FUNGAL DEGRADATION OF CELLULOSIC MATERIALS IN ASSAM, I. STUDIES ON SOIL ASPERGILLEI

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Nineteen species of *Aspergillus* were isolated from the soil of Assam, during a systematic investigation of soil mycoflora in 1972-74. The paper describes the presence of these species in different regions of Assam with special consideration to cellulose destroying capacity of these species, and the results indicate that these isolates play a very important role in degradation of cellulosic materials in stores under user conditions.

A rapid deterioration of military fabrics in many tropical and sub-tropical areas has focused attention on cellulose decomposing micro-organisms. Assam constitute the hot-humid belt of India. The climate of this region is very favourable for growth and proliferation of various types of saprophytic fungi on user materials. Many fungi remain viable and virulent in the soil and atmosphere during the major parts of the year owing to highly conductive climatic conditions. Consequently, all the materials are found to suffer with microbial damage both under storage and user conditions.

With a view to investigate the extent of fungal activity responsible for this deterioration, it was considered essential to study the active fungi present in the soil of Assam in a systematic way. A record of 19 Aspergillei and their cellulose degradation capacity forms the subject of the present communication.

In order to isolate soil Aspergillei concerned in the degradation of stores, the soil samples were collected in the month of July 1972 and April 1973 from Arunachal, Bhalukamara, Chapurmukh, Dibrugarh, Dimapur, Gauhati, Jorhat, Ledo, Lumding, Misamari, Rangiya, Shillong, Simaluguri, and Tinsukia. The samples were taken from the surface and from 15 cm depth in ground under aspetic conditions in sterilized tubes. The collected soil samples were stored at 5°C±2°C before isolation studies and the isolation of fungus was made following the soil dilution method[1]. The properties of soil e.g. temperature, moisture, *pH* and its colour were determined using standard method of Piper[2].

The cellulose destroying capacity was determined following the method described in T.D.E.L.(S.) Kanpur, Tech. Rep[3] No. Bio/47/69. After the incubation period the fungal growth was gently washed off from the strips and the strips were dried at room temperature for 24 hours. The strips were conditioned at 65% relative humidity and at 22°C temperature for 48 hours and then tested by Good Brand breaking strength testing machine according to Indian Standard Specification[4]. The average breaking strength of inoculated and uninoculated (control) strips were used for calculating the percentage loss in strength of inoculated test strips caused by particular fungus.

$$\% \text{ loss in strength} = \frac{A - B \times 100}{A}$$

A=Breaking strength of uninoculated strips.

B=Breaking strength of inoculated strips.

19 species of *Aspergillus* were isolated from the collected soil samples. They were *A. niger* var Tieghem, *A. niger* mut schiemanne, *A. niger* mut cinnamomeus, *A. terreus* Thom, *A. flavus* Link, *A. tamarii* Kita, *A. sydowi* Thom & Church, *A. elegans* Gasperini, *A. versicolor* (Vuillemin) Tiraboschi, *A. candidus* Link, *A. fumigatus* Fresenius, *A. flavipes* (Bain & Sart) Thom & Church, *A. humicola* Chaudhuri & Sachar, *A. awamori* Nakazawa, *A. ustus* (Bainier) Thom & Church, *A. luchuensis* Inui, *A. wentii* wehmer, *A. japonicus* Saito and *A. clavatus* Desmazieres.

All these species except *A. elegans, A. humicola, A. ustus, A. wentii, A. candidus, A. tamarii* and *A. japonicus*, were found to be frequently distributed all over the Assam. *A. elegans* and *A. humicola* showed their presence in Shillong and Guahati soils respectively. *A. ustus* was isolated from Ledo and Shillong, and *A. wentii* was isolated from Chapurmukh and Gauhati soils. The maximum number of *Aspergillus* species (11) were isolate from the soils of Gauhati and 10 species were isolated from soils of Shillong and Jorhat and minimum i.e. only one species was recorded from Lumding soils Table 1. The number of species varied from place to place and this variation in presence of particular species in the soil of particular area may be due to the ecological variation, as physical and chemical properties of soils are interrelated and have

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a direct influence on each other. The effect of *pH* on distribution of *Aspergillus* in soil was not much significant, as the soil samples collected from Shillong also showed high number of *Aspergillus* species though the soil was acidic Table 2, while Warcup[5] reported that *Aspergillus* were abundant in alkaline soils. The soil temperature and moisture played a significant role in distribution of various type of fungi. The results of the present studies clearly shows that the maximum number of species were isolated from Gauhati, Shillong, Jorhat having high moisture content althrough the soils showing both the high and low temperature. Orpurt and Curtis[6] reported that Aspergillei preferred dry soils, where, just contrast was recorded by Leclerg and Smith[7], who indicated that the soil with low moisture content favoured the growth of fungi. A general perusal of the results show that a particular species required certain specific condition for its growth. The soil factors like *pH*, temperature and moisture individually did not effect the distribution of a particular fungus, but had a combined affect on the type and distribution of fungi.

All 19 species were tested for their cellulose destroying capacity and the data are summarized in Table 3. The data indicated that there was a wide difference in cellulose destroying capacity of various species. Isolates of *A. sydowi* and *A. elegans* showed no less of strength in cambric test strips. The isolates of *A. niger* var Tieghen, *A. niger* mut schiemanni, *A. awamori* and *A. luchuensis* showed less than 20% loss within 7 days. The isolates of *A. niger* mut cinnumameus, *A. flavus* caused less than 50% loss, whereas the isolates of *A. terreus*, *A. tamarii*, *A. versicolor*, *A. candidus* and *A. japonicus* showed wide difference in their cellulose destroying capacity and these varied from 10 to 72%. The maximum cellulose destroying capacity exhibited by *A. terreus* 72% (Chapurmukh, Gauhati, Jorhat); *A. flavus* 68·5%, (Ledo & Tinsukia); *A. versicolor* 70% (Gauhati & Shillong); *A. candidus* 53% (Gauhati & Shillong) and *A. japonicus*, 77% (Tinsukia).

TABLE 1

SOIL MYCOFLORA OF ASSAM & MEGHALAYA

Mycoflora	Different locality														Total no of fungi
	Arunachal	Bhalukmara	Chapurmukh	Dibrugarh	Dimapur	Gauhati	Jorhat	Ledo	Lumding	Misamari	Rangiya	Shillong	Simaluguri	Tinsukia	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
Aspergillus candidus	+	—	—	—	—	+	—	—	—	—	—	+	—	—	3
A. clavatus	+	+	—	+	+	—	+	—	—	+	—	—	+	+	8
A. niger var. Tieghem	—	—	+	—	—	+	+	—	—	—	+	+	+	+	7
A. niger mut schiemanne	+	—	+	+	—	+	+	—	+	—	+	—	—	—	7
A. niger mut cinnamomeus	—	+	—	—	—	—	+	—	—	+	—	—	+	—	4
A. terreus	+	—	+	—	+	+	+	—	—	+	+	+	—	—	8
A. flavus	+	—	+	+	+	+	+	—	—	+	+	+	+	+	11
A. tamarii	—	—	—	+	—	—	—	+	—	—	—	—	—	+	3
A. sydowi	—	—	+	—	—	+	+	—	—	+	+	+	—	—	5
A. elegans	—	—	—	—	—	—	—	—	—	—	—	+	—	—	1
A. versicolor	+	+	+	+	+	+	—	—	—	—	—	+	—	—	7
A. ustus	—	—	—	—	—	—	—	+	—	—	—	+	—	—	2
A. fumigatus	+	+	+	+	+	—	+	+	—	—	+	+	+	+	11
A. japonicus	—	—	+	—	—	+	—	—	—	—	—	—	—	—	2
A. flavipes	+	+	—	—	+	+	—	+	—	+	—	+	—	+	8
A. humicola	—	—	—	—	—	+	—	—	—	—	—	—	—	—	1
A. awamori	+	—	—	+	—	—	+	—	—	—	—	—	+	+	5
A. luchuensis	—	+	—	+	—	—	+	+	—	—	—	—	+	—	5
A. wentii	—	—	+	—	—	+	—	—	—	—	—	—	—	—	2

(+), Indicate the presence of species.

(—), Indicate the absence of species.

TABLE 2

PROPERTIES OF SOILS OF DIFFERENT PLACES

Locality	Month in which properties studied	Temperature range in°C	Moisture range	*pH* range
Arunachal	July, 72	26—34	15·0—32·0	6·6—7·0
Bhalukmara	April, 73	27—30	18·0—26·0	6·6—7·0
Chapurmukh	July, 72	28—36	15·0—24·0	6·4—6·6
Dibrugarh	July, 72	27—33	12·0—25·0	7·0—7·4
Dimapur	April, 73	27—34	15·0—28·0	6·7—7·0
Gauhati	July, 72	26—34	13·5—26·0	6·6—7·4
Jorhat	April, 73	25—28	18·0—27·0	6·6—7·0
Ledo	April, 73	22—26	10·0—18·0	6·5—6·7
Lumding	April, 73	27—28	15·0—30·0	6·4—6·7
Misamari	April, 73	23—28	13·0—28·0	6·8—7·0
Rangiya	July, 72	26—34	20·5—26·0	6·4—7·0
Shillong	July, 72	14—21	21·0—34·0	5·4—6·5
Simaluguri	April, 73	26—28	13·0—25·0	6·7—7·0
Tinsukia	July, 72	27—33	7·5—20·0	6·8—7·2

TABLE 3

RELATIVE CELLULOLYTIC CAPACITY OF ASPERGILLI (% Cellulose degradation)

Fungus	*Places of fungal isolations													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
A. niger var Tieghem	—	—	4·3	—	—	18·0	12·0	—	—	—	4·3	13·0	12·8	12·8
A. niger mut schiemanni	14·2	—	14·0	11·4	—	14·0	14·2	—	14·0	—	11·4	—	—	—
A. niger mut cinnamoeus	—	48·0	—	—	—	—	48·5	—	—	48·5	—	—	47·0	—
A. terreus	66·0	—	72·0	—	40·0	72·0	72·0	—	—	42·8	70·0	60·0	—	—
A. flavus	16·9	—	17·0	40·7	15·0	16·9	14·2	—	—	25·7	37·0	37·0	14·2	22·8
A. tamarii	—	—	—	50·8	—	—	—	68·5	—	—	—	—	—	68·5
A. sydowi	—	—	00·0	—	—	00·0	00·0	—	—	00·0	00·0	00·0	—	—
A. elegans	—	—	—	—	—	—	—	—	—	—	—	00·0	—	—
A. versicolor	33·3	10·0	33·3	33·3	10·0	70·0	—	—	—	—	—	70·0	—	—
A. candidus	50·0	—	—	—	—	53·0	—	—	—	—	—	53·0	—	—
A. fumigatus	42·8	00·0	25·0	42·8	00·0	—	00·0	00·0	—	—	47·7	28·5	00·0	28·5
A. japonicus	—	—	44·2	—	—	44·2	—	—	—	—	—	—	—	77·1
A. flavipus	40·0	42·0	—	—	49·0	40·2	—	49·0	—	24·0	—	49·1	—	48·0
A. humicola	—	—	—	—	—	6·4	—	—	—	—	—	—	—	—
A. awamori	12·0	—	—	10·0	—	—	11·1	—	—	—	—	—	11·1	20·0
A. ustus	—	—	—	—	—	—	—	57·1	—	—	—	28·5	—	—
A. luchuensis	—	00·0	—	00·0	—	—	14·2	00·0	—	—	—	—	14·2	—
A. clavatus	48·5	57·1	—	41·1	28·5	—	57·1	—	—	28·5	—	—	57·1	28·5
A. wentii	—	—	27·0	—	—	32·0	—	—	—	—	—	—	—	—

* 1. Arunachal, 2. Bhalukmara, 3. Chapurmukh, 4. Dibrugarh, 5. Dimapur, 6. Gauhati, 7. Jorhat, 8. Ledo, 9. Lumding, 10. Misamari, 11. Rangiya, 12. Shillong, 13. Simaluguri, 14. Tinsukia.

(—) Indicating the absence of species.

The results summarized in Table 3 indicated that out of 102 isolates, 19 isolates were highly cellulolytic and showed more than 50% loss in cambric test strips within 7 days. These isolates were frequently found distributed all over the Assam region, hence play a very important role in degradation of cellulosic materials in stores and user condition.

These studies are important to find out the comparative ability of various species of fungi for decomposition of cellulosic materials in a specific period, the finding may certainly be helpful in improving the quality of cellulosic products necessary for army units. The study presented is a beginning in this direction.

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