THE PREVALENCE OF DERMATOPHYTOSIS, ITS RELATIONSHIP TO BLOOD TYPE AND DISEASE MANAGEMENT HOSPITAL BASED STUDY IN EGYPT

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ABSTRACT

The aim of this study was to investigate the common dermatophytosis and dermatophyte(s) in Cairo hospitals, examining age, gender, blood groups, and dermatophyte incidence. It explores natural extracts like plant oils and fungal extracts as alternatives to commercial antifungal drugs and their synergistic effects. In this study, the prevalence of distinct types of dermatophytosis was investigated in 128 patients who were referred to the dermatology departments of different hospitals, including EL-Houd El-Marsoud, El Zahraa Medical Hospital, and El-Sahel Teaching Hospital in Cairo, Egypt.

Descriptive data for the tested patients was collected, including age, gender, the source of infection, and blood group type. The results showed that *Tinea capitis* was the most prevalent dermatophytosis, mostly in children. Investigating the correlation between blood group types and the incidence of the disease revealed that patients with blood groups B and O were the most sensitive ones. The most prevalent dermatophyte within the studied cases was identified and submitted to GenBank as *Microsporum canis* ON564613. To investigate the effectiveness of antifungal agents against *M. canis*, different common antifungal drugs, including terbinafine, ketoconazole, clotrimazole, fluconazole, and betadine, were evaluated using the agar disc diffusion test. In addition, natural alternatives were used including essential oils and an ethanolic fungal extract from *Fusarium chlamydosporium*. The minimum inhibitory concentration (MIC) of the potent agents was detected, including terbinafine, ketoconazole, clotrimazole, clove oil, and *F. chlamydosporium* extract. The effective antifungal agents against *M. canis* were clove oil and *F. chlamydosporium* extract, as well as commercial drugs. According to the MIC, a synergy between combinations of different concentrations of clove oil with terbinafine, ketoconazole, and the *F. chlamydosporium* extract showed a synergetic effect. These results show the promising potency of these combinations in disease control compared to their use individually.

Keywords: Dermatophytosis, Blood groups, *Microsporum canis*, Antifungal, Synergism

1. Introduction

Dermatophytosis; is the infection of the keratinized tissues by a group of pathogenic fungi called dermatophytes. There are about nine genera which are known to be the causal agents of dermatophytosis among them the most common genera are *Epidermophyton, Microsporum,* and *Trichophyton* (Parrish *et al.*, 2020). They target the keratinized tissues including skin, hair, and nails. According to the source of infection, dermatophytes may be from humans (anthropophilic), animals (zoophilic), or soil (geophilic) (Richardson & Warnock, 2012). Usually, the geophilic infection is acquired from the surrounding environment rather than transmitted from one individual to another or from one animal to another (Dolenc-Voljč & Weitzman, 2017; Gasparič & Summerbell, 1995).

Dermatophyte infections may also refer to as "tinea" with the name of the affected anatomical region. According to that, the tinea capitis referred to infections of the hair and scalp, tinea pedis for the foot, tinea unguium for nails, tinea barbae for beard, tinea cruris for groin, tinea corporis for skin of the body and tinea manuum for hand (Jartarkar *et al.*, 2021).

There is a common consensus that since dermatophytes flourish in warm, humid climates, the frequency of dermatophytosis may be higher in countries with tropical or subtropical climates that meet similar circumstances (Havlickova *et al.*, 2008; Coulibaly *et al.*, 2016). Tinea capitis, a fungal infection of the scalp and hair, can afflict people of any age, although it is most prevalent in school-age children (Alvarez & Silverberg, 2006).

Tinea capitis epidemiology varies throughout geographical areas of the world and evolves with time (Ginter-Hanselmayer *et al.*, 2007; Mapelli *et al.*, 2013). It spreads among students and family members. Tinea capitis clinical signs and symptoms vary based on the kind of hair invasion, host resistance, immune system, and degree of inflammatory host response (Hay, 2017; John *et al*., 2018). The main etiological agents for the tinea capitis infection were *Trichophyton tonsurans* in North American countries, *Microsporum canis* in Europe and Egypt (Aly *et al.,* 2000; Bassyouni *et al*., 2017) and *Trichophyton soudanense* and *M. audounii* in West Africa (Coulibaly *et al.*, 2016).

The environment, temperature, relative humidity, and precipitation of various geographic locations, as well as the natural infection reservoirs, all influence the occurrence of Tinea capitis (Brintha *et al.*, 2017).

While the majority of dermatophyte infections are not life-threatening and respond well to topical treatments present in the market, some dermatophyte infections can be challenging to treat, necessitate lengthy therapeutic regimens, and are becoming more and more resistant to traditional antifungal therapies (Parrish *et al*., 2020). In addition, there is a need for the identification of therapeutic alternatives, including those derived from natural products like microbial extracts, plant-based bioactive compounds, and essential oils. As many currently used antifungal agents have significant side effects in addition to the costs associated with treatment (Gupta *et al.*, 2016).

Thus, the aim of this study was to investigate the common dermatophytosis as well as the common dermatophyte(s) in various Cairo hospitals in Egypt and to find a correlation between different variables, including age, gender, blood groups, and the prevalence of dermatophytosis. In addition, different natural extracts like plant oils and fungal extracts were investigated as an alternative to the commercial antifungal drugs used on the market. The synergistic effect of different combinations was also tested.

2. Materials and methods

2.1. Patients and samples

A total of 128 patients with dermatophytosis were used in this study. The specimens were collected from suspected cases of dermatophytosis attending the Dermatology Outpatient Clinic at three different Cairo Hospitals in Egypt including, Al-Haud Al-Marsoud Hospital, El Zahraa Medical Hospital and El-Sahel Teaching Hospital between December 2020 and May 2021. The clinical samples were taken from hair, nails, and skin. General information about the tested patients was recorded, including the age, type of dermatophytosis, the source of infection and the type of blood group when available. Informed patient consent was performed.

2.2. Mycological examination

A drop of 10 to 20 % potassium hydroxide (KOH) solution was added to the scraping taken from the active border of the lesion and then examined under the light microscope. Further, culturing of the clinical specimens was performed on Sabouraud Dextrose Agar media (SDA) (Merck, Germany) and incubated for 2-3 weeks at 25ºC.

2.3. Molecular identification

2.4. PCR Amplification and Sequencing

The total genomic DNA isolated from the fungal mycelium of one-week-old potato dextrose agar (PDA) culture using Quick-DNA™ Fungal/Bacterial Miniprep Kit (ZYMO RESEARCH). COSMO PCR RED Master Mix (W1020300X) (Birmingham, England) was used for the PCR reactions according to manufacture instructions. All the reactions were performed in 50 µl reaction volume using ITS1 and ITS4 primers to amplify ribosomal internal transcribed spacer. The purified product using Zymo-Spin™ Technology sequenced using Sanger technology on GATC Company using ABI 3730xl DNA sequencer and ITS4 primer. The NCBI database's basic Local Alignment Search Tool for nucleotide blast (https://blast.ncbi.nlm.nih.gov/Blast.cgi) was employed to align the sequence.

2.5. Investigation of antifungal activity using gar disc diffusion

Various commercial and natural antifungal agents were evaluated to determine their antifungal effectiveness against the most prevalent dermatophyte detected during the present study. A total of forty essential oils (Table 1) obtained from market, one fungal extract (*Fusarium chlamydosporium* ethanolic extract (500ug/ml) obtained from Mycology lab, Faculty of Science, Helwan University), and 5 antifungal drugs (fluconazole 150 mg/ml, ketoconazole 2%, clotrimazole 10mg/ml, betadine 7.5% and terbinafine 1%) were tested in this study. The fungal isolate cultured on SDA media (Merck, Germany) was further tested with antifungal agents. Spore suspension was prepared in 5 ml of sterile saline (0.9% concentration), plates streaked evenly with a swab dipped into the standardized inoculum suspension. On the surfaces of the agar media, the test agents added to each disk (20 µl/disk) and allowed to air dry for 10min (Nweze et al., 2010). Plates were incubated at 28°C for 7-21 days and examined daily for growth. Zones of inhibition were measured in mm. All isolates were run in triplicate. In addition, the minimum inhibitory concentrations (MIC) for clove oil, *F. chlamydosporium* ethanolic extract as well as the tested commercial drugs were determined using the agar diffusion test. The lowest dilution of tested antifungal agents resulting in ≥99% inhibition of fungal growth was defined as the MIC.

Table (1): Essential oils evaluated for antifungal activity.

Essential oils	
Castor	Marjoram
Fenugreek	chamomile
Chamomile	fennel
Jojoba	Marmaria
Onion	Lavender
Clove	Carrot seed
Orange	Saffron
Black seed	pomegranate
Wheat germ	Eruca
Ginger	Camphor
Garlic	Argan
Tea	Paraffin
Grape	Cactus
Mustard	Olive
Cinnabon	Almond
Salvia	Lemon
Rosemary	Basil
Moringa	Juniper
Turmeric	Ginseng
Pumpkin	Flaxseed

2.6. Synergy testing

Based on the MIC data, the potent essential clove oil, was used in combination with *F. chlamydosporium* ethanolic extract, ketoconazole and terbinafine for synergy testing against *M. canis* using agar disc diffusion test (Nweze et al., 2010). 100 µl of dermatophytes spore suspension prepared in sterile 0.9% NaCl solution was streaked out on SDA with cycloheximide and chloramphenicol. After that, 6 mm-diameter sterile blank filter paper discs were placed in the center of the inoculated agar plate and loaded with various concentrations of clove oil combined with terbinafine, ketoconazole, and the *F. chlamydosporium* ethanolic extract. Plates kept at refrigerator for 60 min. Then incubated at 25 °C for 4-7 days. Zones of inhibition were measured after incubation. All isolates were run in triplicate.

2.7. Statistical analysis

Descriptive statistics were used to present all measured variables and derived parameters. One-way ANOVA test using SPSS 21.0 was applied for antifungal susceptibility tests.

3. Results

In this study, from a total of 128 patients with dermatophytosis the most prevalent type was tinea capitis (65%). Other types of tineas showed lower incidence as Tinea unguium (25%), Tinea pedis (4%), Tinea cruris (4%), Tinea corporis (1%) and Tinea circinata (2 %)(Fig. 1).

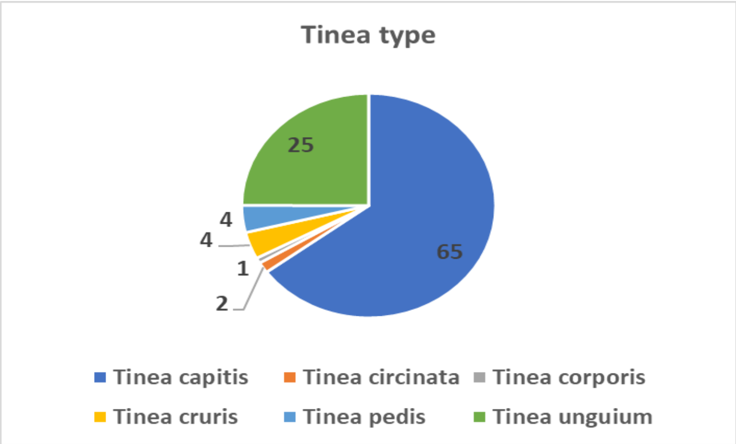

Figure (1): The percentage of different types of tineas detected in 128 patients showing the Tinea capitis was the most prevalent type.

Investigating the incidence of dermatophytosis according to the gender of the tested patients showed that females represented (54%) while males represented (46%). Furthermore, according to patient age, children were found to be the most aged group with dermatophytosis (64%) and the most common source of infection was mostly zoophilic (90%) (Fig. 2A). Interestingly, Tinea capitis was the most common type of the detected dermatophytosis, which was found mostly in males (64%) specifically in children (98%) and the source of infection was mostly zoophilic (94%) (Fig. 2B). Different degrees of Tinea capitis were reported from various cases of children from Al-Haud Al-Marsoud Hospital in Cairo, Egypt showed in (Fig.3).

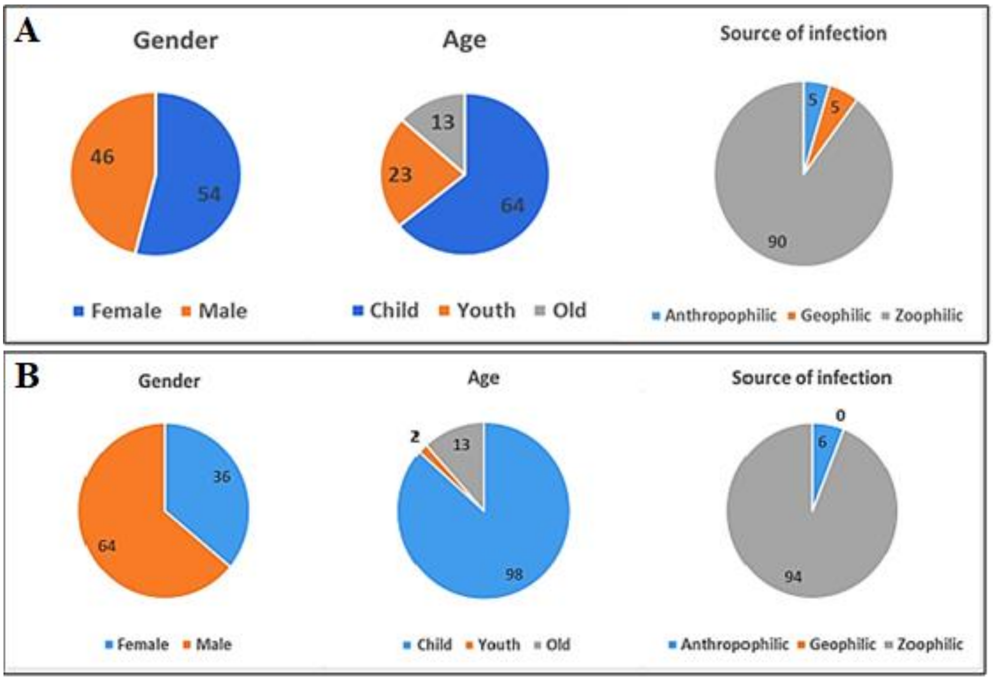

Figure (2): The percentage of the infected patients according to gender, age, and source of infection are shown . A) in all Tinea types, B) in Tinea capitis.

Figure (3): Different degrees of Tinea Capitis seen in various cases of children at Al-Haud Al-Marsoud Hospital in Cairo, Egypt.

3.1. Relation between blood group type and the prevalence of dermatophytosis according to age and gender

In this study, eighty-one patients out of 128 patients were only available for blood group examination due to personal issues as most examined patients were children. Significant variation in the probability of disease incidence according to blood group type is shown in Table 2. The incidence of Tinia was highest in infected persons of the O-type, followed by the B-type. (Fig. 4).

Table (2): Relation between dermatophytosis, age, gender, and the type of blood group.

	Gender	**Age**	**Tinea type**	**Source**	**Blood group**	**Number of cases**
	Male	Child	T. capitis	Zoophilic	O	10
	Female	Child	T. capitis	Zoophilic	B	8
	Male	Child	T. capitis	Zoophilic	B	8
	Male	Child	T. capitis	Zoophilic	A	5
	Female	Child	T. capitis	Anthropophilic	B	1
	Female	Child	T. capitis	Zoophilic	A	2
	Male	Child	T. capitis	Zoophilic	AB	2
	Female	Child	T. capitis	Zoophilic	AB	1
	Female	Child	T. capitis	Anthropophilic	O	1
	Female	Child	T. capitis	Zoophilic	O	3
	Female	Child	T. capitis	Zoophilic	O	1
	Male	Youth	T. pedis	Geophilic	B	2
	Female	Youth	T. unguium	Zoophilic	A	3
	Female	Youth	T. unguium	Zoophilic	AB	3
	Female	Youth	T. unguium	Zoophilic	O	8
	Female	Youth	T. unguium	Zoophilic	B	7
	Female	Youth	T. unguium	Geophilic	B	2
	Female	Youth	T. cruris	Zoophilic	B	1
	Male	Old	T. pedis	Geophilic	O	1
	Male	Old	T. unguium	Geophilic	O	1
	Female	Old	T. unguium	Zoophilic	O	2
	Male	Old	T. pedis	Zoophilic	O	1
	Female	Old	T. pedis	Zoophilic	B	1
	Female	Old	T. unguium	Zoophilic	B	3
	Female	Old	T. cruris	Zoophilic	O	3
	Female	Old	T. unguium	Zoophilic	AB	1
F-value	1.064	3.225	1.849	3.198	3.513	1.064
Sig.	0.3186	0.0684	0.1916	0.0697	**0.0415**	0.3186

* N = 26 (original sample size 81, after excluding the non-detected data).

*The source of infection is determined by the infected person's medical history with the treating doctor. There is a report for each patient regarding his condition and the source of infection, which is determined by asking the patient questions such as if an animal, dirt, or source of infection was dealt with.

*Descriptive statistics are used to present all measured variables and derived parameters. We applied one-way ANOVA using SPSS 21.0.

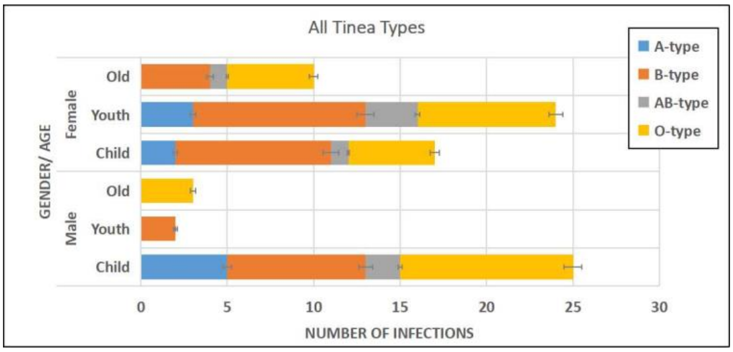

Figure (4): The bar chart describes the Relation between the type of blood group and the incidence of dermatophytosis according to gender and age in all Tinea types.

3.2. Molecular identification of the most prevalent dermatophyte

As tinea capitis was the most common type of tinea found in our study, the most prevalent dermatophyte seen within the studied cases (figure 5) was identified using molecular techniques and submitted to the GenBank as *Microsporum canis* ON564613.

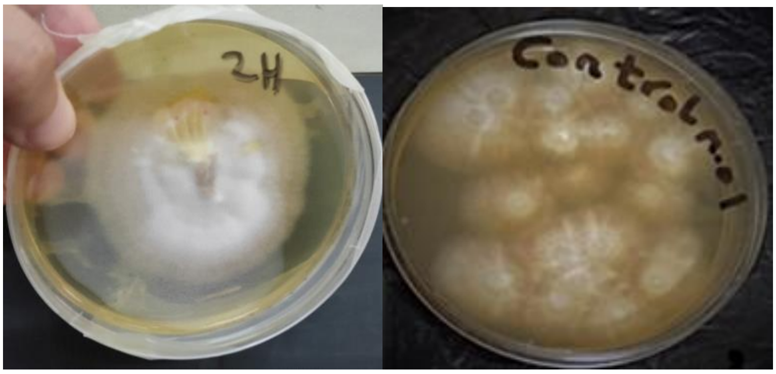

Figure (5): *Microsporum canis* the most prevalent dermatophyte observed in the studied cases growing on Sabouraud’s dextrose agar medium after 15 days of incubation at 28°C.

3.3. Antifungal activity using agar disc diffusion test

Examining the activity of the tested antifungal agents showed that the effective natural agents against *M. canis* were the clove (9mm) from essential oils and the fungal ethanolic extract of *F. chlamydosporium* (21mm), while the most effective commercial antifungal drug were terbinafine, clotrimazole ketoconazole, fluconazole, and betadine (68, 67, 57, 38 and 27mm respectively) (figure 6A). In addition, the minimum inhibitory concentration (MIC) for the most effective agents was determined as shown in (figure 6B), where the MIC of Terbinafine, Fluconazole, Ketoconazole, Clotrimazole, Betadine, Clove and *F. chlamydosporium* was 0.001%, 37.5, 0.0156, 0.02, 0.94, 50 and 50 mg/ml respectively.

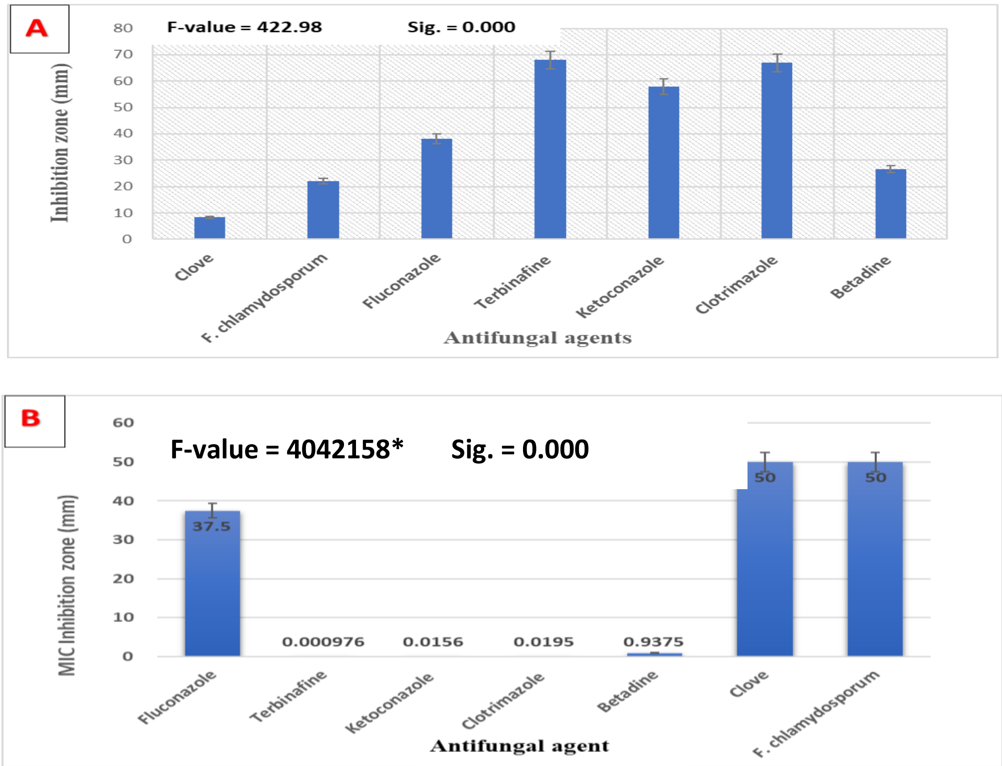

Figure (6): A) Determination of antifungal activity using gar disc diffusion. B) MIC determination for the potent antifungal agents.

In addition, to enhance the effectiveness of the selected antifungal agents, different combinations between the tested agents were investigated. Based on the MIC, the essential clove oil was used (5, 10, 15 and 20 µl) and combined with (20, 15, 10 and 5 µl) of either the ethanolic extract of *F. chlamydosporium*, Terbinafine or Ketoconazole separately. The results showed synergetic effect after 14 days of incubation for all tested combinations compared to the use of individual antifungal agents alone against *M. canis* (Table 3) with the most effective combination found between 20 µl ketoconazole and 5 µl clove oil (figure 7). Interestingly, the mixture of clove, with ketoconazole in different concentrations, prevents the regrowth of *M. canis* again. No matter how suitable growth conditions are available for the microbe, *M. canis* does not grow in the dishes again at the site of inhibition zone, and the microbe cannot overcome the mixture again. Conversely, in the case of putting ketoconazole alone without a clove, the microbe can grow after a period when the proper conditions for growth are available in the dishes at the site of inhibition zone. The second-best combination was between 20 µl Terbinafine and 5 µl clove oil, although at lower concentration of Terbinafine its effectivity against *M. canis* drastically decreased or no antagonism occur. Finally, the combination *F. chlamydosporium* and clove oil showed promising results with all concentrations used in contrast to Terbinafine/clove oil combinations, and the best result was observed using 10 µl *F. chlamydosporium* with 15 µl clove oil.

Table (3): MIC Synergistic results of clove oil, *Fusarium chlamydospoum* ethanolic extract, and commercial antifungal drugs combinations using MIC.

Treatment	Inhibition zone (mm)
20 µl Ketoconazole + 5 µl clove oil	51.3±1.1
15 µl Ketoconazole + 10 µl clove oil	47±1.7
10µl Ketoconazole +15 µl clove oil	27.6±2.5
5µl Ketoconazole +20 µl clove oil	40.6±1.15
20 µl terbinafine + 5 µl clove oil	46.66±1.73
15 µl terbinafine+ 10 µl clove oil	33.6±1.1
10µl terbinafine+15 µl clove oil	0.0
5µl terbinafine+20 µl clove oil	0.0
20 µl *F. chlamydosporum* + 5 µl clove oil	40.6±1.15
15 µl *F. chlamydosporum* + 10 µl Clove oil	34±1
10 µl *F. chlamydosporum* + 15 µl clove oil	42.3±0.57
5 µl *F. chlamydosporum* + 20 µl clove oil	28±2.6
Ketoconazole	24±1
Terbinafine	20±1
Clove oil	6.3±0.57
F. chlamydosporum	22±1

* Inhibition zone is presented as means of three independent replicas (mm) ± SD

Figure (7): Combination between different concentrations of ketoconazole and clove oil against *M. canis*. 1. (20 µl Ketoconazole + 5 µl clove oil), 2 (15 µl Ketoconazole + 10 µl clove oil), 3(10µl Ketoconazole +15 µl clove oil), 4(5µl Ketoconazole +20 µl clove oil).

4. Discussion

The current results showed that the most common dermatophytosis type was Tinea capitis. Similarly, other studies reported that Tinea capitis is the most prevalent in Africa (Gargoom *et al.*, 2000) and Asia (Ng *et al.*, 2003). On the other hand, the most prevalent clinical types of dermatophytosis in Europe were Tinea corporis and Tinea pedis *(Dolenc-Voljč, 2005; Panasiti et al.*, 2007). One of the distinct factors affecting the incidence of dermatophytosis was the gender. In the current study, female was found to be more susceptible to the disease incidence than male. Different studies showed differences in the incidence of dermatophytosis according to gender (Lipner & Scher, 2019; Sakkas *et al.,* 2020).

Moreover, age can be used as another demographic factor to distinguish a population group from other groups in a population that have been screened for a particular illness. Tinea capitis common in children, while other Tineas more commonly affect post pubertal individuals. The hormonal changes that occur after puberty induce the secretion of acids by sebaceous glands, which, in turn, reduce the incidence of Tinea capitis but not of other mycoses (Petrucelli *et al.,* 2020). Moreover, another explanation for why children are more likely to get Tinea capitis than adults is because after puberty, the scalp begins to secrete sebum, which is meant to prevent dermatophytes from invading, but an immunological disorder may make hair invasion easier (Cremer *et al.,* 1997).

One important feature was the investigation of the correlation between the type of blood group and the incidence of dermatophytosis. The incidence of Tinia was highest in infected persons of the O-type, followed by the B-type. This suggested that patients with O-type or B-type are more sensitive to dermatophytosis than other blood group types. Like our results, Al-Daamy *et al.* (2017) reported that there is a relationship between infection of dermatophytosis and blood groups, specifically between tinea pedis, and tinea capitis with blood groups O and B. On the other hand, Balajee *et al.* (1996)reported that blood group A followed by O members had a high frequency of dermatophytosis infection.

The continuous need for new antifungal drugs is necessary since existing antifungals may lose their effectiveness over time or be rendered useless by the emergence of resistance, which emphasizes the significance of creating alternative therapies with fewer side effects and high potency.

In this study, besides the common effective commercial drugs evaluated, the clove oil showed promising antifungal activity against *M. canis*. Chee & Lee (2007) reported that the spore germination and mycelial growth of *Microsporum audouinii*, *Trichophyton mentagrophytes*, and *Trichophyton rubrum* are all severely inhibited by clove essential oil. One of the important constituents of clove oil is Eugenol (Xu et al., 2016). Eugenol, a phenylpropene compound extracted from cloves, shows antimicrobial activity towards several strains of pathogenic microorganisms (Devi et al., 2010). Eugenol can disrupt the cell wall structure, denaturize proteins, and reacts with the phospholipid bilayer of the cell membrane, changing the permeability of the cell (Rahman, 2015).

Moreover, the result revealed that *F. chlamydosporium* ethanolic extract showed antifungal activity against *M. canis.* To our knowledge, this is the first study to document the antifungal efficacy of *F. chlamydosporium* extract against *M. canis*. *F. chlamydosporium* is a well-known biocontrol agent having secondary metabolites that have antimicrobial capabilities. Additionally, it can produce red pigment, which is known as antimicrobial agent (Mathivanan & Murugesan, 2000; Mohammed *et al*., 2018; Wang *et al*., 2020; Thomas & Tirumale, 2022).

The elucidation of the mechanisms of action of the antifungal agents with pharmacological potential, whether of natural or synthetic origin, contributes to the development of rational therapeutic approaches, particularly in terms of infections caused by resistant microorganisms, which often require combinations of drugs or the use of new drugs when the first-choice agent is not effective.

Therefore, in our study, we evaluated different combinations of clove oil with other tested agents such as *F. chlamydosporium*, terbinafine, and ketoconazole to increase the potency of the chosen antifungal agents. The results showed positive synergistic results when compared to the activity of the antifungal agents individually. There are several mechanisms involved in the synergistic activity of antifungal agents: a) the inhibition of different stages in the fungal intracellular pathways that are essential for cell survival; b) increased penetration of one antifungal agent resulting from the action of another antifungal agent on the fungal cell membrane; c) the inhibition of carrier proteins; and d) the simultaneous inhibition of different cell targets (Johnson *et al.*, 2004)**.**

The mechanism of combination of medications appears to entail the inhibition of ergosterol production due to the antifungal agents' effects on the various ergosterol biosynthesis enzymes and/or because of an increase in cell permeability which allows one or both agents to pass through (De Castro *et al.*, 2015).

Conclusion

The prevalent type of dermatophytosis found in the present study was Tinea capitis and the main dermatophyte was *M. canis*. The infection was found in the children, mostly between boys and the source of infection was mostly zoophilic. Patients with blood group B and O were the most affected ones. Beside the use of the common antifungal drugs terbinafine and ketoconazole, clove oil as well as *F. chlamydosporium* ethanolic extract showed a promising antifungal activity against *M. canis*. Moreover, to avoid of the resistance of using individual antifungal agent, a synergetic activity using different combinations of clove oil with other tested agent revealed the promising potency of these combinations in disease control compared to the use of these antifungal agents individually.

Ethical Approval and consent to participate

This research was approved by the Research Ethics Committee at the Ministry of Health and Population (Com. No/Dec. No: 34-2020/10). Informed consent was obtained from all individual participants included in the study.

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Conflict of interests

The authors have no competing interest.

Author contributions

MEO, AFM, HHA, YME designed the study; HHA, YME.; MEE performed the experiments; YME, HAS made data curation and analysis; YME, HAS wrote the original draft; MEO, YME reviewed and edited the final manuscript.

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التحقيق في انتشار الفطريات الجلدية في بعض المستشفيات في القاهرة بمصر ، وعلاقته بفصيلة الدم ، وتقييم إدارة المرض.

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في هذه الدراسة ، تم التحقيق في حالات الإصابة بواسطة الفطريات الجلدية في 128 مريضًا والذين تم تحويلهم إلى أقسام الأمراض الجلدية في بعض المستشفيات المختلفة ، بما في ذلك مستشفى الحوض المرصود ، ومستشفى الزهراء الطبي ، ومستشفى الساحل التعليمي بالقاهرة ، مصر. تم جمع البيانات الوصفية للمرضى المختبرين ، بما في ذلك العمر والجنس ومصدر العدوى وفصيلة الدم. وقد أظهرت النتائج أن مرض سعفة الرأس كان الأكثر انتشارا، وخاصة عند الأطفال. وبتحقيق العلاقة بين فصائل الدم ونسبة الإصابة بالمرض أظهر أن المرضى ذوي فصائل الدم B و O هم الأكثر حساسية للإصابة بالمرض.

وقد تم التعرف على أكثر الفطريات الجلدية شيوعًا في الحالات التي تم فحصها وتم تسجيلها في بنك الجينات باسم*Microsporum canis* ON564613.

وللتحقق من فعالية العوامل المضادة للفطريات ضد *M. canis* ، تم تقييم العديد من الأدوية المضادة للفطريات الشائعة الاستخدام، بما في ذلك تيربينافين ، كيتوكونازول ، كلوتريمازول ، فلوكونازول ، وبيتادين ، باستخدام اختبار انتشار قرص الاجار. وبالإضافة إلى ذلك، تم استخدام البدائل الطبيعية بما في ذلك الزيوت الأساسية والمستخلص الفطري الإيثانولي من *Fusarium chlamydosporium*. تم الكشف عن أدنى تركيز مثبط (MIC) للعوامل الفعالة المختبرة ، بما في ذلك تيربينافين ، كيتوكونازول ، كلوتريمازول ، زيت القرنفل ، ومستخلص الفطر. وكانت العوامل الأكثر فعالية المضادة للفطريات ضد *M. canis* هي زيت القرنفل ومستخلص *F. chlamydosporium* ، وكذلك الأدوية التجارية شائعة الاستخدام. ووفقًا لنتائج MIC ، أظهر التآزر بين تركيزات مختلفة من زيت القرنفل مع تيربينافين ، كيتوكونازول ، ومستخلص *F. chlamydosporium* تأثيرًا تآزريًا إيجابيا. وبالتالي تظهر هذه النتائج الفاعلية الواعدة لهذه التوليفات في مكافحة الأمراض مقارنة باستخدامها بشكل فردي.

كلمات مفتاحية: فطار جلدي، فصائل الدم، ميكروسبوروم كانيس، مضادات الفطريات، التآزر