indian Journal of Exper. Biol. 34 (11): 1114-1120

[10] Lesher, J. L. and Smith, J. F. (2014): Athletes Foot: A logical Approach to Treatment. Drug Ther. 14: 113.

[11] Tamil Amudhan, V., Ravi, A. E. S., Sadulla, S. and Oliverman, M. S. (2015): Study on Water Resistant Shoe Upper Leathers. *Leather Sc*. 32(8) 195.

[12] Edyvean, R. (2005): Development in Leather Preservation. Biodeterioraion and Biodegradation Proceeding of the 19th International Symposium: 88-95.

[13] Bauchop, T. (2009): Rumen Anaerobic Fungi of Cattle and Sheep. *Applied Environmental Microbiology*. 38: 148-158.

[14] Kanegy, J. R., Seebold, R. E., Charles, A. M. and Cassel, I. M. (2009): Degradation of Leather. *Journal of America Leather Chemist Assoc*. 44: 270

[15] Fulton, C. E., Gibson, N. E., and Moore, R. C. (2014): Deterioration of Leather, *J. Res. Canada.* 22: 163.

[16] Wilson, I. G., Gilmour, A., Cooper, J. E., Bjoursen, A. J and Harvey, J. (2014): A Non-Isotopic DNA Hybridization Essay for the Identification of *Staphylococcus aureus* Isolated from Food. *Int. J. Food Microbiol*ogy 22: 43-54.

[17] Hernendez, A. D. (2005): Agents of Dermatophytosis and other Superficial Mycosis. In: Principles and Practice of Infectious Disease. 2nd Ed. New York. Pp. 493-1,2499.

[18] Rother, H. I., Bayer, M. S. and Lever – kesen, A. G. (2015): Peventol. WB – Biodegradable of Preservation for Leather. *J. Leather. Research*. 3(1): 20.

[19] Raul, S., Ducomb, G., Leaute – Labreze, C., Labbe, L. and Ta et, A. (2006): Footwear – Contact Dermatitis in Children. *Coat. Derm*. 35 (6) 334-336.