

Incidence of Tinea pedis and Eczema among Male and Female Students: Effect of Hydraulic Oil and Antifungal Creams

Imaobong T. Adenugba., Nkeneke E. Akpainyang., Emem. I. Ntekpere., Eteyen A. Uko, Agnes. M. Jones and Michael Edidiong Esu

Received 16 October 2020/Accepted 17 November 2020/Published online: 19 November 2020

Abstract This study was designed to assess incident of Tinea pedis and eczema skin infections on male and female students of Akwa Ibom State Polytechnic. The fungal that causes these infections were identified and characterized while the potency of three types of hydraulic oils (Bx oil, Al oil and Ad oil) were tested over known pharmaceutical formulations (i.e antifungal creams including Tr creams, Gd cream and Sk cream). A total of twenty-one (21) students with either Tinea pedis or eczema volunteered for this analysis and the results obtained indicated a significant differences ($p < 0.05$) between incidence of these infections on the female and male students was observed with the female taken the lead. Eleven (11) female students five (5) (45.5%) had Tinea pedis while 6 (54.5%) had eczema and of the 10 male students 8 (80.0%) had Tinea pedis while 2 (20.0%) had eczema. The isolates identified included Trichophyton sp, Microsporum sp and Aspergillus sp. Susceptibility result showed that the Bx oil sample was quite effective on all the fungal isolates while resistance was seen on the Ad and Al oil samples for all the isolates. The susceptibility of the antifungal creams on the isolates showed that all the isolates were sensitive to Tr and Sk creams while moderate sensitivity was seen for Gd cream. This analysis therefore shows that antifungal creams have a higher level of susceptibility on fungal isolates compared to hydraulic oil

Key Words: Skin infections, Tinea pedis and Eczema, sex distribution, treatment, hydraulic oil, antifungal creams

Imaobong T. Adenugba

Department of Science Technology
Akwa Ibom State Polytechnic, Ikot Osurua,
Ikot Ekpene, Akwa Ibom State, Nigeria
Email: timothyimaobong2@gmail.com

Nkeneke E. Akpainyang

Department of Science Technology
Akwa Ibom State Polytechnic, Ikot Osurua,
Ikot Ekpene, Akwa Ibom State, Nigeria
Email: princesslulu5@yahoo.com

Emem I. Ntekpere

Department of Science Technology
Akwa Ibom State Polytechnic, Ikot Osurua,
Ikot Ekpene, Akwa Ibom State, Nigeria
Email: emyemgal27@gmail.com
Orcid id: 0000 0003 4487 0326

Eteyen A. Uko

Department of Science Technology
Akwa Ibom State Polytechnic, Ikot Osurua,
Ikot Ekpene, Akwa Ibom State, Nigeria
Email: uko.eteyen@yahoo.com
Orcid id: 0000-0001-8557-8976

Agnes M. Jones

Department of Science Technology
Akwa Ibom State Polytechnic, Ikot Osurua,
Ikot Ekpene, Akwa Ibom State, Nigeria
Email: agnesjones330@gmail.com
Orcid id: 0000-0002-1744-5773

Michael Edidiong Esu

Department of Science Technology
Akwa Ibom State Polytechnic, Ikot Osurua,
Ikot Ekpene, Akwa Ibom State, Nigeria

1.0 Introduction

Dermatophytic infection of the skin can manifest in different anatomical regions of the body and have been accordingly named (Smith and Relman 2001) (*Tinea capitis*, *Tinea barbae*, *Tinea unguis*, *Tinea manuum* and *Tinea cruris* affect the scalp, the face, the nails, the hand and the groin respectively (Friedlander *et al.*, 2002; Fleece *et al.*, 2004). *Tinea pedis*, also known as athlete's foot, is a chronic fungal infection of the feet and is the focus of this review. *Tinea pedis* is estimated to be the second most common skin disease in the

United States, behind acne (Weinstein and Berman, 2002) and up to 15 % of the population may manifest the disease (Bell-Syer *et al.*, 2002).

Tinea pedis presents its appearance as pruritic, erythematous, inflamed regions on the feet that may be located on the sole or lateral aspects of the foot and sometimes between the toes (Smith and Relman 2001). Three genera of fungi have been identifying with *Tinea pedis*, *Trichophyton*, *Epidermophyton* and *Microsporum*. Other, non-dermatophyte, fungi like *Malassezia furfur*, *Corynebacterium minutissimum*, and *Candida species* have also been linked to the origin of *Tinea pedis*. These fungi may be spread from soil, animals or humans and through contact with formites (Friedlander *et al.*, 2004). Dermatitis, also known as Eczema, is a group of diseases that results in inflammation of the skin (Nedorost, 2012). It is a group of skin conditions that includes atopic dermatitis, allergic contact dermatitis, irritant contact dermatitis and stasis dermatitis (Nedorost, 2012). Allergic contact dermatitis occurs upon exposure to an allergen, causing a hypersensitivity reaction in the skin. Response to antifungal agents is usually good in neonates with no major underlying condition, but a prolonged course may be required and recurrences are common. Use of an infant soother increases the incidence of thrush and may make treatment less effective, unless the soother is carefully washed after use (Kullavanijay *et al.*, 1999). Several new antifungal agents appear to be efficacious and safe in pediatric fungal infections. The systemic triazoles fluconazole and itraconazole appear to be extremely effective in nail and hair infections. They require shorter treatment courses than griseofulvin and therefore promote compliance and minimize the risk of adverse side effects (Kullavanijay, *et al.*, 1999).

Treatment of atopic dermatitis has been reportedly achieved through applications of moisturizers and steroid creams (McAleer *et al.*, 2012).

Hydraulic oil consists of oils and additives designed to transmit power while acting as a lubricant and coolant. The oil is effective in a wide range of temperature and reduces wear, rust and corrosion of equipment and machine components (Eddy and Odoemelam, 2008; Eddy *et al.*, 2008). Studies has reported composition of hydraulic oil to include butanol, esters (such as phthalates (DEHP and adipates), silicones, alkylated aromatic

hydrocarbons, polyalphaolefins, anticorrosion additives, etc. (Keith and Hodges, 1996).

Studies conducted by Placek (2006) indicated that hydraulic oil has strong antifungal effect on skin infections cause by dermatophytes, including ringworm, eczema, skin rashes and pimple especially when applied on the affected parts. The observed antimicrobial properties of hydraulic oil were attributed to some of its chemical composition such as butanol ester, polyalkylene, glycols, silicon's, alkylated aromatic hydrocarbon, polyalpaopons, corrosive inhibitor and anti-erosion additives etc. studies earlier conducted prove the antimicrobial properties of these chemical when tested against hospital mediated skin infection (Placek 2006).

Hydraulic oil has also been reported to be useful in the treatment of pityriasis versicolour (fungal skin diseases). Therefore, the aim of this study is to investigate the potency of hydraulic oil against skin infection such as dermatitis

2.0 Materials and Methods

2.1 Sample collection

A sterile swap sticks were used to aseptically collect the samples from 21(eleven female and ten male) volunteers, after the subjects were well informed of the purpose of the investigation Samples were aseptically transported within an hour to Microbiology Laboratory for fungal investigation and culturing on appropriate fungi media. In order to compare the effect on and treatment of *Tinea pedis* and eczema, hydraulic oils (Bx hydraulic oil, Ad hydraulic oil and Al hydraulic oil) and antifungal creams (Tr Antifungal cream, Gd antifungal creams and sk antifungal cream) were used.

2.2 Sterilization of materials

All glass wares used in this study were thoroughly washed, drained and sterilized in a hot air oven at 160 °C or 1 hour. Plastic containers were properly sterilized with alcohol and thoroughly rinsed with distilled water. The media used for the study were proposed according to the manufacturer's instructions and were sterilized using the autoclave at 121 °C (15 psi) for 15 minutes. Inoculation loops were sterilized using ethanol and cotton wool.

2.3 Cultivation of Fungi

About 15-20 ml of sabouraud dextrose agar (SDA) medium was held at the temperature of 40 °C



Antibiotic as added to the medium before being poured aseptically into the Petri dish, swirled to mix and allowed to solidify. The samples which were collected using sterile swap stick was streak on the medium. The inoculated plates were properly wrapped, labeled and later incubated invertedly for 3-5 days at room temperature.

2.4 Isolation and purification of isolates

The emerging visible discrete fungal colonies from the incubated plates were sub culture onto freshly prepared SDA using a stabbing method and was allowed to grow within 3-5 days. Pure colonies of the organisms were maintained for further analysis.

2.5 Morphological and microbiological analysis

The emerging visible discrete fungal colonies from the incubated plates were viewed using a microscope. The isolate was presumptively identified according to pigmentation presentation on SDA.

2.6 Carbohydrate fermentation test

This test showed the ability of fungi to ferments carbohydrate (sugars) to obtained product like alcohol, acid, gas or other organic molecules.

2.7 Antifungal sensitivity test

Sterile sabouraud dextrose agar (SDA) plates were prepared with antibiotics and allowed to solidify. These plates were seeded uniformly to cover the entire surface with each of the tested organisms. A pair of sterilized forceps was used to transfer hydraulic oil impregnated disc onto each of the plate and incubated at room temperature for 4 days. This process was repeated for antifungal oil including Bx oil, Ad Oil and Al Oil. Observation of zones of inhibition (clearance) around the disc on each cultured plate was measured with meter rule in millimeter (mm). All results were read and interpreted based on the guideline of Clinical and Laboratory Standards, NCCLS (2000) classified as either sensitive (S), or resistance (R) based on the interpretation of zone of inhibition.

3.0 Results and Discussion

The comparative effect of hydraulic oils and topical antifungal creams on *Tinea pedis* and eczema obtained from students in Akwa Ibom State Polytechnic was studied using standard

analytical procedures. From the analysis carried out the following results are presented on tables.

Table 1 4-1 shows the gender distribution of infected students with *Tinea pedis* and eczema in Akwa Ibom State Polytechnic.

Table 1 Population of students in Akwa Ibom State Polytechnic used for the isolation of *Tinea pedis* and eczema

Sex	<i>Tinea pedis</i>	Eczema	Total
Male students	8	2	10
Female students	5	6	11
Total	13	8	21

Table 2 displayed the percentage frequency of *Tinea pedis* and eczema in samples collected from some students of Akwa Ibom State Polytechnic. The results indicate that 80% of *Tinea pedis* and 20% of eczema were identified in the where the male while 45.5% *Tinea pedis* and 54.5% eczema were contributed by the female.

Table 2: Percentage frequency occurrence of *Tinea pedis* and eczema in Akwa Ibom State Polytechnic

Sex	Infection	Percentage occurrence	Total
Male students (10)	<i>Tinea pedis</i>	8	80.00%
	Eczema	2	20.00%
Female students (11)	<i>Tinea pedis</i>	5	45.5%
	Eczema	6	54.5%

Table 3 presents the morphological, microscopical and biochemical characteristic of the fungal genera isolated from *Tinea pedis* and eczema from the following fungal genera, isolates obtained were *Microsporium sp.*, *Trichophyton sp.*, *Epidermophyton sp.*, *Trichoderm sp.*, and *Aspergillus sp.* The fungi isolates were presumptively identified according to their cultural characteristic on SDA.



Table 3: Morphological, microscopic and biochemical characteristics of the fungal genera isolated from student of Akwa Ibom State Polytechnic

Isolates	Colony pigmentation	Appearance	Reverse side	Natural of hyphae	Special and structure	Vegetative reproduction	Nature of conidial	Vesicle head	Germ tube test	Sugar fermentation					Probably	Most organisms
										Maltose	Lactose	Gulose	Manitol			
1 (Ta)	White	Cottony and flat	Yellow	Hyaline Septate hyphae	Thick hyphae single or in group. Small chins of barredishape, anthroconidia and from both hyphae and macroconidia are similar in size	conidiospore with clavate	Ovoid and cylindrical	Smooth and ellipsoidal	+	AG	AG	AG	AG	AG		<i>Trichophyton sp</i>
2(Ta& Ez)	Milky colony	Moist and floppy	Yellow to brown	Septate hyphae	Coniospore are highly branched some formed in distemeterocortic rings with lateral branched that are raised		Gloves		+	AG	AG	AG	AG	AG		<i>Trichoderma sp</i>
3 (Ta)	Milky colony	Mucoid and (clavole) Club shape	Yellow	Hyaline Septate (multi-septate)	Short abundant, smoothwalled macroconidia and much-septate hyphae well developed pseudo mycelium		Gloves vesicle head		-	AG	AG	AG	AG	AG		<i>Epidermophyton sp</i>
4(Ta& Ez)	Milky	Cottony and flat	Orange	Hyaline Septate hyphae	Macroconidia Are Hyaline Multi-Septate Fusiform (Variable In Form). Short conidiophores with thin walled.		Macroconidia Radia and cylindrical to ellipsoidal		+	AG	AG	AG	AG	AG		<i>Microsporum sp</i>
5 (Ez)	Greenish	Cottony	Orange	Non-Septate	Long conidiophores and high branched with a well developed mycelium		Gloves	Gloves	-	AG	AG	AG	AG	AG		<i>Aspergillus sp</i>

Keys: += Positive, -= Negative, Ta= *Tenia pedis*, Ez= *Eczena*, A= Acid production, G= Gas production, AG: Acid and Gas



Table 4 shows the hydraulic oils susceptibility profile of fungal isolates obtained from *Tinea pedis* and eczema. From the table three brands of hydraulic oil were used which included Bx hydraulic oil, Ad hydraulic oil and Al hydraulic oil. Table 5 presents records of the antifungal

cream susceptibility pattern of the fungal isolate obtained from *Tinea pedis* and eczema. Absolutely, three brands of antifungal cream were used for this study including, Gd antifungal cream, Tr antifungal creams and Sk antifungal cream as presented on Table 5.

Table 4: Susceptibility pattern of hydraulic oils on isolates from *Tinea pedis* and Eczema

Hydraulic sample	<i>Epidermophyton</i>	<i>Microsporum</i> sp	<i>Trichophyton</i> sp	<i>Trichoderma</i> sp	<i>Aspergillus</i> sp
Bx sample	28.5mm(S)	6.5mm(R)	15.5mm(I)	9.5mm(I)	12.5mm(I)
Ad sample	6mm(R)	6mm(R)	10mm(I)	6mm(R)	16mm(R)
Al sample	5mm(R)	5mm(R)	8mm(R)	5mm(R)	5mm(R)

**, Bx = Bendix oil, Ad = Allhad oil, Al = Allied oil, S = Sensitive, I = Intermediate, R = Resistance, According to NCCLS (2000) ≥ 18 mm sensitive (susceptible), 17-10mm (intermediate), ≤ 9 mm (Resistance)

Table 5: Susceptibility pattern of antifungal creams on isolates from *Tenia pedis* and Eczema

Anti-fungal sample	<i>Epidermophyton</i>	<i>Microsporum</i> sp	<i>Trichophyton</i> sp	<i>Trichoderma</i> sp	<i>Aspergillus</i> sp
Tr	25mm(S)	21mm(S)	17.5mm(S)	19mm(S)	18mm(S)
Gd	11.5mm(I)	11.5mm(I)	11mm(I)	18mm(S)	17.5mm(I)
Sk	19mm(S)	18mm(S)	20mm(S)	20mm(S)	18mm(S)

**: Tr = Tribat cream, G-D = G-derm cream, Sk = Skineal, S = Sensitive, I = Intermediate, R= Resistance, According to NCCLS (2000) ≥ 18 mm sensitive (susceptible) 17-10mm (intermediate) 9mm (Resistance)

Tinea pedis is a common skin infection of the feet caused by fungus, sign and symptoms often includes itching, scaling, cracking and redness (Bell-syer *et al.*, 2012). Eczema is a group of disease that results in inflammation of the skin, the disease is characterized by itching, red skin and a rash. In rare cases the skin may blister (Bell-syer *et al.*, 2012). Out of the 21 samples analyzed for *Tinea pedis* and eczema, 10 were obtained from male students while 11 samples were obtained from female as presented on Table 1. The result obtained shows that female student of Akwa Ibom State Polytechnic had the highest percentage frequency of eczema (54.5%) while the male student had the higher percentage frequency of *Tinea pedis* of 80%. The finding is in agreement with the work of Hainer (2003), who reported high occurrence of dermatitis in women and attributed to cream reaction and

other environmental factors. The fungal genera isolated from the present study are *Trichophyton* sp. *Trichoderma* sp. *Epidermophyton* sp. *Microsporum* sp and *Aspergillus* sp. The results of the present investigation is in strong agreement with the work of Kaushik *et al.* (2015), who reported that athletes in foot is caused by a number of different fungi including species of *Trichophyton*, *Epidermophyton*, *Microsporum* sp and other non-dermatophyte fungi like *Malassezia* sp and *Candida* sp. The aforementioned organisms are collectively for the vast majority of cases of *Tinea pedis* throughout the world. Fungal infection is not usually serious in otherwise fit, healthy adults, but they can be embarrassing and distressing. Very ill and immune compromised patients are at the risk of serious fungal infection, especially, if they had multiple courses of antibiotics and have



undergone invasive procedures (Alberti *et al.*, 2001). A recent study showed that *Trichophyton sp.* accounted for over 76% of all dermatophyte infections, including *Tinea pedis* (Weinstein and Berman, 2002). The presence of *Aspergillus sp.* and *Trichoderma sp.* maybe associated with fungal infection, exposure of the infection site to moisture like bathtub covered shoes, wet rugs etc., poor sanitation and other environmental factors encourage the spread of the infection. Three varieties of hydraulic oil samples were used (including Bx hydraulic oil, Al-hydraulic oil and Ad hydraulic oil) Bx hydraulic oil exhibited the highest susceptibility pattern while Ad hydraulic oil and Al hydraulic oil displayed the least effect on the isolates as presented in Table 6. Hydraulic oils consist of oil and additive designed to transmit power while acting as a lubricant and coolant. The oil is effective in a wide range of temperatures and reduces wear, rust and corrosion in equipment used in industries. The primary function of hydraulic oil is to convey power according to Placek (2006). Moreover, the three antifungal creams used here included Tr antifungal cream, G-d antifungal cream and sk antifungal cream. From the result obtained, it is evident that *Epidemophyton*, *Microsporium*, *Aspergillus* and *Trichoderma* were sensitive to Tr antifungal cream with zones of inhibition ranging from 18 to 19 mm. G-Derm sample was effective on *Trichoderma sp.* (19mm) and intermediate to *Epidemophyton sp.* (11.5mm), *Microsporium* (11.5mm), *Trichophyton sp.* (11 mm) and *Aspergillus sp.* (11.5 mm), while *Epidemophyton sp.* (20 mm), *Trichoderma sp.* (20 mm) and *Aspergillus sp.* (18 mm) were observed to be sensitive to Sk antifungal cream. These findings are in agreement with the work of other researches like Markova (2002), Gould and Brooker (2012), Gould and Brooker (2008) who reported that superficial *mycoses* are treated mainly with topical antifungal agents. Topical treatment such as cream, spray, liquids and powder are used for the treatment of *Tinea pedis* and Eczema infections. However, there are growing concerns that some fungi are becoming resistant to antifungal drugs, complicating treatment especially for patient with severe infections (Tortorano *et al.*, 2000).

Dermatophytic infections of the feet are very common, they affect the spaces between the toes (inter-digital infection) or the plantar surface (soles). Inter-digital infection usually give rise to areas of macerated skin, while plantar infection

usually looks dry Scaly and flaky. In many cases infection arises through the interaction of several species of fungus of low-grade pathogenicity or the interaction of fungi with bacteria (Gould and Brooker, 2012). The result obtained in this study indicated that antifungal creams have a higher level of susceptibility pattern than the hydraulic oils. Hydraulic oils were not designed primarily for the treatment of superficial mycosis rather antifungal creams were primarily and mainly designed for the prevention and treatment of superficial mycosis.

4.0 Conclusion

From this study, it can be concluded that *Trichophyton sp.*, *Trichoderma sp.*, *Epidermaphyton sp.*, *Microsporium sp.* and *Aspergillus sp.* causes dermatitis and dermatophyte and other complication in both immune compromised and healthy individuals. The infection rate of *Tinea pedis* and Eczema as obtained from this study shows that the female group are more open to Eczema while the male group are more exposed to *Tinea pedis*. It shows that antifungal creams were more effective compared to the moderate effect of hydraulic oils. Therefore, both can be considered appropriate for empirical treatment of *Tinea pedis* and Eczema depending on one's skin type. Based on the analysis the following recommendations are made:

- (i) This study recommends that routine mycological analysis and antifungal susceptibility tests of antifungal creams, should be carried out so as to help in the administration of drugs for the treatment of superficial *mycosis*.
- (ii) There should be public education/enlightenment program on the importance of proper personal hygiene and environmental sanitation habits so as to reduce the transmission rate of dermatophyte and other skin infection.
- (iii) Periodic monitory of antifungal cream, is highly recommended due to high-rate adulteration in the society.
- (iv) Finally, individuals should visit a dermatologist if severe cases or changes occur during treatment.

5.0 References

- Alberti, C., Bovawine, A. and Ribaud, P. (2001). Relationship between environment fungal contamination and the incidence of invasive Aspergillosis in Hematology patients. *Journal of Hospital Infection*, 48, 3, pp. 198-206.



- Bell-Syer, S. E., Khan, S. M. and Torgerson, D. J. (2012). Oral treatments for fungal infections of the skin of the foot. *The Cochrane Database of Systematic Reviews*, 10, pp. 35-84.
- Eddy, N. O. and Odoemelam, S. A. (2008). Sparfloxacin and norfloxacin as corrosion inhibitors for mild steel: Kinetics, thermodynamics and adsorption consideration. *Journal of Materials Sciences* 4, 1, pp. 1-5
- Eddy, N. O., Ekwumemgbo, P. and Odoemelam, S. A. (2008). Inhibition of the corrosion of mild steel in H_2SO_4 by 5-amino-1-cyclopropyl-7-[(3R, 5S) 3, 5-dimethyl-piperazin-1-yl]-6,8-difluoro-4-oxo-uinoline-3-carboxylic acid (ACPDQC). *International Journal of Physical Sciences* 3, 11, pp. 275-280.
- Fleece, D., Gaughan, J. P., Aronoff, S. C. (2004). Griseofulvin versus terbinafine in the treatment of tinea capitis: a meta-analysis of randomized, clinical trials. *Pediatrics*. 114, 5, pp. 1312-1315.
- Friedlander, S. F., Aly, R., Krafchik, B. *et al.* (2002). Terbinafine in the treatment of *Trichophyton* tinea capitis: a randomized, double-blind, parallel-group, duration-finding study. *Pediatrics*. 109, 4, pp. 602-607.
- Gould, D. and Brooker, C. (2008). Infection Prevention and Control. *Applied Microbiological for Healthcare*, (2nd ed), Polgrave Macmillan, London. pp. 23-25.
- Kaushik, N., Pujalte, G. G. and Reese, S. T. (2015). Superficial fungal Infections. Primary care. *Clinic in office practice*, 42, 4, pp. 501-516.
- Keith, P. & Hodges, B. (1996). Hydraulic fluids. <https://doi.org/10.1016/B978-0-340-67652-3.X5000-3>
- Kullavanijaya, P., Reangchainam, S., Ungpakorn, R. (1999). Randomized single-blind study of efficacy and tolerability of terbinafine in the treatment of tinea capitis., *Journal of America Academy of Dermatol.* 37, pp. 272-273
- Maskova, T. (2002). What is the most effective treatment for *Tinea pedis* (Athlete's foot). *Journal of Family Practice*, 51, pp. 21-23.
- McAleer, M. A., Flohr, C. and Irvine, A. D. (2012). Management of difficult and severe Eczema in childhood. *BMJ.*, 345, pp. 4770-4773.
- National Committee for Clinical Laboratory Standards, (NCCLS) (2000). *Performance standard for antimicrobial susceptibility testing. Ninth Informal Suppl.*, National Committee for Clinical Laboratory Standard Wyne Pa., pp. 45-49.
- Nedorost, S. T. (2012). *Generalized Dermatitis in Clinical Practice*, Springer Science and Business Media, pp. 1-3.
- Placek, D. (2006). *Synthetics, Mineral Oils and Bio-based Lubricants*, Rudnick, I., (ed.), CRC Press, p. 519.
- Smith, S.D., Relman, D.A. (2001). Dermatophytes. In: Wilson WR, Sande MA. *Current Diagnosis and Treatment in Infectious Diseases*. New York, NY: McGraw-Hill Professional; 777-778.
- Tortorano, A. M., Kibbler, C. and Pernan, J. (2006). Candidaemia in Europe: Epidemiology and Resistance, *Internal Journal of Antimicrobial Agents*, 27, 5, pp. 389-366.
- Weinstein, A. & Berman, B. (2002). Topical Treatment of Common Superficial Tinea Infections. *America Fam Physician*, 65, pp. 2095-2102.

Conflict of Interest

The authors declare no conflict of interest

