MICROBIAL DETERIORATION OF TENTAGE IN HOT—HUMID REGION OF ASSAM

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Cotton tents exposed in hot-humid region of Assam show heavy microbial attack predominantly of copper tolerant fungi necessitating treatment with higher concentrations of copper naphthenate to prevent deterioration.

Different types of stores, both under storage and in use, suffer microbial attack and consequent degradation. The deterioration by microorganisms is of great intensity in tropical climate, and is more so in hot-humid regions than in hot-dry regions. The hot-humid climate is characterised by high temperature (30—32°C) and high humidity (ranging from 75—95%) followed by nocturnal condensation. This meteorology of the tropical climate is conducive to optimum microbial activity.

The soil of Assam is predominant with Aspergilli[2]. Studies in Defence Research Laboratory (Materials) on deteriorated samples received from Gauhati region (Assam) revealed widespread microbial attack and even the copper naphthenate treated tentage fabric (0·1—0·3% of copper content) showed profuse mildewed patches.

This paper describes the results of the investigations carried out on the types of microorganisms responsible for deterioration of the tentage materials in the hot-humid region of Assam including suitable protective treatment.

MATERIALS AND METHODS

Specimens of tentage fabric, cordages (collected after the Monsoon season near about in October) soil and copper naphthenate solution were investigated for the following

Visual examination—Samples of tentage fabric and cordages were visually examined for mildew stains.

Breaking strength determination—Breaking strength of treated and untreated samples from the tentage were determined to find out the extent of loss in the tentage used in Gauhati region (Assam).

Congo Red Test—The representative fibres drawn from the fabric and cordage pieces were first treated with 11% caustic soda solution for 4-5 minutes and then washed with distilled water, stained with 2·0% Congo Red Solution for 10-15 minutes. Finally the stained fibres were again washed with distilled water and mounted in 18% caustic soda solution and examined under the microscope for the nature of damage[3,4].

Isolation of microflora and its frequency—

(*i*) *Isolation from damaged fabric*—The isolation of the microorganisms from the damaged fabrics was carried out using Waksman[5] and Thornton[6] media.

(*ii*) *Isolation from the soil sample*—The isolation of the microorganisms from the representative sample of the soil was carried out by dilution plating technique[7], using 1/10, 1/100 and 1/1,000 dilutions of the soil in the case of fungal isolates and 1/1,000, 1/10,000 and 1/100,000 dilutions in the case of bacterial isolates.

TABLE 1

VISUAL EXAMINATION, NATURE AND DEGREE OF DAMAGE AND MICROORGANISMS ISOLATED FROM DETERIORATED TENTAGE SAMPLES

Fabric/cordage samples	Visual observations	Type and degree of damage	Microorganisms isoloated
(A) Fabric treated with copper naphthenate.	Black mildew patches observed all over the surface of the fabric on one side only.	Fairly moderate microbial damage and slight chemical damage.	*Diplodia sp., Dematium sp., Rhizopus sp., Fusarium sp.*
(B) Fabric dyed khaki	Sparse black mildew patches observed all over the surface on one side only.	Fairly moderate microbial damage.	*Torula, Fusarium sp., Dematium sp., Alternaria sp., Rhodotoruia sp.*
(C) Fabric treated with copper naphthenate.	No mildew patches observed on either side.	Fairly moderate chemical and slight microbial damage.	*Fusarium sp., Dematium sp., Alternaria sp., Aspergillus sp.*
(D) White scoured dosootie	Black mildew patches observed in two parallel rows leaving a clean unaffected region in between.	Fairly moderate chemical and microbial damage.	*Fusarium sp., Dematium sp., Rhizopus sp.*
(E) Olive green dosootie	Profuse black stains observed in the middle region on one side, and black mildew patches spread all over on the other side.	Fairly severe microbial and slight chemical damage.	*Rhizopus sp., Dematium sp., Fusarium sp.*
(F) Olive green dosootie	Black/brown mildew stains spread all over on one side, and comparatively sparse mildew patches on the other side.	—do—	*Dematium sp., Aspergillus sp., Fusarium sp.*
(G) Cordage treated with copper naphthenate.	No distinct mildew patches, accumulation of dirt/dust and blackening observed at places.	Very slight chemical and microbial damage.	Bacteria, *Aspergillus sp., Torula sp., Fusarium sp., Alternaria sp., Rhodotorua sp.*
(H) —do—	—do—	—do—	*Torula sp., Dematium sp. Fusarium sp.*
(I) —do—	—do—	Very slight chemical damage.	*Aspergillus niger sp. Torula sp,, Dematium sp.,, Fusarium sp,, Alternaria sp.*
(J) Cordage cotton white (untreated).	Black mildew stains all over the twists and black mildew growth observed at places only.	Fairly moderate microbial damage.	*Fusarium sp., Dematium sp.*
(K) —do—	—do—	Moderate microbial damage.	*Fusarium sp., Dematium sp., Aspergillus sp.*
(L) —do—	—do—	Fairly severe microbial damage.	*Fusarium sp., Trichoderma sp.*

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TABLE 2

PERCENTAGE LOSS IN TENSILE STRENGTH OF COPPER NAPHTHENATE TREATED TENTAGE FABRIC

Treatment	Copper content	Average breaking strength (36 replicates)	% loss in breaking strength
Fabric treated with copper naphthenate	0·2—0·3%	72 lbs.	37
Fabric treated with copper naphthenate	0·1—0·15%	61 lbs.	47
*Untreated & undamaged control	..	115* lbs.	..

*It may be taken as the original breaking strength of the tentage fabric.

TABLE 3

MICROORGANISMS ISOLATED FROM THE SOIL SAMPLE

Microorgnisms	Count per gram of soil	Types of microorganisms
Bacteria	6,50,000	Bacteria, both chromogenic and non-chromogenic.
Fungi	600	*Aspergillus niger, Aspergillus fumigatus, Aspergillus japonicus, Aspergillus flavus, Aspergillus sp., Penicillium sp. Cunninghamella sp., Helminthosporium sp. Acrothecium sp., Trichoderma sp., Fusarium sp., Rhodotorula sp.*

TABLE 4

CELLYLOLYTIC ACTIVITY AND COPPER TOLERANT CAPACITY OF SOME COMMON AND FREQUENTLY OCCURRING FUNGI ISOLATED FROM DETERIORATED FABRIC AND THE SOIL

Microorganisms	Cellulose destroying capacity (based on loss in tensile strength of untreated dosootie in 14 days)	%loss in copper naphthenate treated dosootie after test (14 days)	
		Concentration of copper on the fabric	Loss in B.S. (unleached)
	%	%	%
Aspergillus niger	53	0·4	36
		0·8	No loss
Aspergillus japonicus	95	0·4	—do—
		0·8	—do—
Aspergillus fumigatus	92	0·4	46
		0·8	No loss
Trichoderma sp.	81	0·4	—do—
		0·8	—do—
Fusarium sp.	90	0·4	—do—
		0·8	—do—

The media used for the purpose of isolation were (*a*) Waksman (*b*) Thornton and (*c*) Czapek-Dox[8]. Counts for bacterial and fungal colonies were separately carried out.

Copper naphthenate—Copper content of the sample used for treatment of tentage material was found to be 10·1% expressed as copper oxide.

Determination of cellulolytic activity and copper tolerant capacity of the fungi—Cellulolytic activity and copper tolerant capacity of some common and frequently occurring fungi isolated from the soil and the damaged fabric were assessed by "Pure Culture Method" as described in the Indian Standards Specification No. IS: 1389-1959 using dosootie, the fabric of Indian tentage, treated with different concentrations of copper naphthenate together with untreated control.

DISCUSSION

Hot-humid regions are highly conducive to microbiological deterioration. The samples of tentage materials from Gauhati (Assam) have extensively suffered microbial attack. Heavy mildew incidence has even been observed in case of tentage materials treated with copper naphthenate. It is evident from Table 2 that the tentage fabric having copper content ranging from 0·1—0·3% register a loss of 37—47% in tensile strength due to microbial attack.

From Table 3 it may be inferred that *Aspergilli* occur predominantly in the soil of the region. Table 4 shows cellulolytic activity and copper tolerant capacity of some common and frequently occurring fungi isolated from damaged fabric and the soil. It may be inferred from this table that *Aspergillus japonicus, Aspergillus fumigatus, Trichoderma* and *sp. Fusarium sp,* have high collulose destroying capacity, while *Aspergillus niger* shows only moderate cellulolytic activity. *Aspergillus niger* and *Aspergillus fumigatus* are copper tolerant as they cause 36% and 46% loss in breaking strength respectively to the fabric treated with copper naphthenate having 0·4% copper content.

CONCLUSION

These studies give information on the nature of microbial degradation of tentage materials in the hot-humid region of Assam. Common and more frequently occurring fungi both from the deteriorated tentage fabric as well as from the soil of the region are highly cellulolytic in nature. *Aspergillus niger* and *Aspergillus fumigatus* are copper tolerant. Treatment of the tentage fabric with copper naphthenate of concentration not less than 0·4% copper on the weight of the fabric is recommended.

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