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ORIGINAL RESEARCH

Intramural Aeromycobiota in the Stored Husk in Arva Rice Mill, Wadsa, Gadchiroli

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ABSTRACT

The diversity of intramural aeromycobiota have been evaluated in the husk during storage in the Arva Rice Mill, Desaiganj of District- Gadchiroli, Maharashtra. About 1,804 fungal colonies representing 28 species and 13 genera have been isolated using CzA media. The study revealed that fungal counts peaked between July and October, corresponding with elevated humidity and temperature, while the lowest counts were recorded in May. The results underscore the significance of understanding the microbial environment in rice mills, as it directly impacts both food safety and health of mill worker. The study highlights the importance of monitoring fungal diversity in rice mills, offering essential insights for improving air quality management and implementing effective occupational health safety measures in the rice processing industry. These findings contribute to better practices for ensuring hygienic, contamination-free processing environments for rice production.

KEY WORDS: Aeromycobiota, Fungal diversity, Intramural environment, Husk, Rice mill.

INTRODUCTION

Rice is one of the most important staple foods in India significantly contribute to food security and economic stability (Singh *et al.,* 2021). The presence of rice mills in a particular area indicates the region's high rice productivity and agricultural prosperity (Sharma & Verma, 2022). Desaiganj, Wadsa, located in Gadchiroli district, Maharashtra, is a well-known region for rice production, housing numerous rice mills that play a crucial role in processing and supplying rice to various markets (Patil *et al.,* 2023). The operations of rice mills involve different sections where raw paddy is stored, processed, and converted into polished rice, generating several by-products such as husk, bran, and broken rice particles. Understanding the microbial environment in such mills is essential, as it directly affects the quality of processed rice and the health of workers exposed to airborne microorganisms (Kumar *et al.,* 2023).

The presence of airborne fungal spores in indoor environments, particularly in food processing units, has gained significant attention in recent years due to their implications in plant pathology, food spoilage, and health hazards. Various fungal species contribute to food contamination, leading to product deterioration, unpleasant odors, and discoloration of stored materials. Additionally, certain fungal spores pose a threat to human health, causing allergic reactions, respiratory issues, and other mycotoxin-related diseases (Jyoti & Malik, 2013; Sharma *et al.,* 2021). The aeromycoflora of indoor environments, especially in rice mills, is a crucial subject of study as these fungal propagules can influence occupational health and food safety standards.

Several studies have emphasized the importance of aerobiological monitoring in industrial and agricultural settings, particularly in regions where cereal processing is a major economic activity. Airborne fungal spores can lead to occupational diseases such as hypersensitivity pneumonitis, asthma, and sick building syndrome, significantly affecting the workforce involved in rice processing (Ananna *et al.,* 2013). The diversity of aeromycoflora in a rice mill environment is influenced by various factors, including humidity, temperature, ventilation, and the nature of stored materials. Therefore, assessing the fungal diversity in rice mills is vital for implementing effective preventive measures and improving air quality management strategies. The findings of study

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proposed will provide insights into the microbiological environment exist in rice mills which will help in implementing occupational health safety measures, ensuring a hygienic and contamination-free processing unit (Kumar *et al.,* 2023).

The present investigation aims to study the diversity of aeromycoflora in the husk Storage section of Arva Rice Mill Industry situated in Desaiganj, Wadsa, using volumetric sampler and Petri plate exposure methods over a period of two years, to obtain comprehensive data on dominant fungal species variations during different season.

MATERIAL AND METHODS

Selection of Sampling Sites of Aeromycoflora

The husk storage area of Shree Sai Arva Rice Mill, located on Lakhandur Road, Desaiganj, Wadsa, selected for the isolation of aeromycoflora. This site provides a unique environment for fungal growth due to the presence of organic matter, high humidity, and fluctuating temperatures. As fungi are cosmopolitan in distribution and thrive in diverse habitats, sampling from this area ensures a comprehensive representation of airborne fungal diversity associated with rice husk storage. To achieve a holistic understanding of the aeromycoflora prevalent in the study area, air sampling was systematically conducted inside the husk storage facility. The present study has been undertaken for two consecutive years *i.e.*, February 2022 to January 2023 & February 2023 to January 2024.

Sampling Equipments and Procedure

Air sampling in the husk storage portion of Rice Mill was undertaken using a Hi Air Sampler (Mark II) (HiMedia Laboratories, India) and the exposure plate method. Two intramural sampling stations were selected, considering controlled temperature, humidity, and limited air circulation, which favour microbial survival. Sampling was performed fortnightly on Czapek's Dox Agar (CDA) with streptomycin, having petri plates placed at a height of five feet and exposed for 24 hours. Plates were incubated at room temperature, and after 3-4 days, fungal colonies were observed, counted, and subcultured for identification (Sharma & Gugnani, 2020).

Identification of Fungal Species

Fungal identification was based on the morphological characteristics of spores and spore-bearing structures using direct microscopy. Cultures were examined at regular intervals, recording growth rate, colony colour, texture, and changes in pigmentation. The development of fruiting structures, including sporangia, perithecia, pycnidia, and sporodochia, observed along with the shape, size, and septation of spores. Colony identification was done using standard methods described earlier (Thom & Raper,1949; Barnett & Hunter, 1991; Smith, 1990; Ainsworth,1973; Ellis & Ellis,1971).

Data analysis

The isolated fungal colony counts were noted in the form of tabulated data and were further analyses for frequency, CFU/m ^{3} by using following formulas:

$$\text{CFU s/m}^3 = \frac{\text{colonies on agar strips x 25}}{\text{Sampling time in minutes}}$$

$$\text{Frequency} = \frac{\text{Number of individual colony}}{\text{Total number of all fungal colonies}} \times 100$$

Graphical and Statistical Analysis of Results

The recorded data statistically analyzed and presented in tabular and graphical formats using MS Office Excel (Version 13). Basic statistical parameters were applied to derive inferences aligned with the study's objectives and hypotheses. Graphs were plotted to visualize trends and patterns in the aeromycoflora distribution.

RESULTS

The study on indoor aeromycoflora in the husk (konda) storage area of Arva Rice Mill during 2022-23 showed 1,804 fungal colonies, with the highest counts between July and October and the lowest in May. The peak was observed in August 2022 (229 colonies, 12.69%), followed by September (219 colonies, 12.14%), July (189 colonies, 10.48%), and October (186 colonies, 10.31%), and colonies declined from November to May, and in May, 2022 the colonies were lowest (76 colonies, 4.21%. During second year (February 2023–January 2024), a total of 1,610

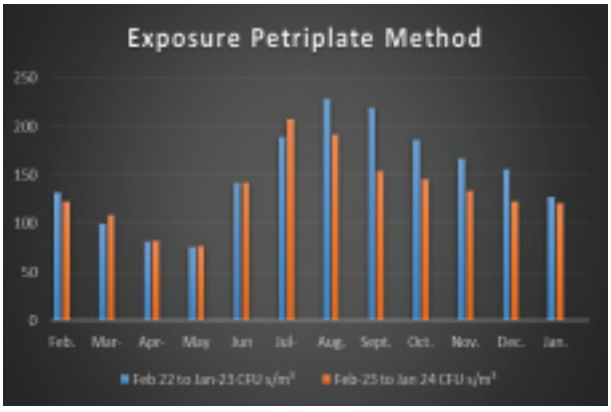

Fig. 1: Total number of fungal colonies recorded in Husk Storage Section Exposure Petri plate Method

fungal colonies have been isolated, with the highest number in July (207 colonies, 12.86%), followed by August (192 colonies, 11.93%) and September (154 colonies, 9.57%), while May 2023 the lowest (77 colonies, 4.78%) (Fig. 1).

Volumetric Air Sampler Method

During first year (Feb 2022–Jan 2023), the highest spore concentration was observed in August (2,290 CFUs/m³), followed by September (2,170 CFUs/m³), July (2,075 CFUs/m³), and October (1,990 CFUs/m³), while the lowest was in May (940 CFUs/m³). During 2023-24, the spore concentration peaked again in August (2,225 CFUs/m³), followed by September (2,150 CFUs/m³), while in May colonies were lowest (875 CFUs/m³) (Fig. 2).

Seasonal Variation

During monsoon season (June-September) number of colonies were highest and spore concentration using both the exposure petriplate and air sampler methods, followed by winter (October-January), while the lowest number of colonies observed during summer (Fig. 3).

DISCUSSION

The study on the indoor aeromycoflora in the husk storage area of Arva Rice Mill for the period from 2022 to 2024, offers significant insights into the seasonal variation of fungal colonies in such environments. The highest fungal counts observed in the months of July through October, and the lowest in May, aligned with the findings of other similar studies conducted in agricultural and food processing environments, where fungal colonization tends to follow seasonal patterns related to temperature and humidity fluctuations.

The present study suggests highest fungal counts between July and October and the lowest in May, closely align with observations from several other studies conducted in similar environments. This consistent seasonal variation in fungal contamination can be attributed to the influence of environmental conditions, particularly humidity and temperature essential for fungal proliferation.

The earlier study by Srinivasan *et al*. (2019), focused on fungal contamination in stored rice, the peak fungal counts were observed during the monsoon season, particularly between June and August. This mirrors the results of our study, where the months of July through October consistently recorded the highest fungal activity due to higher moisture level in the atmosphere and temperature during this period created favourable conditions for fungal species to thrive. The increased moisture in the air during the monsoon season provides the necessary environment for fungal spores to germinate and proliferate, leading to a higher number of fungal colonies in stored grains. The earlier observations are in accordance with the present study, where the peak fungal activity during the monsoon months correlates directly with the environmental conditions of elevated humidity and warmth promoted fungal growth.

Similarly, Kumar *et al.* (2020), have reported similar trend in rice mill environments, where fungal contamination peaked during the rainy season, particularly from July to October. This is in line with our findings, supporting the hypothesis that fungal contamination in storage areas is largely driven by climatic conditions. The wet and humid environment during the monsoon season creates optimal conditions for the growth of various fungal species, contributing to a higher prevalence of fungal colonies in

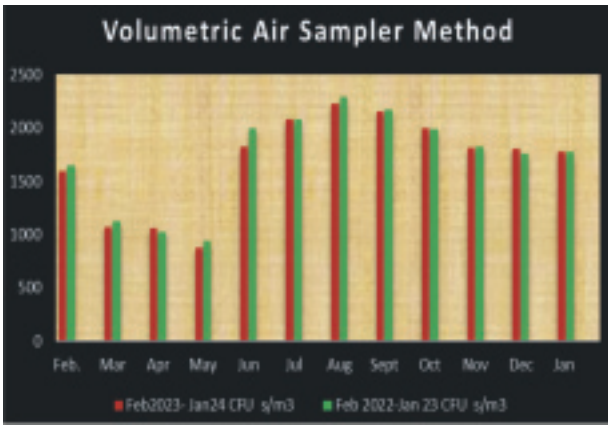

Fig. 2: Total CFUs/m³ Trapped in Husk Storage Section Volumetric Air Sampler Method

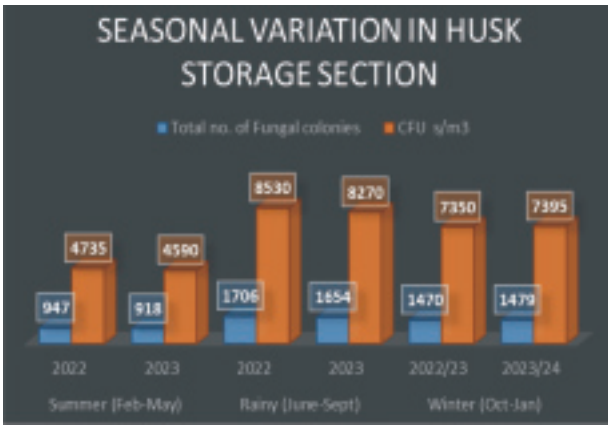

Fig. 3: Seasonal Variation in Husk Storage Section

stored rice. Such studies further affirm the direct relationship between high fungal activity and moisture-rich conditions, which play a crucial role in the distribution and growth of fungal colonies in storage environments.

Studies on fungal flora in the storage of grain mils Patil *et al.* (2018), also observed similar seasonal trend where fungal contamination peaked during the monsoon months, with a noticeable decline during the dry winter months. This drop-in fungal activity during the dry period is likely a result of the reduced ambient humidity and cooler temperatures, which are less conducive to fungal growth. The observations by Patil *et al.* (2018), strengthen the present study outcome which postulates the environmental factors are pivotal in determining the distribution of fungal colonies in storage areas. When conditions are dry and cool, fungal activity diminishes significantly, as seen in the lower fungal counts recorded from November to May in both years of our study.

The prevalence of specific fungal species have been highlighted by Singh &Shukla, (2015) during peak fungal activity periods, particularly Aspergillus and Penicillium. These genera are commonly associated with high humidity conditions and dominant fungal species in grain storage areas during rainy season. The moisture-rich environment of the monsoon months provides ideal conditions for these species to proliferate, which may explain the observed increase in fungal counts during the peak months in our study. Aspergillus is known to be a frequent contaminant in stored grains, contributing not only to the fungal load but also to potential mycotoxin production, which can affect the quality of stored food products.

In regions with more stable climates, Deshmukh *et al.* (2021), reported that, less pronounced seasonal variation in fungal contamination in the absence of extreme fluctuations in temperature and humidity throughout the year resulted in more stable fungal activity. However, the general trend of higher fungal counts in humid conditions and lower counts in dry months was consistent with our findings. This suggests that while climatic stability may reduce the intensity of seasonal fungal fluctuations, the fundamental relationship between humidity and fungal growth remains consistent across different geographical settings.

The contrast between regions with stable climates and those with more extreme seasonal changes highlights the adaptability of fungal species to varying environmental conditions. Even in regions with more moderate climates, fungal contamination tends to be higher during the rainy season due to the inherent increase in humidity. This further emphasizes the critical role that moisture plays in fungal colonization, not only in areas with pronounced seasonal changes but also in those with relatively stable climates. The decline in fungal counts from November to May, with May recording the lowest count in both the years, corresponds with the decrease in temperature and humidity during the winter months. These trends align with findings of Garg & Yadav (2017), who observed reduced fungal contamination in storage areas during the colder, drier months. The reduction in fungal colonies during this period can be attributed to the inhospitable environment created by lower relative humidity and cooler temperatures, which inhibit fungal growth.

However, the difference between the peak and trough counts between the two years was relatively minor, suggesting a consistent seasonal pattern in fungal proliferation. This consistency indicates that environmental factors, such as temperature and humidity, remain stable enough to influence fungal colonization similarly over the years. The slight decrease in fungal colonies in the second year could be attributed to a variety of factors, including minor changes in mill operation practices, storage conditions, or external environmental conditions, though these changes are not drastic enough to alter the general trend.

CONCLUSION

In conclusion, the study on indoor aeromycoflora in the husk storage area of Arva Rice Mill highlights the strong influence of seasonal fluctuations in temperature and humidity on fungal proliferation. The consistent peak in fungal counts during the monsoon months (July to October) and the decline in colder, drier months (November to May) aligns with findings from similar studies in agricultural and food processing environments. The results underscore the critical role of moisture in promoting fungal growth, while also demonstrating the stability of this seasonal pattern across two years, despite slight annual variations.

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