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First report of storage rot in yam (*Dioscorea alata* L.) caused by *Junghuhnia* sp. AK15 in Odisha and its *in vitro* biocontrol strategies

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ABSTRACT

Dioscorea alata L. is well known for its starchy root tubers, which serve as both a staple food and a source of income in many tropical and subtropical regions, including Odisha. In Odisha, yam tubers hold significant importance in traditional Odia cuisine. However, due to the region's warm and humid climate, post-harvest decay of the tubers is commonly observed during storage. This decay leads to several serious issues, adversely impacting the agricultural economy and threatening the livelihoods of farmers. A fungal pathogen, *Junghuhnia* sp. AK15 was identified as being associated with post-harvest rot of yam (*D. alata*) tubers in Odisha. The incidence of infection was recorded at 27% among the collected tubers. The pathogen was found colonizing both injured and apparently healthy tuber surfaces. Although several fungal pathogens have been reported in association with yam storage rots, this is the first record of *Junghuhnia* sp. infecting *D. alata* tubers, making it a new host-pathogen association in Odisha. The isolate exhibited robust growth (100%) on both Sabouraud's dextrose agar and potato dextrose agar media. Under laboratory conditions, artificial inoculation of the pathogen in the healthy tubers caused the rotting of around 11% tubers among all the test tubers, but caused, on average, 48% of damage in each test tuber within 10 days of incubation. The *in vitro* antifungal efficacy of petroleum ether and methanolic leaf extracts from sixteen selected medicinal plants was assessed against *Junghuhnia* sp. AK15 is using the poisoned food technique. The plant extracts effectively inhibited fungal growth, with inhibition rates ranging from 18% to 100%, whereas four tested synthetic fungicides exhibited comparatively lower efficacy, ranging from 18.75% to 80%. Among the botanicals tested, the petroleum ether extracts of *Alstonia scholaris* and *Pongamia pinnata*, along with the methanolic extracts of *Ageratum conyzoides* and *Averrhoa carambola*, were the most effective at 20 mg/mL. The comparative analysis suggests that plant-based formulations may serve as promising biofungicidal alternatives to conventional chemical fungicides.

1. INTRODUCTION

Underground modified crops are plants with starchy roots; these are mostly used by humans as food [1]. In developing countries, these are important sources of food both for humans as well as animals. According to Scott *et al*., these rooted crops generate more carbohydrate per hectare per day and yield more energy than any other food crops, even under adverse growing conditions [2]. *Dioscorea alata* L. (yam), a member of the family Dioscoreaceae, is a twining climber characterized by its modified tuberous roots. The plant is dioecious, bearing male and female reproductive structures on separate plants, typically on axillary spikes. Male inflorescences are long, slender, and highly branched, whereas female spikes are comparatively shorter and less branched. Male flowers have six tepals and six stamens, which are positioned opposite the tepals. The female flowers also possess six tepals and contain a trilocular, inferior ovary topped with three bifid stigmas. The fruit develops as a capsule [3]. *D. alata* is ranked as the third most widely consumed tuber crop globally, following cassava and sweet potato [4]. At present, yam cultivation is reported in 61 countries, with African nations contributing approximately 98.20% of global production [5]. In 2021, total yam output reached 75 million tonnes, cultivated across more than 8.8 million ha of land [6]. In India, yam production stands at 8.10 lakh tonnes, covering an area of 30,000 ha. In India, the major yam-producing states include Andhra Pradesh, Gujarat, Kerala, Madhya Pradesh, Odisha, Tamil Nadu, and Uttar Pradesh [5]. In Odisha, *D. alata* is widely consumed and holds cultural and dietary significance across various regions of the state [7]. It acts as one of the major food and medicinal sources for rural and tribal people of Odisha [8]. Its tubers are rich in carbohydrates, protein, vitamins, and other nutrients [7,9,10]. After harvest, yams are usually stored at room temperature for a long time, but it is difficult to control its germination and post-harvest decay during storage [11]. During post-harvest storage, high temperature usually increases the severity of decay [12,13], and in Odisha, these crops face huge microbial decay

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due to its warm climatic conditions, which cause serious problems and sustain heavy losses. Okigbo and Ikediugwu in 2000 reported that around 20–39.5% storage decay of yams occurs because of microbes, whereas it was around 40% by the estimation of Bonire [8,14]. Among the microbes, fungi are mainly causal agents of post-harvest rotting of yams [15,16]. In general, farmers use different types of chemical fungicides to control the fungal decay of yam tubers for long-term post-harvest storage [17-21]. Despite knowing their negative impacts on health and the environment, these chemicals are still predominantly used by local farmers and agro-wholesalers in most of the developing countries [22]. However, now, the studies on the potential use of plants and their products have opened a new slant to control the microbe-based plant diseases. These are safe, non-toxic, eco-friendly, and sustainable ways to control the plant pathogens [23].

In view of this background, the objectives of this study were to isolate fungal pathogens associated with storage rots of yams, its morphological and molecular identification, followed by the study of their control using medicinal plants.

2. MATERIAL AND METHODOLOGY

2.1. Collection of Samples

A total of 280 yam tubers showing clear signs of rot – such as discoloration, mycelial growth, tissue decay, foul odour, and other indicative symptoms – were collected in three phases from various regions across Odisha, India. The affected tubers were individually placed in sterile polythene bags and transported to the Microbiology Laboratory at the Department of Botany, Utkal University, Bhubaneswar, Odisha, India, for further phytopathological analysis.

2.2. Isolation of Fungus

The collected tubers were initially washed with tap water and surface sterilized using 0.1% mercuric chloride solution for 2–3 min to eliminate surface contaminants. Of the 280 tubers collected, 58 exhibiting severe infections were selected for further study. Their symptomatology and morphological features were recorded. Each tuber was cut into small sections (5 × 5 mm) using a sterile knife, starting from healthy tissue and moving toward infected areas. Tissue fragments from the infected regions were plated onto potato dextrose agar (PDA, Hi-Media) and incubated at room temperature for 24–35 h. Representative fungal colonies were purified by subculturing onto fresh PDA plates. Pure cultures were maintained on PDA slants for subsequent cultivation. The frequency of fungal incidence was calculated using the formula: Frequency of incidence (%) = (X/Y) × 100, where X = number of tubers showing fungal growth, and Y = total number of tubers examined. All procedures were replicated 3 times, and the results were recorded for statistical accuracy.

2.3. Identification of Fungus

The isolated fungus was cultured on PDA plates for identification. Morphological characteristics were observed using the slide culture technique [24]. For molecular identification, genomic DNA was extracted from the fungal isolate [25], followed by amplification of the 26S rRNA gene with universal primers DF (5'-ACCCGCTGAACTTAAGC-3') and DR (5'-GGTCCGTGTTTCAAGACGG-3'). The amplified product was sequenced at Xcelris Genomics, India. The raw sequence data were analyzed using BioEdit software (v7.0.5.3), and the identity of the isolate was determined by BLAST (Basic Local Alignment Search Tool) against the NCBI nucleotide database (www.ncbi.nlm.nih.gov/nucleotide). Multiple sequence alignment was performed using the MUSCLE algorithm [26]. A phylogenetic tree was constructed using the UPGMA distance algorithm in Mega software v5.1, and its topology was validated through bootstrap analysis of the MUSCLE dataset with 500 resamplings. The final sequence was submitted to NCBI GeneBank for the assignment of an accession number.

2.4. Pathogenicity Test

A pathogenicity test was conducted to evaluate the virulence of the fungal isolate. A total of 160 fresh, healthy yam tubers were collected, washed, and surface sterilized using 0.1% mercuric chloride for 2–3 min. Cylindrical cores (5 mm) were removed from each tuber using a sterile cork borer. Each tuber received one inoculation site, into which a 4 mm PDA disc containing a 7-day-old fungal culture was inserted. The wounds were sealed with sterile Vaseline and wrapped in moist sterile cotton. Control tubers received PDA discs without fungal inoculum. All tubers were individually packed in sterile polythene bags and incubated at 28 ± 2°C for 10 days. Post-incubation, tubers were assessed for infection symptoms – weight loss, lesion diameter, mycelial growth, and odour [27]. For statistical robustness, three replicates of 50 tubers each (total = 150) were tested, along with 10 healthy tubers maintained as uninoculated controls. The presence of the pathogen was reconfirmed through morphological examination and microscopic re-isolation. Observed symptoms and the extent of decay were compared with those found in naturally infected tubers. The incidence of rot was calculated using the same formula: Incidence (%) = W/Z×100, where W represents the number of tubers showing rot, and Z represents the total number of inoculated tubers. Each replicate was analyzed independently. For tubers infected through artificial inoculation, pathogenicity (degree of rotting) was assessed by comparing the lesion diameter with the total surface area of each tuber and expressed as a percentage.

2.5. Nutritional Study

A comparative nutritional study was conducted to evaluate the effect of different solid nutrient media on the growth of the isolated fungus. The solid media tested included Czapek dox agar (CDA), Sabouraud dextrose agar (SDA), and PDA [22]. A piece of well-grown mature mycelium was placed at the center of the test petriplates carrying nutrient media and kept for 7 days at 28 ± 2°C inside the incubator [27].

2.6. Collection and Identification of Plant Material

In this investigation, the leaves of 16 medicinal plants were studied: *Ageratum conyzoides*, *Abutilon indicum*, *Artocarpus heterophyllus*, *Alstonia scholaris*, *Averrhoa carambola*, *Centella asiatica*, *Cassia fistula*, *Dillenia indica*, *Eucalyptus globulus*, *Haldina cordifolia*, *Justicia adhatoda*, *Lawsonia inermis*, *Murraya paniculata*, *Pithecellobium dulce*, *Pongamia pinnata,* and *Tamarindus indica*. These plants were collected from the Chandaka Reserve Forest area near Bhubaneswar, Odisha, India. The identification of voucher plant specimens was performed using available literature [28]. The specimens were preserved as herbarium samples and deposited in the Post-Graduate Department of Botany, Utkal University, Vani Vihar, Bhubaneswar, Odisha.

The collected leaves were processed in bulk. They were washed under running tap water, dried in the shade, and ground into a coarse powder. The powdered samples were then successively extracted with petroleum ether and methanol using a Soxhlet apparatus [29]. The extracts were concentrated under reduced pressure using a rotary evaporator and stored in desiccators for further use.

2.7. *In vitro* Control of Isolated Fungus

The *in vitro* antifungal activity of the isolated fungus was evaluated using both plant-based extracts and synthetic fungicides. For this purpose, petroleum ether and methanolic leaf extracts of the sixteen previously mentioned medicinal plants were tested. In parallel, the efficacy of synthetic fungicides Dhanustin, Mancozeb, Blitox-50, and Indofil was also assessed. Plant extract samples were prepared by dissolving three concentrations (20, 10, and 5 mg/mL) in dimethyl sulfoxide (DMSO). In contrast, synthetic fungicide solutions were prepared using sterile distilled water at a concentration of 0.05 mg/mL. The antifungal activity was determined using the poisoned food technique, following the method described by Satish *et al*. with slight modifications [30]. For treatment preparation, 1 mL of each diluted sample was added to 19 mL of molten PDA, and the mixture was poured into sterile petri plates (20 mL/plate) and allowed to solidify. PDA medium containing 1 mL of DMSO without any test sample served as the control. A 0.5 cm disc of the 7-day-old fungal culture was placed at the center of each plate, and the plates were incubated at 27°C for 5 days. Each treatment, including controls, was performed in triplicate to ensure reproducibility. The antifungal efficacy of each plant extract and fungicide was assessed by measuring the radial growth of fungal colonies (in cm). The percentage inhibition of fungal growth (zone of restriction) was calculated using the following formula [31]:

$$\% \text{ Inhibition} = [(A–B)/A] \times 100, \text{ where:}$$

- A = average increase in mycelial growth in the control,
- B = average increase in mycelial growth in the treatment (plant extracts).

3. RESULTS

3.1. Identification and Characterization of *Junghuhnia* sp. AK15

The fungus *Junghuhnia* sp. AK15 (GenBank accession number: KT946990; NCBI: txid1792223) was identified as the causal agent of post-harvest rot in yam tubers. In culture media, it exhibits a characteristic milky-white, velvety mycelial growth. Upon maturation, the culture produces numerous colourless spores, and the aging mycelium develops abundant pale-yellow, small oil globules [Figure 4a]. Microscopic observations revealed dimitic hyphal systems composed of clamped, sparingly branched, cyanophilous skeletal hyphae. The fungus also forms oval, smooth, colourless, and thick-walled basidia [Figure 4b]. Molecular identification based on sequence analysis showed 99% similarity with *Junghuhnia subundata* strain LR-38938 (GenBank accession number: AF518625) [Figure 3]. The detailed nucleotide sequence of *Junghuhnia* strain AK15 is presented in Figures 1 and 2. The taxonomic lineage of *Junghuhnia* sp. AK15 is as follows: Eukaryota; Fungi; Dikarya; Basidiomycota; Agaricomycotina; Agaricomycetes; Polyporales; Steccherinaceae; Junghuhnia; and strain AK15.

3.2. Frequency of Incidence *Junghuhnia* sp. AK15

Out of the total number of shortlisted yam tubers examined, an average of 15.91 ± 0.25 tubers showed infection by *Junghuhnia* sp. AK15, based on three replicates. Using the standard formula, the incidence of *Junghuhnia* sp. AK15 was calculated to be 27.44% [Table 1].

3.3. Pathogenicity Test

In the artificial pathogenicity test, 17 out of 150 inoculated yam tubers developed rot symptoms caused by *Junghuhnia* sp. AK15,

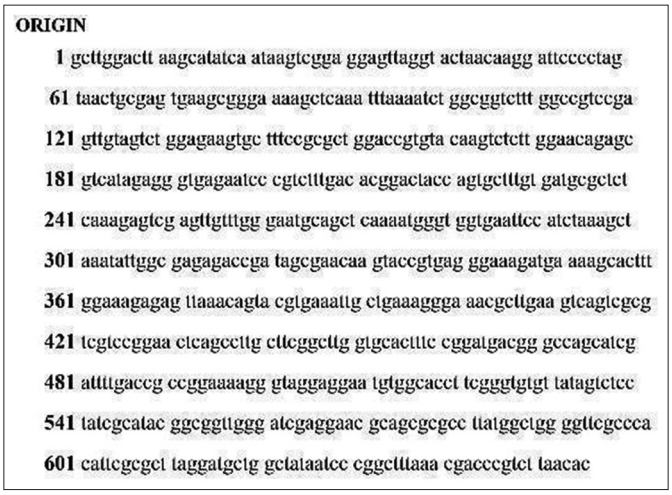

Figure 1: 26S Ribosomal RNA nucleotide sequence of *Junghuhnia* sp. AK15 (< 1 >656).

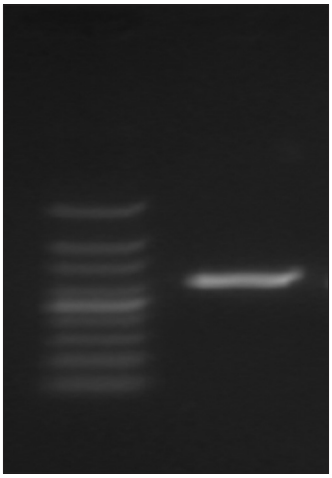

Figure 2: Visualization of the 26S rDNA band of *Junghuhnia* sp. AK15 by the gel documentation system.

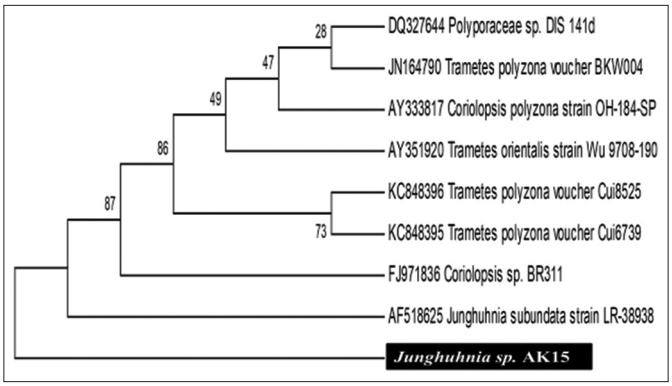

Figure 3: Phylogenetic tree of *Junghuhnia* sp. AK15.

corresponding to an infection rate of 11% [Table 2]. However, detailed examination revealed that each infected tuber exhibited an average rot severity of approximately 48% [Table 3]. All infected tubers displayed morphological characteristics and symptoms identical to those observed in naturally infected specimens. These symptoms included the formation of a dense, white, velvety mycelial mat on the tuber

surface, accompanied by a sticky exudate ranging in colour from dirty white to light pinkish [Figure 5]. Panel *et al*. described various types of rotting symptoms in yams, including: crumbling of the underlying bark tissues in dry rot; softening of internal tissues with a brownish to pinkish discoloration in soft rot; and water-soaked, dirty white pulp with internal tissue softening in watery rot [31].

3.4. Nutritional Study

Studies on the effect of three different solid nutrient media on the mycelial growth of *Junghuhnia* sp. AK15 revealed no significant variation in growth across the media [Figure 6]. In the comparative analysis, both PDA and SDA supported 100% mycelial growth, whereas CDA promoted 71.25% of the mycelial growth [Table 4].

Table 1: Frequency of incidence of *Junghuhnia* sp. AK15.

The number of tubers showed the presence of *Junghuhnia* sp. AK15	Total number of tubers investigated	Frequency of incidence (%)
15.91±0.25	58	27.44

Results expressed as mean±standard deviation of three determinations

Table 2: Frequency of incidence of *Junghuhnia* sp. AK15 from the pathogenicity test.

The number of tubers tubers infected by *Junghuhnia* sp. AK15 (W)	Total number of tubers taken for artificial inoculation of *Junghuhnia* sp. AK15 (Z)	Frequency of incidence (%)
17	150	11.33

Table 3: Extent of rotting of yam tubers in pathogenicity test.

Total Samples considered	Lesion diameter (cm)	Total surface area of tuber (cm)	Percentage of damage
17	3.19±1	6.68±2	48±4.7

Results expressed as mean±standard deviation of seventeen determinations

Table 4: Assessment of growth response of *Junghuhnia* sp. AK15 to three solid nutrient media.

Study organism	Mycelial growth rate percentage		
	Potato dextrose agar	Czapek dox agar	Sabouraud dextrose agar
Junghuhnia sp. AK15	100	71.17±2.07	100

Results expressed as mean±standard deviation of three determinations

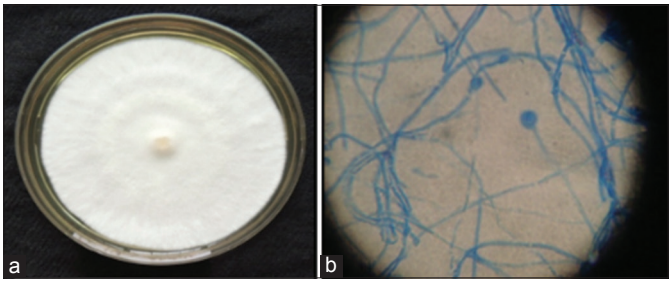

Figure 4: (a) Morphology of fungal colony, (b) Microscopic structure of *Junghuhnia* sp. AK15.

3.5. *In-vitro* Control of *Junghuhnia* sp. AK15

The antifungal activity of sixteen tested plant species, evaluated at three concentrations (20, 10, and 5 mg/mL), showed inhibition rates ranging from 18% to 100% against the isolated pathogen *Junghuhnia* sp. AK15. Notably, the petroleum ether extracts of *A. scholaris* and *P. pinnata*, as well as the methanolic extracts of *A. conyzoides* and *A. carambola*, achieved complete inhibition of fungal growth at 20 mg/mL [Figure 7]. Among the concentrations tested, 20 mg/mL consistently demonstrated the highest efficacy compared to 10 mg/mL and 5 mg/mL. Depending on the plant species, petroleum ether extracts were more effective in some cases, whereas methanolic extracts were superior in others. In contrast, synthetic fungicides exhibited varying levels of inhibitory activity [Figure 8]. Among the four fungicides tested, Mancozeb was the most effective against *Junghuhnia* sp. AK15, followed by Dhanustin, Indofil, and Blitox-50. Detailed inhibition percentages for both plant extracts and synthetic fungicides are presented in Table 5.

4. DISCUSSION

Although 26 species of *Junghuhnia* have been identified worldwide to date [32], the isolate *Junghuhnia* sp. AK15 represents a novel strain

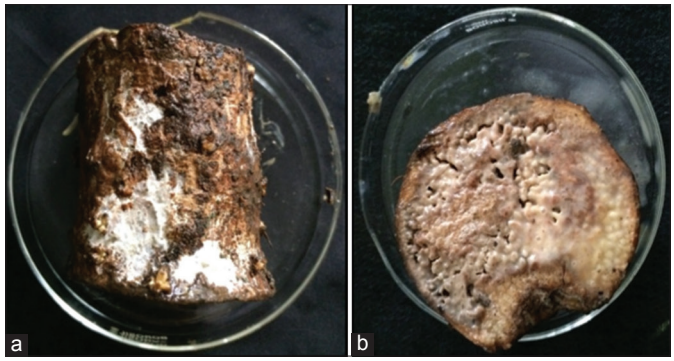

Figure 5: (a and b) Yam tubers showing rotten symptoms during the pathogenicity test.

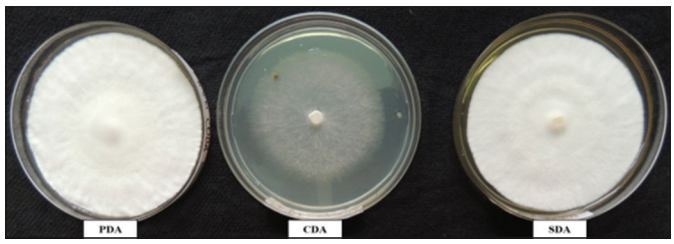

Figure 6: Growth of *Junghuhnia* sp. AK15 on different nutrient media.

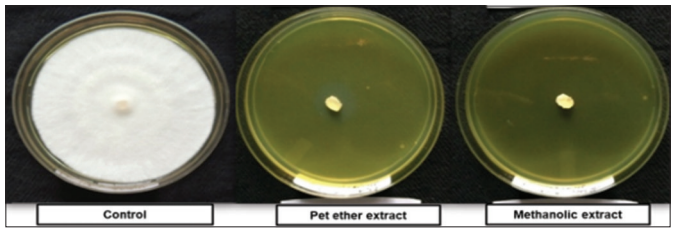

Figure 7: *In vitro* antifungal activity of plant extracts (petroleum ether extracts of *Alstonia scholaris*).

Table 5: Antifungal activity of test plant extracts and synthetic fungicides.

Sl. No.	Test plants	Common name	Family	Leaf extracts (mg/mL)	Inhibition of mycelial growth (%)	
					MET	PET
1.	*Averrhoa carambola* L.	Carambola	Averrhoaceae	20	99.66±0.27	98.93±0.42
				10	75.3±2.51	71.64±2
				5	43.64±1.52	35.64±1.52
2.	*Artocarpus heterophyllus* Lam.	Jackfruit	Moraceae	20	97±0.47	98.66±0.54
				10	62.65±1.52	63.91±4.58
				5	27.61±2	33.6±2.51
3.	*Alstonia scholaris* (L.) R.Br.	Devil's Tree	Apocynaceae	20	99.46±0.23	100
				10	70.63±2.51	72.96±2.64
				5	43.97±97	40.63±2
4.	*Ageratum conyzoides* L.	Goat weed	Asteraceae	20	100	98.13±0.38
				10	68.28±3	71.65±1.52
				5	36.99±1	30.92±2.64
5.	*Abutilon indicum* (L.) Sweet	Indian Mallow	Malvaceae	20	95.22±0.95	98.63±0.55
				10	65.31±2	55.62±2.51
				5	23.25±2.3	31.27±2.30
6.	*Cassia fistula* L.	Golden Shower Tree	Caesalpiniaceae	20	94.83±0.82	90.29±1.68
				10	60.3±2.51	67.99±1
				5	33.27±2.51	33.64±1.52
7.	*Centella asiatica* Urban.	Indian Pennywort	Apiaceae	20	93.93±1.66	90.33±1.18
				10	64.97±2	54.29±2.51
				5	32.95±2	27.66±0.5
8.	*Dillenia indica* L.	Elephant Apple	Dilleniaceae	20	94.66±1.08	91.66±0.72
				10	68.92±4	55.65±1.52
				5	26.27±2	20.77±1.89
9.	*Eucalyptus globulus* Labill	Eucalyptus	Myrtaceae	20	92±1.24	98
				10	54.31±1.52	63.31±2
				5	24.63±1.52	28.28±2
10.	*Haldina cordifolia* (Roxb.) Ridsdale	Haldu	Rubiaceae	20	92.59±1.24	91.58±1.25
				10	52.97±2	53.29±2.51
				5	36.96±2	40.99±1
11.	*Justicia adhatoda* L.	Malabar nut	Acanthaceae	20	94.66±0.72	94±0.81
				10	66.64±2	62.65±1.52
				5	34.6±2.51	41.29±2
12.	*Lawsonia inermis* L.	Henna	Lythraceae	20	95.63±0.25	90.33±0.72
				10	63.96±2.64	53.57±3.78
				5	29.61±2	31.46±1.8
13.	*Murraya paniculata* Jack.	Orange Jasmine	Rutaceae	20	94.72±0.67	93.78±0.99
				10	53.29±2.51	44.51±4.5
				5	33.64±1.52	26.98±1
14.	*Pongamia pinnata* (L.) Panigrahi	Karanj	Papilionaceae	20	94±0.81	99.66±0.27
				10	71.32±1.52	74.65±1.52
				5	33.92±2.64	38.64±1.52
15.	*Pithecellobium dulce* (Roxb.) Benth.	Manila	Mimosaceae	20	89.29±1.46	94.53±0.82
				10	52.95±2.64	61.99±1
				5	22.57±2.51	25.9±2.64

(*Contd...*)

Table 5: (*Continued*).

Sl. No.	Test plants	Common name	Family	Leaf extracts (mg/mL)	Inhibition of mycelial growth (%)	
					MET	PET
16.	*Tamarindus indica* L.	Tamarind	Caesalpiniaceae	20	95.59±0.77	93.28±0.68
				10	56.6±3.21	45.31±1.52
				5	22.6±2.08	18.94±1.73
	Test fungicides (0.05 mg/mL)	**Inhibition of mycelial growth (%)**				
1.	Dhanustin	76.24±1.33				
2.	Mancozeb	80.43±1.26				
3.	Blitox-50	17.79±0.24				
4.	Indofil	72.5±1.17				

MET: Methanolic plant extracts; PET: Petroleum ether plant extracts

Results expressed as mean±standard deviation of three determinations

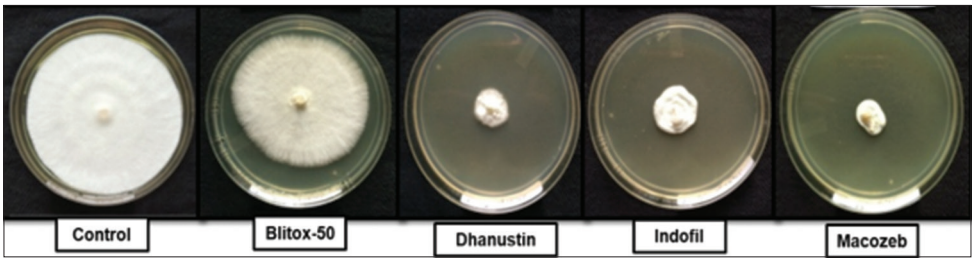

Figure 8: *In vitro* antifungal activity of synthetic fungicides.

within the genus. This study is the first to report *Junghuhnia* sp. AK15 as the causal agent of storage rot in yams (*D. alata* L.) in Odisha. Typically, *Junghuhnia* is known as a white-rot polypore fungus associated with wood decay [33], and has not previously been linked to tuber rot. However, earlier reports by Hood and Dick identified *Junghuhnia vincta* as pathogenic to *Pinus radiata* roots [34], whereas Taylor and Sale documented its association with roots of other coniferous and some dicotyledonous tree species [35]. The current isolation of *Junghuhnia* sp. AK15 from decaying yam tubers, corroborated through morphological and molecular identification, confirms a novel host-pathogen interaction. This finding broadens the known ecological niche and pathogenic potential of the genus, suggesting its adaptation to starchy, high-moisture substrates such as yam tubers.

In the present investigation, the isolate (*Junghuhnia* sp. AK15) was found to form a velvety white mycelial growth over the surface of infected yam tubers, producing dry rot symptoms. Traditionally, post-harvest rots in *Dioscorea* spp. have been attributed to a variety of fungal pathogens: *Rhizopus nigricans*, *Sclerotium rolfsii*, and *Mucor circinelloides* (soft rot); *Aspergillus tamarii*, *Botryodiplodia theobromae*, and *Penicillium oxalicum* (dry rot); and *Erwinia carotovora* (wet rot) [36].

Pathogenicity tests confirmed the ability of *Junghuhnia* sp. AK15 to initiate and propagate rot in healthy yam tubers under storage-like conditions, establishing it as a potential storage pathogen of economic importance. The study also assessed the *in vitro* antifungal efficacy of selected plant leaves as bio-control agents. Among the 16 tested species, *A. scholaris*, *P. pinnata*, *A. conyzoides*, and *A. carambola* exhibited strong antagonistic activity against *Junghuhnia* sp. AK15. This inhibitory effect is likely due to the presence of bioactive phytochemicals such as flavonoids, phenols, alkaloids, tannins, saponins, sterols, glycosides, anthraquinones, coumarin derivatives, leucoanthocyanidins, reducing sugars, simple phenolics, carbohydrates, fixed oils, terpenes, and phenylpropanoids [37-41].

This study contributes significantly to the understanding of post-harvest pathology in yams, especially in tropical and subtropical regions where warm, humid conditions favour tuber decay. The findings also offer promising avenues for developing eco-friendly, non-chemical management strategies. Biological control approaches are particularly advantageous for small holder farmers in regions such as Odisha, where yams are a key staple and income source, yet suffer considerable post-harvest losses due to rot. Even though the severity of infection by *Junghuhnia* sp. may be relatively low, its impact on tuber marketability is notable. Further research is essential to validate the efficacy of these bio-control agents under real-world storage and field conditions. Studies should explore the influence of environmental variables, formulation techniques, and application methods to ensure practical applicability. In addition, a deeper understanding of the life cycle and infection biology of *Junghuhnia* sp. yam tubers could guide the development of integrated and sustainable storage management practices.

5. CONCLUSION

The present study concludes that *Junghuhnia* sp. AK15 is responsible for causing storage rot in *D. alata* L. tubers under post-harvest storage conditions in Odisha, India. While the disease severity caused by the pathogen is relatively low, it remains significant as it reduces the market value of the tubers. Therefore, urgent attention is needed for its management. Both fungicides and plant extracts can effectively control the growth of this pathogen; however, fungicides pose risks to living organisms and have various side effects. In contrast, plant extracts, with no known adverse effects on the environment or health,

offer a safer alternative. Employing plant extracts instead of chemical fungicides would be more beneficial for the ecosystem and human health, ensuring a sustainable contribution of yam crops to food security and the national economy.

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7. AUTHORS' CONTRIBUTIONS

All authors made substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; took part in drafting the article or revising it critically for important intellectual content; agreed to submit to the current journal; gave final approval of the version to be published; and agreed to be accountable for all aspects of the work. All the authors are eligible to be an author as per the International Committee of Medical Journal Editors (ICMJE) requirements/guidelines.

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9. CONFLICTS OF INTEREST

The authors report no financial or any other conflicts of interest in this work.

10. ETHICAL APPROVALS

The work does not need any ethical appoval.

11. DATA AVAILABILITY

All data underlying the results is available as part of the article.

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