Biochemical Degradation of *Coriandrum Sativum* Under Fungal Stress and Its Mitigation Through Eco-Friendly Management

Khan Farheen Kauser[1], Baig Mumtaz[2]
[1,2]*Department of Botany Dr. Rafiq Zakaria College for women, Navkhanda, Chatrpati sambhaji nagar Aurangabad (M.S) India*

***Abstract*—The present study was undertaken to investigate the fungal association, biodeterioration and eco-friendly management of coriander (*Coriandrum sativum* L.) seeds. Seed samples were examined for seed-borne mycoflora using blotter, agar plate and seed washing methods. A diverse fungal population was detected, with *Aspergillus niger* showing the highest incidence, followed by *Aspergillus flavus* and *Curvularia lunata*. Among the three isolation methods, the agar plate method recorded comparatively higher fungal incidence than the blotter and seed washing methods, indicating its greater effectiveness in detecting seed-associated fungi.**

The effect of fungal infestation on the physical and chemical characteristics of coriander seeds was subsequently assessed. Infestation with *A. niger* and *C. lunata* resulted in visible deterioration in oil colour and odour, together with a reduction in oil content and changes in specific gravity. Biochemical analysis further showed reductions in dry weight, pH, protein content, iodine number and saponification number, whereas moisture content increased following fungal infestation. These changes indicated deterioration of seed quality and alteration of important nutritional and oil-related characteristics. For eco-friendly management, leaf extracts of *Annona squamosa* and *Calotropis procera* were evaluated against *A. niger* and *C. lunata* using the poisoned food technique at different concentrations. Both plant extracts exhibited concentration-dependent antifungal activity, with greater inhibition at higher concentrations. At 20% concentration, *C. procera* extract produced the highest inhibition, reaching 88.89% against *A. niger* and 84.44% against *C. lunata*, whereas *A. squamosa* produced 75.56% and 70.00% inhibition, respectively. The findings demonstrate the occurrence of potentially important seed-associated fungi in coriander and their adverse effects on seed quality. The inhibitory activity of the tested botanical extracts indicates their potential as simple, economical and eco-friendly alternatives for the management of fungal deterioration in stored coriander seeds.

***Index Terms*—antifungal activity, biochemical degradation, Curvularia lunata, Eco friendly**

I. INTRODUCTION

Coriander (*Coriandrum sativum* L.) is an important culinary and aromatic spice valued for its characteristic flavour, aroma and essential oil. During storage, coriander seeds may become contaminated with seed-borne and storage fungi, which can adversely affect their physical quality and biochemical constituents. Fungal infestation may cause changes in seed moisture, oil content, odour, colour and other chemical properties, thereby reducing the quality and storage value of the seeds.

The detection and management of seed-associated fungi are therefore important for maintaining the quality of stored coriander. Although chemical fungicides are commonly used for fungal control, increasing interest in safer and eco-friendly alternatives has encouraged the investigation of plant-derived antifungal agents. Botanical extracts contain various bioactive compounds that may suppress the growth of storage-associated fungi.

The present study was undertaken to assess the seed-borne mycoflora associated with coriander seeds using different detection methods, determine the effect of selected fungi on important physical and chemical characteristics, and evaluate the antifungal activity of *Annona squamosa* and *Calotropis procera* leaf extracts against selected fungi. The study also explores their potential as simple, economical and eco-friendly options for managing fungal deterioration during storage.

II. METHODS AND MATERIALS

Phase I: Isolation and identification of seed-associated mycoflora

Coriander (*Coriandrum sativum* L.) seed samples were collected from agricultural fields, storage facilities, and local markets following the sampling procedure described by Neergaard (1977). The collected samples were pooled to prepare a composite sample and stored in gunny bags at room temperature. Seed-associated fungi were isolated using the Agar Plate Method and Seed Washing Method following standard procedures described by ISTA (1966), De Tempe (1970), and Neergaard (1977). The isolated fungi were identified on the basis of colony morphology, sporulation characteristics, and microscopic features using standard taxonomic manuals (Subramanian, 1971; Neergaard & Mathur, 1980; Jha, 1993; Mukadam, 1997).

Pure cultures were maintained on Potato Dextrose Agar (PDA) slants. The incidence of mycoflora obtained by the Agar Plate and Seed Washing methods was recorded and compared to determine the occurrence of different fungal species associated with coriander seeds.

Phase II: Assessment of fungal biodeterioration

To assess the effect of fungal infestation on the physical and biochemical properties of coriander seeds, healthy seeds were artificially inoculated with selected seed-associated fungi. Appropriate untreated seeds were maintained as controls. Following incubation/storage, the control and artificially infested seeds were evaluated for changes in selected physical and chemical parameters.

Moisture content was determined using standard procedures (Neergaard, 1977; AOAC, 1947). Protein content was estimated by the Lowry method (Lowry et al., 1951), while total oil content was determined according to Meara (1955).

Free fatty acid content was estimated following Zenely and Coleman (1938). Iodine value and saponification value were determined according to AOAC (1960). Changes in these parameters were recorded to assess the extent of deterioration caused by fungal infestation.

Phase III: Evaluation of botanical extracts

Aqueous and ethanolic leaf extracts of selected plants, including *Annona squamosa* (custard apple), were evaluated for their antifungal activity against selected seed-associated fungi.

The extracts were incorporated into PDA medium at different concentrations using the poisoned food technique (Biswas et al., 1995). A suitable untreated PDA medium served as the control. Fungal growth was measured after incubation and the percentage inhibition was calculated using:

Inhibition (%) = $[(C - T) / C] \times 100$

Table: 01 Incidence of Seed-Borne Mycoflora Associated with Coriander Seeds by Different Methods

Sr. No.	Name of Fungi	Blotter Method (%)	Agar Plate Method (%)	Seed Washing Method (%)	Appearance
1	*Aspergillus niger*	22.5	27.0	18.9	Early
2	*Aspergillus flavus*	15.8	19.4	13.6	Early
3	*Curvularia lunata*	17.2	21.5	14.8	Early
4	*Fusarium oxysporum*	11.5	14.2	9.8	Late
5	*Penicillium chrysogenum*	9.8	12.1	8.4	Early
6	*Alternaria alternate*	8.7	11.0	7.5	Late
7	*Rhizopus stolonifer*	7.9	10.2	6.8	Early
8	*Mucor* spp.	6.8	8.9	5.9	Early
9	*Aspergillus fumigatus*	6.1	8.0	5.2	Late
10	*Trichoderma viride*	5.4	7.1	4.6	Early

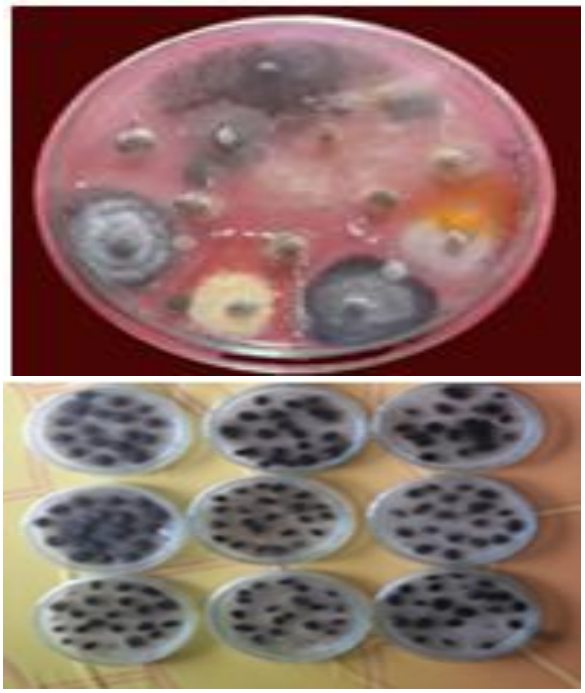


Fig. MYCOFLORA ASSOCIATED WITH CORIANDER SEEDS

Fungi identify from coriander seeds

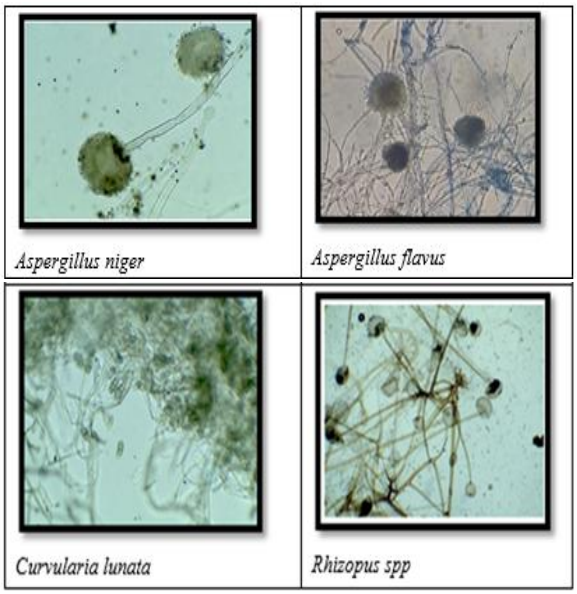
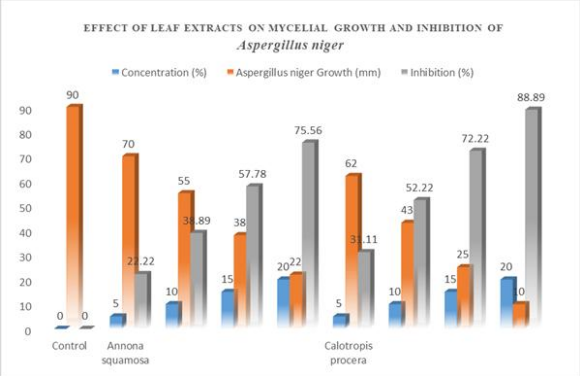


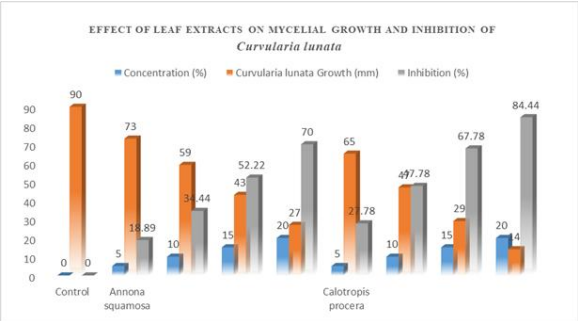
Table: 02 Effect of seed Infestation with moulds on Physical – chemical characters in Coriander

Characteristics	Control	*Aspergillus niger*	*Curvularia lunata*
Oil colour	Pale yellow	Yellowish Brown	Brownish
Oil Odour	Pleasant citrusy	Slightly off note	Sour
Oil content %	20	18	16
Specific gravity	0.913	0.917	0.921
Dry weight %	89	87	84
Ash content %	6	605	7
PH	7.0	6.4	6.0
Moisture content %	7	9	11
Protein content %	14	12.5	11
Iodine number gI_2/100g)	118	114	110
Saponification number (mg KOH/g)	189	184	178
Free fatty acid	68	64	60

Table: no 03 Effect of Leaf Extracts on Mycelial Growth and Inhibition of Dominant Fungi

Plant extract	Concentration (%)	*Aspergillus niger* Growth (mm)	Inhibition (%)	*Curvularia lunata* Growth (mm)	Inhibition (%)
Control	0	90.0	0.00	90.0	0.00
Annona squamosal	5	70.0	22.22	73.0	18.89
	10	55.0	38.89	59.0	34.44
	15	38.0	57.78	43.0	52.22
	20	22.0	75.56	27.0	70.00
Calotropis procera	5	62.0	31.11	65.0	27.78
	10	43.0	52.22	47.0	47.78
	15	25.0	72.22	29.0	67.78
	20	10.0	88.89	1.0	84.44





III. REULTS AND DISSCUSSION

The present investigation showed that coriander (*Coriandrum sativum* L.) seeds were associated with a variety of fungi. Ten fungal taxa were recorded by the three isolation methods used, namely the blotter method, agar plate method and seed washing method. Among these fungi, *Aspergillus niger* was the most frequently occurring fungus, with an incidence of 22.5% in the blotter method, 27.0% in the agar plate method and 18.9% in the seed washing method. *Aspergillus flavus* was the next commonly occurring fungus, showing 15.8%, 19.4% and 13.6% incidence, respectively. *Curvularia lunata* was also recorded at a relatively higher incidence of 17.2% in the blotter method, 21.5% in the agar plate method and 14.8% in the seed washing method. When the three methods were compared, the agar plate method consistently recorded higher fungal incidence than the blotter and seed washing methods.

This may be because the nutrient-rich agar medium provides favourable conditions for fungal growth and allows fungi present on or within the seed to develop more readily. The seed washing method showed comparatively lower values, as it mainly detects fungi present on the external surface of the seeds. The early appearance of *A. niger*, *A. flavus*, *C. lunata*, *Penicillium chrysogenum*, *Rhizopus stolonifer*, *Mucor* spp. and *Trichoderma viride* suggests that these fungi were able to establish and grow rapidly under the test conditions. In contrast, *Fusarium oxysporum*, *Alternaria alternata* and *Aspergillus fumigatus* appeared later.

The presence of these fungi is important because fungal growth during storage can gradually affect the physical quality of spice seeds and their oil. In the present study, clear changes were observed after artificial infestation of coriander seeds with *A. niger* and *C. lunata*. The control seeds produced pale-yellow oil with a pleasant citrusy odour. In contrast, the oil obtained from *A. niger*-infested seeds became yellowish brown and developed a slightly off odour, while *C. lunata*-infested seeds produced brownish oil with a sour odour. These changes indicate visible deterioration in the quality of the oil following fungal infestation. Oil content also decreased from 20% in the control to 18% after infestation with *A. niger* and 16% with *C. lunata*. Specific gravity increased slightly from 0.913 in the control to 0.917 and 0.921 in the respective treatments. Such changes may be associated with fungal utilization and modification of seed constituents during growth. The reduction was more pronounced in *C. lunata*-infested seeds, suggesting greater deterioration of the measured oil characteristics under the conditions of the present experiment. The chemical characteristics also showed noticeable changes following fungal infestation. Dry weight decreased from 89% in the control to 87% in *A. niger*-infested seeds and 84% in *C. lunata*-infested seeds. At the same time, moisture content increased from 7% in the control to 9% and 11%, respectively. The increase in moisture may provide more favourable conditions for further fungal development and may contribute to progressive deterioration during storage. A gradual reduction in pH was also observed, from 7.0 in the control to 6.4 in *A. niger*-infested seeds and 6.0 in *C. lunata*-infested seeds. Protein content decreased from 14% in the control to 12.5% and 11%, respectively. Similarly, the iodine number declined from 118 in the control to 114 and 110, while the saponification number decreased from 189 to 184 and 178 mg KOH/g. These changes suggest that fungal infestation affected important biochemical constituents of coriander seeds and their oil. The decrease in iodine number may indicate changes in the unsaturated components of the oil, while the reduction

in saponification value may reflect changes in the lipid fraction during fungal deterioration. The free fatty acid value also showed a decrease in the present set of observations, from 68 in the control to 64 and 60 following infestations with *A. niger* and *C. lunata*, respectively. Although free fatty acids commonly change during lipid deterioration, their direction and magnitude can depend on the fungal species, storage conditions and stage of deterioration. Therefore, the present values are interpreted specifically as the changes observed under the experimental conditions rather than as a general pattern for all fungal infestations.

The antifungal activity of selected plant extracts was then evaluated against *A. niger* and *C. lunata*. Both *Annona squamosa* and *Calotropis procera* extracts showed increasing inhibition with increasing concentration. The control treatment showed 90 mm fungal growth for both fungi, whereas the plant extracts progressively reduced fungal growth as their concentration increased. Among the two extracts, *C. procera* showed greater inhibitory activity. At 5% concentration, it reduced the growth of *A. niger* to 62 mm, corresponding to 31.11% inhibition, while *C. lunata* showed 65 mm growth and 27.78% inhibition. At 10% concentration, inhibition increased to 52.22% against *A. niger* and 47.78% against *C. lunata*. At 15%, the inhibition further increased to 72.22% and 67.78%, respectively. The highest activity was recorded at 20%, where *C. procera* produced 88.89% inhibition of *A. niger* and 84.44% inhibition of *C. lunata*. *Annona squamosa* also showed a clear concentration-dependent response. At 5% concentration, inhibition was 22.22% against *A. niger* and 18.89% against *C. lunata*. At 10%, the inhibition increased to 38.89% and 34.44%, respectively, and at 15% it reached 57.78% and 52.22%. At 20%, *A. squamosa* produced 75.56% inhibition against *A. niger* and 70.00% against *C. lunata*. Thus, under the present experimental conditions, *C. procera* extract showed stronger inhibition than *A. squamosa* at all tested concentrations. Overall, the findings indicate that coriander seeds can harbour several storage-associated fungi, among which *A. niger* was the most frequently detected in the present study. Fungal infestation was accompanied by changes in the physical appearance and several chemical characteristics of the seeds and their oil. The botanical extracts, particularly *C. procera*, showed promising antifungal activity and therefore may have potential for further investigation as an economical and eco-friendly approach for managing fungal deterioration of stored coriander seeds.

REFERENCES

[1] Anonymous, *Cereal Laboratory Methods*, 5th ed. St. Paul, MN, USA: American Association of Cereal Chemists, 1947.

[2] Association of Official Agricultural Chemists (AOAC), *Official Methods of Analysis of the Association of Official Agricultural Chemists*. Washington, D.C., USA, 1947.

[3] Association of Official Agricultural Chemists (AOAC), *Official Methods of Analysis of the Association of Official Agricultural Chemists*. Washington, D.C., USA, 1960.

[4] Association of Official Agricultural Chemists (AOAC), *Official Methods of Analysis*, 9th ed. Washington, D.C., USA: AOAC, 1966.

[5] M. Baig, "Assessment of mycoflora of some spice from Aurangabad," *International Journal of Research and Technology Innovation (IJRTI)*, vol. 5, 2020.

[6] M. Baig and Farheen K. Khan, "Screening of pathogen associated with some spices," *Journal of Emerging Technologies and Innovative Research (JETIR)*, vol. 10, no. 7, 2023.

[7] S. Biswas, N. K. Das, S. M. H. Quadri, and B. Sarechandra, "Evaluating different plant extracts against three major diseases of mulberry," *Journal of Indian Phytopathology*, vol. 48, no. 3, pp. 342–346, 1995.

[8] C. M. Christensen, "Deterioration of stored grains by fungi," *The Botanical Review*, vol. 23, p. 108, 1957.

[9] J. De Tempe, "The blotter method of seed health testing," *Proceedings of the International Seed Testing Association*, 1953.

[10] J. De Tempe, "The blotter method of seed health testing," in *Proceedings of the International Seed Testing Association*, 1970.

[11] International Seed Testing Association (ISTA), "International rules for seed testing," *Proceedings of the International Seed Testing Association*, vol. 31, pp. 1–152, 1966.

[12] D. K. Jha, *A Manual of Seed Pathology*. New Delhi, India: Vikas Publishing House, 1993.

[13] Farheen K. Khan and M. Baig, "Evaluation of mycoflora of fenugreek seeds," *International Journal of Research and Technology Innovation (IJRTI)*, 2021.

[14] Farheen K. K. Khan and M. Baig, "Biodeterioration of *Foeniculum vulgare* Mill. seeds during storage by fungi," *International Journal of Innovative Research in Technology*, vol. 11, no. 12, pp. 5540–5543, 2025.

[15] O. H. Lowry, N. J. Rosebrough, A. L. Farr, and R. J. Randall, "Protein measurement with the Folin phenol reagent," *Journal of Biological Chemistry*, vol. 193, pp. 265–275, 1951.

[16] M. L. Meara, "The determination of oil in seeds and related materials," 1955.

[17] D. S. Mukadam, *The Illustrated Kingdom of Fungi: Some Selected Genera*. Aurangabad, India: Akshar Ganga Prakashan, 1997.

[18] P. Neergaard, *Seed Pathology*, vols. I–II. London, U.K.: The Macmillan Press Ltd., 1977.

[19] P. Neergaard and S. B. Mathur, *Seed Pathology*. Copenhagen, Denmark: Danish Government Institute of Seed Pathology for Developing Countries, 1980.

[20] P. Sharma and R. C. Dubey, "Antifungal activity of medicinal plants," *Journal of Applied Botany*, vol. 94, no. 2, pp. 123–131, 2021.

[21] A. Singh and M. Meena, "Post-harvest fungal spoilage in spices," *Mycological Research Today*, vol. 8, no. 1, pp. 45–52, 2020.

[22] C. V. Subramanian, *Hypomycetes*. New Delhi, India: Indian Council of Agricultural Research, 1971.

[23] H. Wangensteen, A. B. Samuelsen, and K. E. Malterud, "Antioxidant activity in extracts from coriander," *Food Chemistry*, vol. 88, no. 2, p. 293, 2004.

[24] J. Zenely and D. H. Coleman, "Method for determination of free fatty acids in oils," 1938.