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Mycoflora associated with the goat's hair and sheep wool in Taif, Saudi Arabia

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The objective of this study was to evaluate the occurrence of mycoflora in 30 samples of healthy goat's hair and sheep wool collected from different localities in Taif, Saudi Arabia, and the ability of some fungal isolates for keratinase activities. Sixty four species belonging to 28 genera were collected from the two substrates. The wool of sheep was polluted with fungi than goat hairs, and contained high total counts and number of fungal genera and species. Nine species of true dermatophytes isolated belonged to *Microsporum* (3 species) and *Trichophyton* (6 species). Several keratinophilic species were isolated of which, *Chrysosporium indicum, Chrysosporium keratinophilum* and *Chrysosporium tropicum* were the most prevalent. The commonest saprophytes in order of frequency were members of the genera, *Aspergillus, Penicillium, Alternaria* and *Cochliobolus.* In addition, the other genera found included *Acremonium, Chaetomum, Cladosporium, Cochliobolus, Fusarium, Mucor, Paecilomyces, Phoma, Rhizopus, Scopulariopsis, Stachybotrys, Trichoderma* and others. Five species from 20 tested isolates (*Aspergillus niger, C. keratinophilum, C. tropicum, Microsporum gypseum* and *Trichoderma viride*) had high keratinase activity. The results of this study indicate that both goat hair and sheep wool provide a suitable habitat for dermatophytes and other keratinophilic fungi. Most of these fungi play an important role in the degradation of keratin substrates, so that they can help preserve the environment and reduce pollution.

Key words: Mycoflora, goat's hair, sheep wool, keratinase activities, Saudi Arabia.

INTRODUCTION

Keratinophilic fungi are natural colonizers of keratinous substrates. Some are keratolytic and play an important ecological role in decomposing *α*-keratins, insoluble fibrous proteins (Filipello Marchisio, 2000). Keratinophilic fungi include a variety of filamentous fungi mainly comprising of hyphomycetes and several other taxonomic groups. Hyphomycetes include dermatophytes and a great variety of non dermatophyte filamentous fungi. They occur on cornfield debris in the soil and degrade hard keratin and keratinous material. Therefore, they play an important ecological role in decomposing such residue (Filipello Marchisio, 2000; Sharma and Rajak, 2003).

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Animals are known to carry dermatophytes and other keratinophilic fungi on their hairs. These animals may act as a source of human and animal infections by direct contact or by contaminating working areas and dwelling places (Ripon, 1982). Therefore, the studies on dermatophytes and keratinophilic fungi present on the hair of domestic animals are of considerable significance.

Keratinophilic fungi along with dermatophytes are responsible for various cutaneous mycoses. Dermatophytes require keratin for growth. These fungi can cause different types of tinea in humans and animals. The majority of the fungi responsible for diseases in human beings and animals exist freely in nature as soil saprophytes (Kumari et al., 2005).

The presence of keratinophilic fungi on hairs of various animals has been briefly reviewed by numerous researchers in many parts of the world (Ali-Shtayeh et al., 2000; Dobrowolska et al., 2006; Al-Duboon and Farhan, 2007; Nichita and Marcu, 2010; Sallam and ALKolaibe, 2010; Jain and Sharma, 2012; Emenuga and Oyeka, 2013; Enany et al., 2013).

Keratin is the major component of poultry feathers waste. Distribution of keratinolytic microbes in the nature is widespread. Some fungal strains can produce keratin proteases which have keratolytic activity and can keratinolyse feather. These enzymes have been produced by fungi, including the species of *Aspergillus* spp.*, Cochliobolus* spp.*, Mucor* spp. and *Penicillium* spp. (Friedrich et al., 1999; Soomro et al., 2012; Ramakrishnaiah et al., 2013; Singh, 2014; Singh et al., 2016).

The aim of this investigation was to study the occurrence, distribution and prevalence of mycoflora associated with goat's hair and sheep wool in Taif, Saudi Arabia and the ability of some fungal isolates for keratolytic activity.

MATERIALS AND METHODS

Thirty samples of each of healthy goat's hair and sheep wool were collected from different localities in Taif, Saudi Arabia. The samples were placed in sterile polyethylene bags, transferred immediately to the laboratory, and stored in a refrigerator (3-5°C) until examination. For isolation of mycobiota associated with hair or wool samples, two methods were used:

Hair-baiting technique

For isolation of dermatophytes and other keratinophilic fungi, the hair-baiting technique (Vanbreuseghem, 1952) was employed. Five fragments from each sample were scattered on the surface of moistened sterile soil (20 to 25% moisture content) in sterile plates (3 plates for each sample). The plates were incubated at 25°C for 10-12 weeks and the soil in plates was remoistened with sterile distilled water whenever necessary. The molds which appear on the hair fragments were transferred to the surface of Sabouraud's dextrose agar medium from Sigma (mycological peptone 10.00, dextrose 40.00, agar 15.00) in 1000 ml of distilled water (Moss and McQuown, 1969). The medium was supplemented with 0.5 g cycloheximide (actidione), 40 µg/ml streptomycin and 20 units/ml penicillin as bacteriostatic agents. The plates were incubated at 25°C for 2-4 weeks and the developing fungal colonies were counted, identified (based on morphological and microscopic characters) and calculated per 10 hair fragments for each sample. The relative importance value (RN) was calculated (Ali-Shtayeh and Asad Al Sheikh, 1988; Shearer and Webster, 1985).

The dilution-plate method

The dilution-plate method described by Johnson and Curl (1972) was used for estimation of saprophytic fungi associated with the hair and wool. Czapek Dox Agar medium from Sigma (sucrose 30.0, sodium nitrate 3.0, potassium chloride 0.5, magnesium sulfate heptahydrate 0.5 iron(ii) sulfate heptahydrate 0.01, di-potassium hydrogen phosphate 1.0, Agar 15.0) was used in which rose-bengal (1/15000) and chloramphenicol (25 µg/ml) was added as bacteriostatic agents. Three plates were used for each sample and the plates were incubated at 25°C for 2-3 weeks. The developing fungi were counted, identified and calculated per g hair.

Screening of fungi for keratinase activity

Twenty fungal isolates were screened by using solid medium method (Wawrzkiewiez et al., 1991). Chicken feather was cut into small fragments, washed extensively with water and detergent and dried in a ventilated oven at 40°C for 72 h to prepare feather powder. The feather powder which was the only source of carbon, was added to the sterile agar medium. The diameter of the clear zone was measured after 7 days at room temperature to quantify activity. Keratinase activity of fungus was detected as a clear zone around the colony.

RESULTS AND DISCUSSION

Dermatophytic and keratinophilic fungi (using hair baiting technique)

Sixteen species belonging to 3 genera of dermatophytes and closely related fungi were isolated from goat (13 species and 3 genera) and sheep hairs (14 species and 3 genera). The most contaminated hairs were that of sheep with the higher total counts (226 isolates/300 fragments) and a wide spectrum of species (14 species) than that of goat (174 isolates and 13 species) as shown in Table 1. Similar observations were obtained from goats and sheep in many parts of the world (Nasser and Abdel-Sater, 1997; El-Said et al., 2009; Sallam and ALKolaibe, 2010).

Chrysosporium was the most frequent genus and emerged in 90 and 96.6% of the samples comprising 83.3 and 80.5% of total isolates and have relative importance value RIV of 173.3 and 177.1 of goat and sheep, respectively. This genus was also isolated from goat and sheep hairs in Yemen as reported by Sallam and ALKolaibe (2010), indicating that *Chrysosporium* was recorded in 73 and 68% of the goat hairs and sheep wool samples constituting 57.1 and 47.1% of total fungi, respectively. Also, in Libya, El-Said et al. (2009) observed that *Chrysosporium* was the most frequent genus and emerged in 92 and 96% of the samples comprising 91.2 and 87.8% of the total isolates and have

Table 1. Total isolates (TI, calculated per 300 hair fragments), number of cases of isolation (NCI, out of 30 samples), occurrence remarks (OR) and relative importance values (RIV) of dermatophytic and keratinophilic fungi recovered from hairs of 30 animals of each goats and sheep at 25°C.

	Goats hair			Sheep wool		
	TI	**NCI & OR**	**RIV**	**TI**	**NCI & OR**	**RIV**
Chrysosporium	145	27H	173.3	182	29H	177.1
C. asperatium Carmichael	13	5L	24.1	-	-	
C dermatitidis Carmichael	13	8L	34.1	15	8M	33.3
C. indicum (Randhawa and Sandhau) Garg	15	8M	35.2	17	6L	27.5
C. keratinophilum D. Frey ex J.W. Carmich.	45	12M	65.9	73	19H	95.6
C. pannorum (Link) Hughes	-	-	-	3	2R	8.0
C. tropicum Carmichael	49	10M	61.5	62	14M	74.0
C. xerophilum Pitt	10	6L	25.8	12	4L	18.6
Microsporum	5	3R	12.9	9	7L	27.3
M. canis Bodin	-	-	-	1	1R	3.8
M. ferrugineum M. Ota	-	-	-	2	2R	7.5
M. gypseum (E. Bodin) Guiart & Grigoraki	5	3R	12.9	6	5L	19.3
Trichophyton	24	16H	67.1	35	18H	75.48
T.ajelloi (Vanbreus.) Ajello	2	2R	7.8	-	-	-
T. interdigitale Priestley	4	2R	9.0	8	5L	20.2
T. mentagrophytes (C.P. Robin) Sabour.	7	6L	24.0	5	4L	15.5
T. rubrum (Castell.) Sabour.	2	2R	18.2	7	3R	13.1
T. terrestre Durie & D. Frey	6	5L	20.1	15	7L	36.6
T. tonsurans Malmsten	3	2R	8.4	-	-	
Total isolates		174			226	
Number of genera = 3		3			3	
Number of species= 16		13			14	

Occurrence remarks (OR): H= high occurrence, between 15-30 cases (out of 30); M= moderate occurrence, between 8-14 cases; L= low occurrence, between 4-7 cases; and R= rare occurrence, less than 4 cases.

RIV of 183.2 and 183.8 of goats and sheep, respectively. It was represented by seven species of which *C. keratinophilum , C. tropicum, C dermatitidis* and *C. indicum* were the most prevalent. They emerged in 40.0; 33.0; 26.66 and 26.66% of goat and 63.33; 46.66; 26.66 and 20.0% of samples matching 31.03, 33.8; 9.0 and 10.34%; and 40.1; 34.06; 8.24 and 9.34% of total isolates on the two substrates, respectively. These three species were also, predominant among fungi isolated from cloven hooves and horns of goats and sheep (Abdel-Hafez et al., 1990) and from hairs of goat and sheep (El-Said et al., 2009). The above species were also, isolated from mammals in El-Bahrain by El-Said and Abdel-Sater (1995), Saudi Arabia by Nasser and Abdel-Sater (1997), Bokhary et al. (1999) and Yemen by Sallam and ALKolaibe (2010).

Chrysosporium asperatium and *C. xerophilum* were of low frequency on goats hairs. They were encountered in 16.7 and 20.0% of the samples matching 7.5 and 5.7% of the total isolates. While *C. xerophilum* and *C. pannorum* were of low and rare frequency on sheep hairs. They were encountered in 13.3 and 6.7% of the samples matching 5.3 and 1.3% of the total isolates. The previously identified species was found to be in 4, 1.7, 16 and 12% of goat and sheep hairs in Libya (El-Said et al., 2009). Some species were isolated only from one substrate and not from the other such as *C. asperatium* from goat and *C. pannorum* from sheep hairs (Table 1). Most of these fungi were recovered, with variable degrees and densities from animals hair or natural soil baited, with sterilized human or animals hair from different parts of the world (El-Said, 2002; Periasamy et al., 2004; Dobrowolska et al., 2006; Yahyaraeyat et al., 2009; Beraldo et al., 2011; Emenuga and Oyeka, 2013; Enany et al., 2013; Debnath et al., 2015).

Trichophyton was the next most common genus, and emerged in 53.3 and 60% of the samples comprising 13.8 and 15.5% of the total isolates and have RIV of 67.1 and 75.48 of goat and sheep, respectively (Table 1). It was represented by 6 species of which *T. mentagrophytes, T. terrestre* were of low frequency on goat hairs. They were encountered in 20.0 and 16.6% of the samples matching 4.0 and 3.4% of the total isolates. While *T. interdigitale, T. mentagrophytes* and *T. terrestre* were of low frequency on sheep hairs. They were encountered in 16.6; 13.3 and 23.3% of the samples

matching 2.2; 1.7 and 3.0% of the total isolates. Some species were isolated only from goats such as *T. ajelloi* and *T. tonsurans*, they were isolated with rare frequency (Table 1). This result is in agreement with the finding of Abdel-Hafez et al., (1990) that reported that this genus has rare frequency from cloven hooves and horns of goats and sheep. Also, Bokhary et al. (1999) reported that *T. mentagrophytes* and *T. rubrum* were isolated from goat and sheep in Saudi Arabia. El-Said and Abdel-Sater (1995) noted that *Trichophyton* was represent by 2 species and 1 unidentified species of which *T. rubrum* and *T. terrestre* ware isolated from the two substrates in a rare occurrence. It emerged in 8 and 4% of the samples constituting 2.9 and 3.5% of the total isolates recovered on goats and sheep, respectively. El-Said et al. (2009) reported that *Trichophyton* occurred in 12 and 24% of the animal hair samples examined representing 8.8 and 12.2% of the total isolates and have RIV of 20.7 and 36.1 on goats and sheep, respectively.

Trichophyton was isolated from different animals as reported by several researchers from all over the world (Yahyaraeyat et al., 2009; Nichita and Marcu, 2010; Seker and Dogon, 2011; Jain and Sharma, 2012; Ana Paula et al., 2013; Emenuga and Oyeka, 2013; Enany et al., 2013; Mattei et al., 2014; Debnath et al., 2015; Ilhan et al., 2016; Roshanzamir et al., 2016).

Microsporum was isolated at a low frequency from 10 and 23.3% of the samples, comprising 2.9 and 4% of total isolates and have RIV of 12.9 and 27.3of goat and sheep, respectively (Table 1). It was represented by 3 species (*M. canis; M. ferrugineum* and *M. gypseum*). Some species were isolated only from sheep hairs only *M. canis* and *M. ferrugineum)*. Three species previously mentioned were recovered, with variable degrees and densities from animals in different parts of the world (Sallam and Alkolaibe, 2010; Nichita and Marcu, 2010; Beraldo et al., 2011; Seker and Dogon, 2011; Emenuga and Oyeka, 2013; Mattei et al., 2014; Debnath et al., 2015; Luján-Roca et al., 2016; Roshanzamir et al., 2016).

Saprophytic fungi (using glucose-Czapek's agar)

Forty-eight species belonging to 25 genera were collected from 30 hair samples of each of goats (33 species and 16 genera) and sheep (34 and 20) on glucose-Czapek's agar at 25°C (Table 2). Various saprophytic fungi were encountered and the most prevalent species on the goat sheep were members of *Aspergillus, Penicillium, Alternaria* and *Cochliobolus*. These results are similar to those obtained by El-Said and Abdel-Sater (1995) and El-Said et al. (2009). They reported that members of *Aspergillus, Penicillium, Alternaria* and *Cochliobolus* were the most common in order of frequency, saprophytic fungi from goat and sheep hairs in El-Bahrain and Libya.

Aspergillus was the most common genus, recovered from 56.6 and 66.6% of goat and sheep samples, respectively. From the genus, nine species were identified. *A. niger* was the most prevalent species, although it was isolated at low and moderate frequencies (23.3 and 30%) of goat and sheep samples, respectively. The remaining *Aspergillus* species were less common. *Aspergillus parasiticus* and *Aspergillus terreus* were isolated only from goat hair but were not encountered on sheep hairs. Whilst *Aspergillus ochraceus* and *Aspergillus ustus* were isolated only from sheep hairs but were not encountered on goat hair (Table 2). Mitra et al. (1998) noticed that *Aspergillus* species were the most common among fungi other than dermatophytes isolated from the goats and sheep. Also, Gherbawy et al. (2006) noticed that *Aspergillus* (7 species +1 variety) was the first most dominant fungi on human hairs in Upper Egypt. Additionally, most of *Aspergillus* species were previously isolated in Gaza from the sheep (Abdel-Hafez, 1987), as well as hairs of animals in many parts of the world (Sanches and Coutinho, 2007; Blyskal, 2009; Sallam and AL-Kolaibe, 2010; Nichita and Marcu, 2010; Luján-Roca et al., 2016).

Penicillium (5 species) was the second most predominant genus and occurred in 43.3% of goat hairs contributing 24.4% of the total moulds. *P. chrysogenum* was the most prevalent species, although it was isolated at moderate frequencies (26.6%) of goat samples. The remaining *Penicillium* species were less common and were isolated in rare frequencies (Table 2). While *P. chrysogenum* and *P. corylophilum* were isolated in low and rare frequencies, occurring in 16.66 and 3.33% of sheep hairs, and contributing 4.1 and 1.36% of the total moulds, respectively (Table 2). *Penicillium brevicompactum, P. purpurogenum* and *P. variabile* were isolated only from goat hair but were not encountered on sheep hairs (Table 2). Additionally, members of *Penicillium* were among the most common fungi on the hair of different animals from Libya (El-Said et al., 2009), Saudi Arabia (Nasser and Abdel-Sater, 1997), Romania (Nichita and Marcu, 2010) and Yemen (Sallam and AL-Kolaibe, 2010).

Alternaria (*A. alternate*, *A. raphani* and *A. tenuissima*) was isolated in low and moderate occurrence from one or two substrates. They were found in 13.3-26.6% of the samples tested comprising 7.3-13.7% of total isolates on goats and sheep, respectively. While *Cochliobolus* (*Cochliobolus australiensis, Cochliobolus lunatus* and *Cochliobolus spicifer*) was isolated in low occurrence from sheep. Other species of the preceding genera were less frequent (Table 2). The remaining genera were isolated in rare or low frequencies of occurrence and were encountered collectively in 1.2-7.3% and 1.4-6.8% of the total molds on goat and sheep hairs, respectively (Table 2).

Some fungi were isolated only from goat hairs, which include *Acremonium kiliense, Aspergillus parasiticus, A. terreus, Chaetomium spirale, Cladosporium cladosporioides, Curvularia lunata, Geotrichum candidum, Paecilomyces*

Table 2. Total counts (TC), percentage frequency (%F, calculated per 30 samples, numbers of cases of isolation (NCI) and occurrence remarks (OR) of various fungal genera recovered from hairs of 30 animals of each of goats and sheep on agar at 25°C.

Genera and species	Goats hair			Sheep wool		
	TC	F (%)	NCI & OR	TC	F (%)	NCI & OR
Acremonium	2	6.6	2R	1	3.3	1R
A. strictum W. Gams	1	3.3	1R	1	3.3	1R
A. kiliense Grütz	1	3.3	1R	-	-	-
Alternaria	6	13.3	4L	10	26.6	8M
A. alternata (Fr.) Keissl.	4	10	3R	6	20	6L
A. raphani J.W. Groves & Skolko	-	-	-	1	3.3	1R
A. tenuissima (Kunze) Wiltshire	2	6.6	2R	3	6.6	2R
Aureobasidium pullulans (de Bary & Löwenthal) G. Arnaud	-	-	-	1	3.3	1R
Aspergillus	24	56.6	17H	26	66.6	20H
A. flavus Link	3	6.6	2R	3	10	3R
A. fumigatus Fresenius	1	3.3	1R	2	6.6	2R
A. ochraceus G. Wilh.	-	-	-	2	6.6	2R
A. parasiticus Speare	1	3.3	1R	-	-	-
A. niger sensu auct. pro parte, pre	10	23.3	7L	12	30	9M
A. sydowii (Bainier & Sartory) Thom & Church	4	13.	4R	2	6.6	2R
A. terreus Thom	2	6.6	2R	-	-	-
A. ustus (Bainier) Thom & Church	-	-	-	4	10	3R
*A. variecolo*r Thom & Raper	3	6.6	2R	1	3.3	1R
Botryotrichum piluliferum Sacc. & Marchal	-		-	1	3.3	1R
Chaetomium	2	6.6	2R	1	3.3	1R
C. globosum Kunze	1	3.3	1R	1	3.3	1R
C. spirale Zopf	1	3.3	1R	-	-	-
Cladosporium cladosporioides (Fresen.) G.A. de Vries	2	3.3	1R	-	-	-
Cochliobolus	4	10	3R	9	16.6	5L
C. australiensis (Tsuda & Ueyama) Alcorn	-	-	-	3	10	3R
C. lunatus R.R. Nelson & F.A. Haasis	2	3.3	1R	1	3.3	1R
C. spicifer R.R. Nelson	2	3.3	2R	5	10	3R
Curvularia lunata (Wakker) Boedijn	1	3.3	1R	-	-	-
Emericella nidulans (Eidam.) Vuillemin	-	-	-	1	3.3	1R
Eurotium amstelodami Mangin	1	3.3	1R	3	6.6	2R
Fusarium	4	10	3R	4	10	3R
F. oxysporum Schltdl.	2	6.6	2R	1	3.3	1R
F. solani (Mart.) Sacc.	2	3.3	1R	3	10	3R
Geotrichum candidum Link	1	3.3	1R	-	-	-
Myrothecium verrucaria (Alb. & Schwein.) Ditmar	-	-	-	2	6.6	2R
Mucor hiemalis Wehmer	-	-	-	1	3.3	1R
Paecilomyces lilacinus (Thom) Samson	2	3.3	1R	-	-	-
Penicillium	20	43.3	13H	4	13.3	4L
P. brevicompactum Dierckx	2	6.6	2R	-	-	-
P. chrysogenum Thom	11	26.6	8M	3	16.6	5L
P. corylophilum Dierckx	5	10	3R	1	3.3	`1R
P. purpurogenum Stoll	1	3.3	1R	-	-	-
P. variabile Sopp	1	3.3	1R	-	-	-
Phoma	3	10	3R	1	3.3	1R
P. herbarum Westend.	2	6.6	2R	1	3.3	1R
P. glomerata (Corda) Wollenw. & Hochapfel	1	3.33	1R	-	-	-

Table 2. Contd.

Genera and species	Goats hair			Sheep wool		
	TC	F (%)	NCI & OR	TC	F (%)	NCI & OR
Pleospora herbarum P. Karst.	-	-	-	1	3.3	1R
Rhizopus nigricans Ehrenb.	1	3.3	1R	-	-	-
Scopulariopsis	6	6.6	2R	3	10	3R
S. brevicaulis (Sacc.) Bainier	4	10	3R	2	6.6	2R
S. brumptii Salv.-Duval	2	3.3	1R	-	-	-
S. candida Vuill.	-	-	-	1	3.3	1R
Stachybotrys chartarum (Ehrenb.) S. Hughes	-	-	-	1	3.3	1R
Stemphylium botryosum Wallr.	-	-	-	1	3.3	1R
Sterile mycelia	2	6.6	2R	3	6.6	2R
Trichoderma viride Pers.	-	-	-	1	3.3	1R
Ulocladium	1	3.3	1R	5	10	3L
U. alternariae (Cooke) E.G. Simmons	-	-	-	2	6.6	2R
U. chartarum (Preuss) E.G. Simmons	1	3.3	1R	3	6.6	2R
Total count		82			73	
Number of genera = 25		16			20	
Number of species= 48		33			34	

Activity remarks H= high, M= moderate, L= low keratinase activity. Occurrence remarks (OR): H= high occurrence, between 15-30 cases (out of 30); M= moderate occurrence, between 8-14 cases; L= low occurrence, between 4-7 cases; and R= rare occurrence, less than 4 cases.

lilacinus, Penicillium brevicompactum, P. purpurogenum, P. variabile, Phoma glomerata, Rhizopus nigricans and *Scopulariopsis brumptii*. While *Alternaria raphani, Aureobasidium pullulans, Aspergillus ochraceus, Aspergillus ustus, Botryotrichum piluliferum, Cochliobolus australiensis, Emericella nidulans, Myrothecium verrucaria, Mucor hiemalis, Pleospora herbarum, Scopulariopsis candida, Stachybotrys chartarum, Stemphylium botryosum, Trichoderma viride* and *Ulocladium alternariae* were isolated only from sheep wool (Tables 1 and 2). These results agree to some extent with some findings (Ogawa et al., 2008; Nichita and Marcu, 2010; Sallam and Alkolaibe, 2010; Emenuga and Oyeka, 2013; Luján-Roca et al., 2016).

Keratinase activity of the isolated fungi

Data in Table 3 and Figure 1 show that the high keratinase activity as a clear zone around the colony (54, 65, 50, 58 and 60 mm) were observed for *A. niger, Chrysosporium keratinophilum, C. tropicum, Microsporum gypseum* and *Trichoderma viride,* respectively. While *Acremonium strictum, Fusarium oxysporum, Myrothecium verrucaria, Mucor hiemalis, Scopulariopsis brevicaulis* and *Trichophyton terrestre* had moderate keratinase activities (45, 43, 32, 45, 45 and 34mm), respectively. On the other hand, the *C. dermatitidis, C. cladosporioides, P. chrysogenum,*

Table 3. Keratinase activity as clear zone (MM) of dermatophytes and other keratinophilic fungi.

Fungal isolates	Clear zone (MM)
Acremonium strictum	45M
Alternaria alternata	0
Aspergillus niger	54H
Chrysosporium dermatitidis	25L
C. keratinophilum	65H
C. tropicum	50H
Cladosporium cladosporioides	18L
Curvularia lunata	0
Fusarium oxysporum	43M
Microsporum gypseum	58H
Myrothecium verrucaria	32M
Mucor hiemalis	45M
Penicillium chrysogenum	20L
Scopulariopsis brevicaulis	45M
Trichoderma viride	60H
Trichophyton interdigitale	25L
T. mentagrophytes	15L
T. rubrum	23L
T. terrestre	34M
Ulocladium chartarum	21L

Trichophyton interdigitale, T. mentagrophytes, T. rubrum and *Ulocladium chartarum* were low keratinase activities

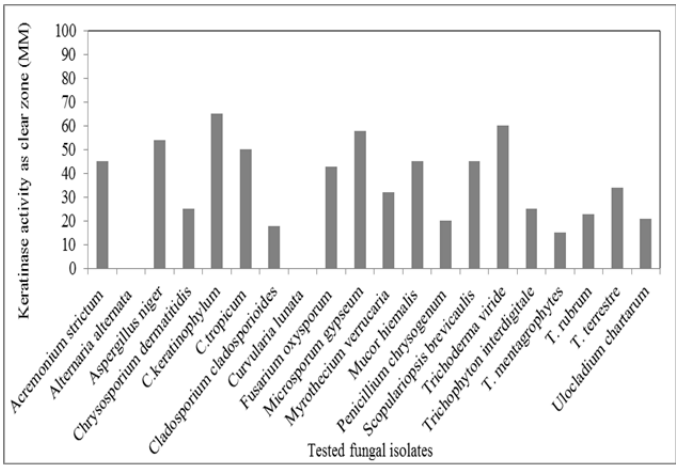

Figure 1. Keratinase activity as clear zone (MM) of dermatophytes and other keratinophilic fungi.

(25, 18, 20, 25, 15, 23 and 21 mm), respectively. While *Alternaria alternate* and *Curvularia lunata* had negative keratinase activity

The results agree to some extend with previous findings (Anbu et al., 2008; Awasthi and Kushwaha, 2011; Ramakrishnaiah et al., 2013; Kumar and Kushwaha, 2014; Singh, 2014; Singh et al., 2016; Bohacz, 2017).

Thus, the study concluded that members of *Chrysosporium* and dermatophytes (*Trichophyton* and *Microsporum*) were consistently the most frequent fungi on the goats' hairs and sheep wool. Also, various saprophytic and cycloheximide resistant fungi were common on goat and sheep hairs tested and these were members of *Acremonium, Alternaria, Aspergillus, Chaetomium, Cochliobolus, Chdaetomium, Fusarium, Penicillium* and *Scopulariopsis.* The wool of sheep was contaminated more than the goat's hairs. This may be due to the increase of organic in sheep hair than goat hair. Most dermatophytes and other keratinophilic fungi play an important role in the degradation of keratin substrates, so that they can help preserve the environment and reduce pollution.

CONFLICT OF INTERESTS

The author has not declared any conflict of interests.

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