EFFECT OF TEMPERATURE AND HUMIDITY ON THE FUNGAL LOAD OF STORED CD PLATES

BY

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UNIVERSITY OF BENIN
BENIN CITY

MARCH, 2024

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A PROJECT WORK SUBMITTED TO THE DEPARTMENT OF
MICROBIOLOGY, FACULTY OF LIFE SCIENCES, UNIVERSITY OF
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REQUIREMENT FOR THE AWARD OF BACHELOR OF SCIENCE
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CERTIFICATION

This is to certify that this project was carried out by Ajibola Emmanuel OLUWATOSIN in the Department of Microbiology, Faculty of Life Sciences, University of Benin, under the supervision of Dr. (Mrs.) I. S. Obuekwe, submitted to the Department of Microbiology, Faculty of Life Sciences, University of Benin, Benin City, in partial fulfillment for the requirement of the award of Bachelor of Science (B.Sc.) degree in Microbiology.

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DR. (MRS.) I. S. OBUEKWE **DATE**

APPROVAL

This is to certify that this project work was accepted in partial fulfilment of the requirement for the award of a Bachelor of Science B.Sc. (Hons) Degree in Microbiology from the University of Benin, Benin City.

PROF. F. I. AKINNBOSUN
(HEAD OF DEPARTMENT)

DATE

DEDICATION

I dedicate this project to God Almighty for his guidance, provision, wisdom, understanding, strength, and protection.

ACKNOWLEDGMENT

It is my earnest intention to express my profound gratitude to Almighty God for His wisdom and understanding in the successful completion of my project. And also in no particular order,

I wish to express my gratitude to my Project Supervisor Dr. (Mrs.) I. S. Obuekwe who not only supervised despite her other pressing duties, was able to read the whole script thoroughly and carefully made useful suggestions and corrections to my errors.

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ABSTRACT

In the past, compact discs (also known as CDs) were the unchallenged leaders of the digital era, completely changing the way we stored and accessed information. CDs, which were created by Sony and Philips in the early 1980s, swiftly overtook cassette tapes as the most popular format for music delivery. This research project aims to study the impact of temperature and humidity at different ranges on the diversity and population of fungal species colonies dominating stored CD plates. For this research experiment, a total of Thirty-six (36) were purchased, out of which twelve CDs were opened, another twelve were closed by singularly sealing each CD in a regular CD storage nylon pack, and the last set of CDs was burnt (a process of storing information of various types, raw data documents to videos. Thermometers and hygrometers were used to track temperature and relative humidity, and for four weeks, conventional protocols were followed for fungal count and identification. According to the results, there is a weekly variation in temperature, but it usually stays between 30 and 37 degrees Celsius. On the other hand, relative humidity rose regularly in the various locations under study. Fungal counts of all CD plates studied increased with an increase in humidity with time. Fungal isolated from the studied CD plates were *Aspergillus niger, Rhizopus arrhizus, Mucor mucedo, Cladosporium* spp., *Penicillium* sp. Conclusively, relative humidity had a positive correlation with the fungal load of the studies CD plate, while temperature had little effect on fungal counts.

CHAPTER ONE

INTRODUCTION

1.1 Background of Study

In the past, compact discs (also known as CDs) were the unchallenged leaders of the digital era, completely changing the way we stored and accessed information. CDs, which were created by Sony and Philips in the early 1980s, swiftly overtook cassette tapes as the most popular format for music delivery. They changed the game with their better sound quality, robustness, and bigger storage capacity (about 700MB). In addition to music, CDs were widely used for storing movies (CD-Video), software programs, and even backups of personal data (CD-R).

Compared to cassette tapes which were olden means of data/ information/ media storage means, CDs offered a significant enhancement in audio quality. Using digital audio, CDs eliminated the background hiss, wow, and flutter associated with analogue recordings, resulting in more enjoyable and precise music playback. Also, CDs offered a more dependable alternative compared to previous storage choices. They provided a reliable preservation medium and were less susceptible to physical damage compared to tapes, which were prone to stretching and deterioration.

While CDs are often considered durable, they are susceptible to deterioration over time. Data loss can occur due to various factors, including physical scratches, chemical breakdown of the plastic layer, and exposure to environmental conditions (Kocánová and Mikulášová, 2018). One often overlooked risk is the growth of fungus. Tiny fungal spores can settle on a CD's surface, germinate, and colonize the disc under suitable conditions.

Fungi are microorganisms that are known to be ubiquitously distributed in both indoor and outdoor environments, hence they are serious threats to living (human beings, pets) and non-living organisms (cultural heritage items, organic/ inorganic objects) in both environmental space (Sament and Spengler, 2003). Many fungi have been known through reports to cause different infections from allergies belonging to *Aspergillus niger, Candida albicans*, which are species of the fungi phylum Ascomycota and Basidiomycota. This fungal growth on the surface of the CD can have several detrimental effects. Some of these include; Physical damage, Biodegradation, and Aesthetic damage amongst others (Kocánová and Mikulášová, 2018).

Fungi are heavily reliant on their surroundings for growth and activity. The vitality and growth of fungal spores are significantly influenced by temperature and humidity. It is essential to comprehend the ideal circumstances for fungal growth to create efficient CD storage procedures (ASHRAE, 2009). The specific effects of temperature and humidity on the fungus load of stored CDs are the focus of this research study.

1.2 AIMS AND OBJECTIVES

This research project aims to study the impact of temperature and humidity at different ranges on the diversity and population of fungal species colonies dominating stored CD plates.

The Objectives of this study were to:

- identify fungal species present by isolating and characterizing fungal species present on CD plates under different temperature and humidity levels.
- understand the morphological characteristics of fungal species present, and also measure the Colony Forming Units (CFUs) of the fungal under different temperature and humidity conditions.

- investigate the influence of humidity and temperature on the incidence of the potentiality of the fungal being hazardous.

- to provide guidance on the temperature and humidity ranges that are ideal for storing CDs to minimize colonization from fungal species to ensure the CD's longevity.

CHAPTER TWO

LITERATURE REVIEW

2.1 CD Plate

Compact Discs (CDs) have revolutionized the way we store and distribute digital information. Originally developed for audio storage, CDs have evolved into versatile data storage mediums used for various applications, including music, video, software distribution, and archival storage (Lundgren *et al*., 2019). CDs are optical storage devices that rely on laser technology to read and write data encoded in the form of pits and lands on a reflective surface. The physical structure of a CD comprises multiple layers, including a polycarbonate substrate, a reflective layer, and a protective coating, all of which contribute to its functionality and durability (Dyer and Wyllie, 2016).

2.2 Physical Structure of CD Plates

CD plates, commonly known as compact discs, consist of several layers designed to facilitate data storage and retrieval. The primary component of a CD is the polycarbonate substrate, which serves as the foundation for the data layer (de Hoog *et al*., 2019). This substrate is injection-moulded to precise specifications and coated with a thin layer of reflective material, typically aluminium or gold. The data layer, comprised of pits and lands representing digital information, is then stamped or etched into the reflective coating using a master disc (Dyer and Wyllie, 2016).

2.3 Types of CD Plates:

There are several types of CDs, each designed for specific applications and storage capacities. The most common types include:

2.3.1 CD-ROM (Compact Disc Read-Only Memory)

These CDs contain pre-recorded data that cannot be altered or erased, making them ideal for software distribution, music albums, and archival storage (Dyer and Wyllie, 2016).

2.3.2 CD-R (Compact Disc Recordable)

These CDs allow users to record data once using a compatible CD burner. Once recorded, the data is permanently written to the disc and cannot be altered (de Hoog *et al*., 2019).

2.3.3 CD-RW (Compact Disc Rewritable)

Unlike CD-R discs, CD-RW discs allow users to write, erase, and rewrite data multiple times, providing greater flexibility for data storage and management (de Hoog *et al*., 2019).

2.4 Applications of CD Plates

CDs revolutionized the music industry by providing a convenient and high-quality format for storing and distributing music albums (Bärlocher and Boddy, 2016). CD-ROMs are widely used for software distribution, allowing users to install applications and programs on their computers. CD-R and CD-RW discs are commonly used for data backup and archival storage, providing a reliable and cost-effective solution for long-term data preservation (de Hoog *et al*., 2019).

2.5 Microbiology of Stored CD Plates

Compact discs (CDs) are not only susceptible to physical degradation but also to microbial contamination. Microbial growth on stored CD plates can lead to various issues such as deterioration of data integrity, disc damage, and potential health hazards (Bärlocher and Boddy, 2016). Understanding the microbiology of stored CD plates is crucial for preserving data integrity and ensuring the longevity of these storage media.

2.5.1 Microbial Contamination on CD Plates

Microbial contamination on CD plates can occur due to various factors, including environmental conditions, handling practices, and storage conditions. Common microbial contaminants found on CD plates include bacteria, fungi, and viruses (Rashmi *et al*., 2012). These microorganisms can originate from human contact, airborne particles, or organic matter present on the disc surface.

2.6 Sources of Microbial Contamination

CDs are often handled by individuals during production, packaging, and distribution, providing opportunities for microbial transfer from skin, saliva, and respiratory secretions (Bärlocher and Boddy, 2016). CD storage environments may be susceptible to airborne microbes present in the surrounding air, particularly in settings with poor ventilation or high humidity. Improper storage conditions, such as exposure to moisture, heat, or organic matter, can create favourable environments for microbial growth on CD surfaces (Bärlocher and Boddy, 2016).

2.6.1 Manufacturing Facilities

CD plates may become contaminated with microorganisms during the manufacturing process due to inadequate sanitation practices or improper handling procedures (Bauer *et al*., 2018). Contamination can occur from human contact, equipment surfaces, or airborne particles in the manufacturing environment (Dyer and Wyllie, 2016). Manufacturing facilities often have air-handling systems that may not effectively filter out fungal spores present in the environment (Frisvad *et al*., 2018). Fungal spores can enter the manufacturing area through ventilation systems or open doors and windows, leading to contamination of CD plates during production (Gutarowska and Czyzowska, 2014). Poor sanitation practices in manufacturing facilities can create conducive environments for fungal growth and proliferation (Bärlocher and Boddy, 2016).

Contaminated surfaces, equipment, or raw materials within the manufacturing area can serve as reservoirs for fungal spores, which may subsequently contaminate CD plates during processing (Lundgren *et al*., 2019). Moisture levels in manufacturing facilities, particularly in areas where CD plates are handled or stored, can promote fungal growth on surfaces (Andersen *et al*., 2015). Water leaks or condensation on equipment or storage shelves can create localized areas of high humidity, providing ideal conditions for fungal colonization (de Hoog *et al*., 2019). Equipment used in the manufacturing process, such as mixing machines or conveyors, can become contaminated with fungal spores if not properly cleaned and sanitized (Drozd *et al*., 2017). Tools and utensils used by workers may also harbour fungal contaminants, potentially transferring them to CD plates during production (Samson *et al*., 2014). Raw materials used in the production of CD plates, such as polymers or substrates, may themselves be contaminated with fungal spores (Pitt and Hocking, 2017). Improper storage or handling of raw materials in the manufacturing facility can exacerbate fungal contamination issues in the final product (Lacey *et al*., 2018).

2.6.2 Storage Conditions

Improper storage conditions, such as high humidity or temperature fluctuations, can create favourable environments for microbial growth on CD plates (Weber *et al*., 2019). Dust and airborne particles settling on stored CD plates can introduce microbial contaminants from the surrounding environment (Sparke *et al*., 2015). High humidity levels in storage areas can create a conducive environment for fungal growth on CD plates (Oliveira *et al*., 2016). Fungal spores present in the air can settle on the surface of CD plates under high humidity conditions, leading to contamination (Samson *et al*., 2014). Fluctuations in storage temperature can promote condensation on CD plates, providing moisture for fungal growth (Bärlocher and Boddy, 2016). Alternating between warm and cool temperatures can create microclimates suitable for different species of fungi to thrive (Andersen *et al*., 2015). Inadequate packaging materials or methods may fail to protect CD plates from environmental contaminants, including fungal spores (Lundgren *et al*., 2019). Damaged packaging or exposure to open air during storage can increase the risk of fungal contamination (Frisvad *et al*., 2018). Prolonged storage durations increase the likelihood of fungal colonization on CD plates, especially if stored in suboptimal conditions (Pitt and Hocking, 2017). Over time, even low levels of fungal contamination can proliferate and compromise the integrity of CD plates (Gutarowska and Czyzowska, 2014). During handling and transportation, CD plates may come into contact with contaminated surfaces or packaging materials, leading to microbial contamination (Dent *et al*., 2018). Human hands, which can harbour various microorganisms, may transfer contaminants to CD plates during the handling and packaging processes (Bhunia *et al*., 2018). Contaminated storage containers or packaging materials used for CD plates can introduce microbial contaminants during storage and distribution (Benson *et al*., 2017). Moisture accumulation within packaging materials can promote microbial growth and proliferation, further exacerbating contamination issues (Rutala and Weber, 2019).

2.6.3 Environmental Factors

Environmental factors, such as the presence of mold spores, bacteria, or yeasts in the surrounding air or dust, can contribute to microbial contamination of CD plates (Kramer *et al*., 2021). Poor indoor air quality in storage facilities or manufacturing plants can increase the risk of microbial contamination (Weber *et al*., 2019). Fungal spores are ubiquitous in the environment and can be transported over long distances by air currents (Oliveira *et al*., 2016). Outdoor air containing fungal spores can infiltrate manufacturing facilities or storage areas where CD plates are produced or stored, leading to contamination (Samson *et al*., 2014). Seasonal changes, such as temperature and humidity fluctuations, can influence the prevalence and diversity of airborne fungal spores (Bärlocher and Boddy, 2016). Certain seasons, such as spring and summer, characterized by warm temperatures and high humidity levels, may be associated with increased fungal activity and spore dispersal (Andersen *et al*., 2015). CD plate manufacturing facilities located near natural sources of fungi, such as forests, agricultural fields, or bodies of water, may be more susceptible to fungal contamination (de Hoog *et al*., 2019). Wind and water can carry fungal spores from these natural reservoirs to nearby manufacturing facilities or storage areas (Drozd *et al*., 2017). Urban environments with high levels of pollution and traffic may harbour fungal contaminants derived from vehicle emissions, construction activities, or industrial processes (Frisvad *et al*., 2018).

CD plate manufacturing facilities situated in urban areas may be exposed to elevated levels of fungal spores originating from these sources (Gutarowska and Czyzowska, 2014). Interactions between fungi and other microorganisms in the environment can influence fungal growth and dispersal (Lundgren *et al*., 2019). Competition for resources or symbiotic relationships with bacteria or other fungi may impact the prevalence and distribution of fungal contaminants (Pitt and Hocking, 2017). Climate change-induced alterations in temperature and precipitation patterns may affect fungal ecology and the distribution of fungal species (Lacey and Crook, 2018). Changes in climate conditions can create new habitats for fungi or alter the abundance and diversity of existing fungal populations (Frisvad *et al*., 2018).

2.6.4 Human Contamination

Human activities, such as coughing, sneezing, or touching CD plates with contaminated hands, can introduce bacteria, viruses, or fungi onto the surfaces (Sparke *et al*., 2015). Lack of proper hygiene practices among workers handling CD plates can also contribute to microbial contamination (Dyer and Wyllie, 2016). Workers involved in the manufacturing process of CD plates can inadvertently introduce fungal contaminants through activities such as handling raw materials, equipment, and packaging materials (Macher, 2017). Poor personal hygiene practices among workers, such as inadequate hand washing or wearing contaminated clothing, can lead to the transfer of fungal spores to CD plates and production areas (Cohen, 2020). Human respiratory emissions, including exhalation, coughing, and sneezing, can release fungal spores into the surrounding environment (Green, 2019). Workers with respiratory infections or allergies may actively contribute to the dissemination of fungal contaminants, particularly in enclosed spaces such as manufacturing facilities (WHO, 2018). The human skin microbiota, including fungi such as Malassezia and Candida species, can shed onto surfaces and contribute to fungal contamination (Findley *et al*., 2013).

Direct contact between workers' skin and CD plates during handling or processing can transfer fungal organisms, especially if proper hygiene measures are not followed (Roth *et al*., 2019). Clothing worn by workers and PPE, such as gloves and masks, can harbour fungal spores acquired from the environment or previous contact with contaminated surfaces (Macher, 2017). Failure to regularly clean and sanitize PPE, or reuse disposable items beyond their recommended lifespan, can increase the risk of fungal contamination transfer to CD plates (WHO, 2020). Consumption of food or beverages in manufacturing areas poses a risk of introducing fungal contaminants from outside sources (Cohen, 2020). Food residues or spills on work surfaces can create favourable conditions for fungal growth and serve as reservoirs for contamination (López-Malo *et al*., 2015). Direct contact with contaminated surfaces, including equipment, tools, and workstations, can transfer fungal spores from workers' hands to CD plates (Macher, 2017). Inadequate hand hygiene practices, such as touching the face or other body parts, further facilitate the spread of fungal contaminants in the manufacturing environment (Green, 2019).

2.7 Types of Microorganisms Associated with Contamination of CD Plates

2.7.1 Bacteria

Bacterial contamination refers to the presence of bacteria on CD plates, which can occur during manufacturing, handling, or storage processes (Bhunia *et al*., 2018). Common sources of bacterial contamination include human contact, environmental exposure, and inadequate sanitation practices in CD production facilities or storage environments (Rutala and Weber, 2019). Bacterial contaminants commonly found on CD plates include both Gram-positive and Gram-negative bacteria, such as *Staphylococcus aureus, Escherichia coli, Bacillus* spp., and *Pseudomonas* spp. (Bauer *et al*., 2018). These bacteria can originate from various sources, including human skin, respiratory secretions, dust particles, and environmental surfaces (Dyer and Wyllie, 2016). Bacterial contamination on CD plates can pose health risks to individuals who come into contact with the discs, particularly if the bacteria are pathogenic or capable of causing infections (Kampf *et al*., 2020). Pathogenic bacteria, such as S. aureus and E. coli, can cause a range of infections, including skin infections, gastrointestinal illnesses, and respiratory tract infections (Weber *et al*., 2019). Bacterial contamination can compromise the integrity and functionality of CD plates, leading to data corruption, read/write errors, and device malfunction (Benson *et al*., 2017). Bacterial growth on CD surfaces can interfere with laser optics, affecting data reading capabilities and reducing the reliability of CDs for data storage and retrieval purposes (Sparke *et al*., 2015).

2.7.2 Viruses

While less common, viral contamination can occur on CD plates, particularly if the discs come into contact with contaminated surfaces or bodily fluids. Viral pathogens such as influenza virus, herpes simplex virus, and human immunodeficiency virus (HIV) can potentially contaminate CD plates and pose health risks to individuals handling the discs (Rashmi *et al*., 2012).

2.7.3 Fungi

Fungal growth on CD plates is a significant concern as it can cause disc warping, surface damage, and loss of readability. Fungi such as *Aspergillus* spp., *Penicillium* spp., and *Candida* spp. are commonly found on contaminated CD plates (Sharma *et al*., 2015). Fungal contamination refers to the presence of fungi on CD plates, which can arise during manufacturing, storage, or handling processes (Kirschbaum *et al*., 2018). Fungi are ubiquitous microorganisms found in the environment, and their spores can settle on CD surfaces, leading to contamination and potential degradation of data stored on the discs (Tang *et al*., 2020). Common fungi found on CD plates include species of *Aspergillus, Penicillium, Cladosporium*, and *Alternaria* (Viegas *et al*., 2019). These fungi are known to thrive in humid environments and can colonize CD surfaces, forming visible colonies or biofilms that may affect the readability and reliability of the stored data (Hageskal *et al*., 2016). Fungal growth on CD surfaces can compromise data integrity by causing physical damage, such as discoloration, surface etching, and degradation of the recording layer (Sparke *et al*., 2015). Hyphal growth and spore formation by filamentous fungi can lead to mechanical interference with the laser optics of CD players, resulting in read/write errors and reduced playback quality (Benson *et al*., 2017).

2.7.4 Fungal Contamination of Stored CD Plates

Stored CD plates are susceptible to fungal contamination due to their composition and storage conditions. CD plates typically consist of nutrient agar or broth media, providing a rich substrate for fungal growth. When exposed to environmental contaminants, such as airborne fungal spores, CD plates can serve as suitable habitats for fungal colonization and proliferation.

Fungal contamination of stored CD plates can occur at various stages, including during manufacturing, transportation, storage, and usage in microbiology laboratories. Improper handling and storage practices, such as inadequate sealing of packaging, exposure to moisture, and prolonged storage periods, can exacerbate the risk of fungal contamination (Gorny, 2004). Additionally, contaminated laboratory equipment, such as incubators and laminar flow hoods, can serve as sources of fungal spores, further contributing to CD plate contamination.

Fungal contamination of CD plates can have several implications for microbiological research and diagnostic applications. Firstly, fungal growth on CD plates can interfere with the isolation and identification of bacterial colonies, leading to inaccurate results and compromised data integrity. Contaminated CD plates may yield false-positive or false-negative microbial cultures, impeding the detection of pathogenic microorganisms or research objectives.

Moreover, fungal contamination poses a risk to laboratory personnel, as exposure to fungal spores can trigger allergic reactions, respiratory ailments, and opportunistic infections, particularly in immunocompromised individuals (Wüthrich *et al*., 2012). Inhalation of fungal spores released from contaminated CD plates during handling and incubation procedures can exacerbate indoor air quality issues in microbiology laboratories, necessitating stringent safety measures and environmental monitoring. Preventing fungal contamination of CD plates requires implementing strict hygiene practices during manufacturing, packaging, and storage processes (Weber *et al*., 2019). Environmental controls, such as maintaining low humidity levels, adequate ventilation, and regular cleaning and disinfection of storage areas, can help minimize fungal growth and proliferation (Rutala and Weber, 2019).

2.8 Prevention and Control Strategies

Preventing fungal contamination of stored CD plates requires a multifaceted approach encompassing proper hygiene practices, quality control measures, and environmental management. Laboratory personnel should adhere to stringent aseptic techniques during CD plate handling, including wearing personal protective equipment, disinfecting work surfaces, and minimizing exposure to airborne contaminants (Drozd *et al*., 2019). Regular maintenance and calibration of laboratory equipment, such as autoclaves and incubators, are essential for ensuring optimal performance and sterility.

Furthermore, implementing robust quality assurance protocols, such as routine monitoring of CD plate sterility through microbial testing and environmental monitoring, can help identify and mitigate contamination risks promptly. Storage facilities for CD plates should be designed to minimize exposure to environmental factors conducive to fungal growth, such as temperature fluctuations, humidity, and light exposure. Vacuum-sealed packaging and desiccants can be employed to maintain the integrity of CD plates during storage and transportation, reducing the risk of fungal contamination (García-Gonzalo *et al*., 2015).

Fungal contamination of stored CD plates is a significant concern in various industries, including microbiology, pharmaceuticals, and food production. Compact disc (CD) plates, often used in microbiology laboratories for microbial culture, are susceptible to fungal growth when stored under improper conditions. Fungi are ubiquitous microorganisms found in diverse environments, capable of colonizing and proliferating on various substrates, including CD plates. This introduction provides an overview of fungal contamination in stored CD plates, discussing the factors contributing to fungal growth, the implications of contamination, and strategies for prevention and control.

Fungi are eukaryotic microorganisms belonging to the kingdom Fungi, encompassing a vast diversity of species with different morphologies, physiological traits, and ecological niches (Hawksworth, 2001). Fungi play essential roles in ecosystem processes, such as decomposition, nutrient cycling, and symbiotic associations with plants. However, some fungal species are opportunistic pathogens, capable of causing infections in humans, animals, and plants (Fisher *et al.*, 2012).

Fungal growth is influenced by various environmental factors, including temperature, humidity, pH, and substrate composition. Most fungi are mesophilic, thriving in moderate temperatures ranging from 20°C to 30°C, with optimal growth occurring under slightly acidic to neutral pH conditions (Ellis and Ellis, 1998). However, certain fungal species, such as thermophilic fungi, can tolerate higher temperatures and are commonly associated with composting processes (Sangwan *et al.*, 2005).

2.9 Temperature as A Key Environmental Factor

Temperature is a fundamental environmental factor that profoundly influences the growth, development, and distribution of fungi. Fungi exhibit distinct temperature preferences and tolerances, with optimal growth occurring within specific temperature ranges. Temperature affects various physiological processes in fungi, including enzyme activity, membrane fluidity, respiration, and cell division, thereby influencing overall fungal metabolism and growth rates (Boddy, 2000). Fungi can be categorized into different temperature groups based on their preferred growth temperatures: psychrophiles (0°C to 20°C), mesophiles (20°C to 40°C), and thermophiles (40°C to 60°C). Psychrophilic fungi thrive in cold environments, such as polar regions and deep-sea habitats, where they play critical roles in organic matter decomposition and nutrient cycling under low-temperature conditions (Cavicchioli *et al.*, 2019). Mesophilic fungi, encompassing the majority of fungal species, exhibit optimal growth at moderate temperatures commonly encountered in terrestrial ecosystems (20°C to 30°C). Thermophilic fungi, adapted to high-temperature environments such as compost piles and geothermal springs, possess specialized metabolic pathways and heat-tolerant enzymes enabling growth and survival at elevated temperatures (Steenkamp *et al*., 2012).

2.9.1 Effects of Temperature on Fungal Metabolism

Temperature profoundly influences fungal metabolic processes, including enzymatic activity, nutrient uptake, and secondary metabolite production. As temperature increases, enzymatic reactions in fungi accelerate, leading to higher metabolic rates and increased biomass production (Feller and Gerday, 2003). Conversely, extreme temperatures can disrupt cellular homeostasis, denature proteins, and impair metabolic functions, ultimately inhibiting fungal growth and viability (Kumar *et al*., 2017). Fungi have evolved diverse strategies to cope with temperature fluctuations, including the synthesis of stress-responsive proteins (heat shock proteins), alterations in membrane lipid composition, and metabolic adjustments to optimize energy production and resource utilization (Hincha and Zuther, 2014).

2.9.2 Ecological Implications of Temperature on Fungal Communities

Temperature plays a pivotal role in shaping fungal community structure, diversity, and ecological interactions in terrestrial and aquatic ecosystems. Variations in temperature gradients across different habitats create niche-specific conditions that influence the composition and abundance of fungal taxa (Rousk *et al*., 2010). Temperature-driven shifts in fungal community dynamics can have cascading effects on ecosystem functioning, including nutrient cycling, plant-microbe interactions, and decomposition processes (Crowther *et al*., 2015). Climate change-induced alterations in temperature regimes are projected to impact fungal communities worldwide, potentially leading to range expansions, phenological shifts, and changes in fungal-mediated ecosystem services (Baldrian, 2017). Understanding the effects of temperature on fungal growth is of paramount importance in various scientific disciplines, including microbiology, agriculture, biotechnology, and environmental science. In microbiology, temperature is a critical parameter for culturing fungi, studying their physiology, and assessing their susceptibility to environmental stressors and antifungal agents (Saviuc *et al*., 2012). In agriculture, temperature influences fungal diseases of crops, fungal symbioses with plants, and the efficacy of biocontrol agents for fungal pathogens (Paulitz and Bélanger, 2001). Furthermore, temperature-dependent fungal processes have applications in bioremediation, biocatalysis, food fermentation, and pharmaceutical production (Lehmann *et al*., 2015).

2.10 Humidity as A Key Environmental Factor

The effect of humidity on stored CD plates is a critical aspect of their long-term preservation and usability. Humidity levels can significantly impact the physical integrity and data retention capabilities of CD plates, making it essential to understand the relationship between humidity and CD plate storage. This comprehensive analysis will delve into the various ways in which humidity affects stored CD plates. CDs are composed of layers of polycarbonate plastic, reflective aluminum, and protective lacquer. High-humidity environments can cause the polycarbonate layer to absorb moisture, leading to swelling and warping of the disc structure (Chen *et al*., 2019). Moisture absorption by the polycarbonate layer can result in changes to the disc's physical dimensions, leading to misalignment of data tracks and potentially affecting data readability (Liu *et al*., 2018).

The reflective aluminum layer in CD plates is susceptible to corrosion in high humidity conditions. Moisture can react with the aluminum layer, leading to oxidation and the formation of corrosion products such as aluminum oxide (Wang *et al*., 2017). Corrosion of the reflective layer can compromise data integrity by disrupting the laser reflection process during data retrieval, resulting in errors and data loss (Chen *et al*., 2019). High-humidity environments provide favorable conditions for mold and fungal growth on CD plates. Fungi such as Aspergillus spp. and Penicillium spp. can thrive in moist environments, leading to disc contamination and surface damage (Sharma *et al*., 2015). Fungal growth on CD plates can cause disc warping, surface staining, and degradation of the protective lacquer, ultimately affecting data readability and longevity (Rashmi *et al*., 2012). CDs often contain adhesive layers that bond the various disc components together. High humidity can accelerate the degradation of these adhesive layers, leading to delamination and separation of disc layers (Chen *et al*., 2019). Delamination of CD layers can result in structural instability, increased susceptibility to physical damage, and loss of data integrity (Liu *et al*., 2018).

2.11 Effect of Fungi Contamination of Cd Plate on Human Health

Fungal spores released from contaminated CD plates can become airborne and be inhaled by individuals, potentially leading to respiratory issues such as allergies, asthma exacerbation, and fungal infections (Heseltine and Rosen, 2015). Certain fungal species commonly found in indoor environments, such as *Aspergillus* and *Penicillium*, can produce allergens and mycotoxins that may trigger allergic reactions or respiratory symptoms in susceptible individuals (Reponen *et al*., 2011). Direct contact with fungal-contaminated CD plates or handling surfaces can cause skin irritation, allergic dermatitis, or fungal skin infections, particularly in individuals with compromised skin barriers or pre-existing skin conditions (Sivasubramanian *et al*., 2019). Fungal spores and hyphae present on CD surfaces may transfer onto users' hands during handling, increasing the risk of skin exposure and potential adverse reactions (Verhoeff *et al*., 2016).

Fungal contamination on CD plates may lead to the deposition of fungal spores or particles on optical surfaces, increasing the likelihood of eye irritation, conjunctivitis, or ocular infections in individuals exposed to contaminated CDs (Horner *et al*., 2018). Inadequate handling practices, such as rubbing or touching the eyes with contaminated hands after CD handling, can introduce fungal pathogens into the ocular environment, potentially causing eye-related health issues (Verallo-Rowell and Verallo, 2015). Fungal growth on CD plates contributes to indoor air pollution, as airborne fungal spores released from contaminated CDs can disperse throughout indoor environments, leading to poor indoor air quality and potential health risks for occupants (WHO, 2009). Individuals with respiratory conditions or compromised immune systems may be particularly vulnerable to the effects of indoor fungal exposure from contaminated CDs, emphasizing the importance of minimizing fungal contamination in indoor settings (Douwes *et al*., 2018).

CHAPTER THREE

MATERIALS AND METHODS

3.1 Study Area

This experiment was carried out at ABPROVY Enterprise, Department of Microbiology, University of Benin, Benin City.

3.2 List of Apparatus

CD plates, Swab sticks, Autoclave, Conical flask, Beakers, Sample container, Test tubes, Micropipettes, measuring cylinders, Test tube racks, Slides, inoculating loop, Incubator, Petri dishes, Measuring scale, Spatula, Bunsen burner, Light microscope, Thermometer, Hydrometer.

3.3 Sample Collection

The CD plates, a total of 36 were purchased from a certain shop at Ring-road, Benin City, Nigeria. Out of which twelve CDs were set to be opened, another twelve were set to be closed by singularly sealing each CD in a regular CD storage nylon pack, and the last set of CDs was burnt (a process of storing information of various types, raw data documents to videos). A process to ascertain the quality of information on the CD after the exposure time. After which the CDs were labeled according to location.

3.4 Preparation of Media

The media used for isolation was Potato Dextrose Agar (PDA). It was prepared by displacing 39 grams of Potato Dextrose Agar powder in 1000 ml of sterile water. The mixture is then agitated for complete dissolving of the PDA powder in water, after which the solution is autoclaved at

121°C for 15 minutes and left to cool. After cooling the sterile agar is dispensed into already labelled petri dishes and left to solidify.

3.5 Preparation of CD-ROM Plates

The CD plates were exposed at different locations to collect settling fungi spores from the atmosphere on its surface. These different locations were at the Microbiology 400 level laboratory, Microbiology Lecture Theatre, and Dr. (Mrs.) I. S. Obuekwe’s office, all at the University of Benin. The total exposure time of the CD Plates was four weeks and a set of CD plates were collected weekly for experiment purposes. Temperature and Humidity of the different locations were read at different intervals during CD plate exposure.

3.6 Isolation of Fungi from CD-ROM Plates

A swab of the surface of three different CD plates was taken using sterile swab sticks and then placed in sample containers, containing saline water. After this, 1 ml of each of the diluted samples was taken using a micropipette and placed in 18 already labeled different Petri dishes as it was a dual sampling method. Then already prepared Potato Dextrose Agar was dispensed into the petri dishes containing the diluted samples and then incubated at 37°C for 72 hours to grow.

3.7 Subculturing of Fungal Isolates

From the different mixture cultures, fungi isolates were taken using an inoculating loop and plates on already PDA plates using the streaking method. After the inoculation, the agar plates were left to incubate at 37°C for 72 hours.

3.8 Identification of Fungal Isolates

A sample from the pure culture was taken using an inoculating loop and placed on a sterile glass slide. Then a drop of distilled water was placed on the slide and mixed gently with an inoculating loop to scatter the cells of the fungi. After this process, the slide was then viewed under a light microscope.

CHAPTER 4

RESULTS

4.1 Results

Temperature and relative humidity of three different locations (Laboratory, Lecture theatre and Office) were determined, as well as fungal load of different stored CD plates in these locations for four (4) weeks. Before taking samples every week, the temperature and relative humidity of each location were recorded, as Figures 4.1 and 4.2 demonstrate. Except for the lab storage location, which had a drop in temperature in the second week before experiencing an increase in the third and fourth, Figure 4.1 depicts a slight weekly decline in temperature. Figure 4.2 shows a significant increase in the relative humidity of the studied locations at week 2 and week 4. Temperatures were within the range of 30°C-37°C. Tables 4.3(a, b, c and d) show the fungal colony count, mean and standard deviation of the CD plate samples stored at the laboratory, with the fourth week having the highest fungal colony count. Tables 4.4(a, b, c, and d) show the fungal count, mean and standard deviation of the CD plate samples stored at the lecture theatre, with the fourth week showing the highest fungal load. Tables 4.5(a, b, c, and d) show the fungal count, mean and standard deviation of the CD plate samples stored at the supervisor's office, with the third week having the highest fungal load. The mean data of the fungal load of the CD plate samples in the studied location for the four weeks are shown in Tables 4.3e, 4.4e and 4.5e. Table 4.3e shows an increase in fungal load as time progresses, with the open CDs having the highest count of fungal load due to the increase in humidity every week. Table 4.4e shows that there is a decrease in the fungal load in the second week, due to the little decrease in humidity. Table 4.5e shows that there is a decrease in the fungal load in the fourth week, which correlates with the decrease in humidity in the fourth week. Tables 4.3f, 4.4f and 4.5f show the morphological characteristics and the microscopic characteristics of the CD plate samples of each location and possible fungi such as; *Aspergillus niger, Rhizopus arrhizus, Mucor mucedo, Cladosporium* spp., *Penicillium* sp., which were identified.

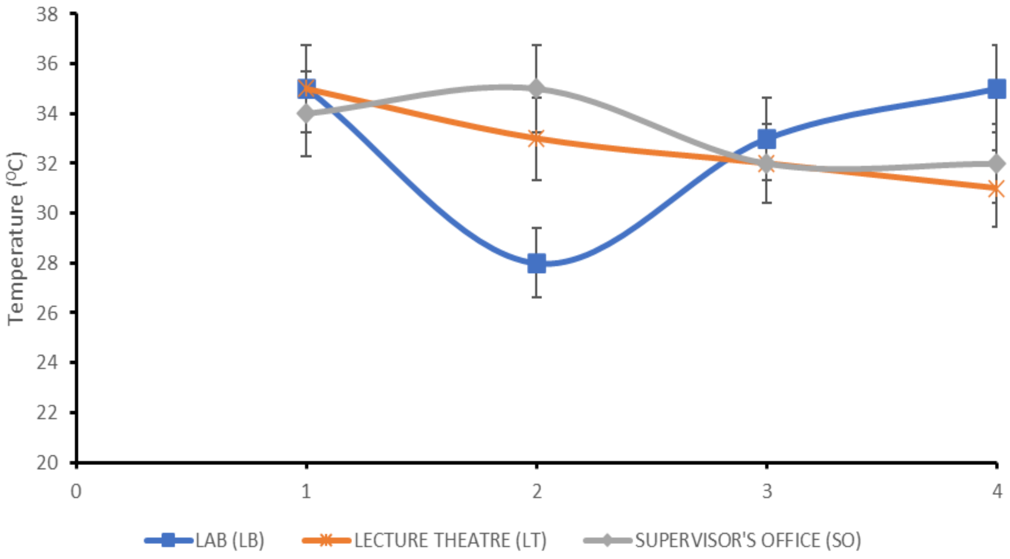

Fig 4.1: Graphical Representation Showing the Temperature of Each Location Collection for the Four Weeks

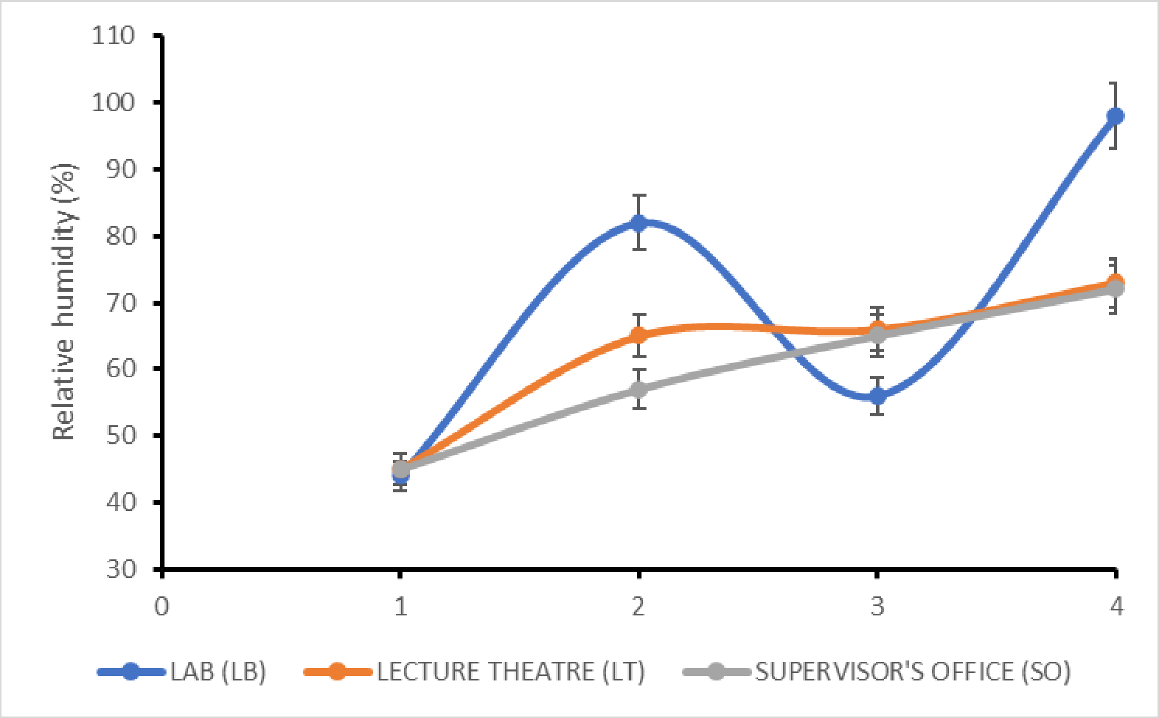

Fig 4.2: Graphical Representation Showing the Relative Humidity of Each Location Collection for the Four Weeks

4.2 Data from LAB Isolation

Table 4.3a: Fungal count of CDs placed at the Lab at Week 1

SAMPLE CODES		Log$_{10}$ (cfu/g)	Log$_{10}$ (cfu/g)	Mean	SD
LBO1	Open CD	2.60	2.60	2.60	0.00
LBO2	Open CD	2.70	2.85	2.77	0.10
LBC1	Closed CD	3.04	3.04	3.04	0.00
LBC2	Closed CD	2.60	2.60	2.60	0.00
LBB1	Burned CD	2.70	2.78	2.74	0.06
LBB2	Burned CD	2.85	2.78	2.81	0.05

Table 4.3b: Fungal count of CDs placed at the Lab at Week 2

SAMPLE CODES		**Log$_{10}$ (cfu/g)**	**Log$_{10}$ (cfu/g)**	**Mean**	**SD**
LBO1	Open CD	2.48	2.30	2.39	0.12
LBO2	Open CD	2.30	2.30	2.30	0.00
LBC1	Closed CD	-	-	-	-
LBC2	Closed CD	-	-	-	-
LBB1	Burned CD	2.30	2.30	2.30	0.00
LBB2	Burned CD	2.48	2.48	2.48	0.00

Table 4.3c: Fungal count of CDs placed at the Lab at Week 3

SAMPLE CODES		Log_{10} (cfu/g)	Log_{10} (cfu/g)	Mean	SD
LBO1	Open CD	3.11	3.11	3.11	0.00
LBO2	Open CD	3.00	2.95	2.98	0.03
LBC1	Closed CD	3.40	2.90	3.15	0.35
LBC2	Closed CD	3.04	3.00	3.02	0.03
LBB1	Burned CD	3.00	2.78	2.89	0.16
LBB2	Burned CD	3.11	2.85	2.98	0.19

Table 4.3d: Fungal count of CDs placed at the Lab at Week 4

SAMPLE CODES		Log_{10} (cfu/g)	Log_{10} (cfu/g)	Mean	SD
LBO1	Open CD	2.95	3.00	2.98	0.03
LBO2	Open CD	3.46	2.85	3.15	0.44
LBC1	Closed CD	2.60	2.48	2.54	0.09
LBC2	Closed CD	2.85	2.48	2.66	0.26
LBB1	Burned CD	2.95	2.70	2.83	0.18
LBB2	Burned CD	3.11	2.95	3.03	0.11

Table 4.3e: Mean Data on The Fungal Load on CD Placed in The Laboratory

	WEEK			
SAMPLES	1	2	3	4
Open CD	2.69	2.35	3.05	3.07
Closed CD	2.82	_	3.09	2.60
Burned CD	2.78	2.39	2.93	2.74

Table 4.3f: Fungal identification of Lab CD plate samples

Cultural Morphology					
Color of mycelium on an agar plate	Dark colored growth	Green mycelium	Army green and entire, non-luxuriant with concentric ring	Initially white, with age turning gray and developing black dots	grey to off-white or white
Colour of plate culture reverse	Dark	Pale yellow	Orange	light gray	black
Microscopic characteristics					
Nature of hyphae	Septate	Septate	Septate	Non- septate	Non- septate
Type of Spore	Conidiospore	Conidiospore	Conidiospore	Sporangiophores	Sporangiophores
Spore structure/Attachment	A. niger consists of a smooth and colorless conidiophores and spores.	Conidia size and shape are similar to Penicillium and Aspergillus but Trichoderma forms sticky clumps of conidia with a distinctive green pigment rather than in chains. Typical green spore clumps are identified as Trichoderma.	clear (not pigmented) hyphae with smooth-walled conidiophores, stipes are rather long and are bi-verticillate	single and unbranched sporangiophore	sporangiospores
Rhizoids	Absent	Absent	Absent	Present	Absent

Appearance of special structure	Conidial heads radiate, becoming columnar when mature; conidiophores are long and smooth-walled; biseriate; two rows of phialides cover the entire vesicle.	Conidiophores are hyaline and loosely branched at right angles. Phialides are flask-shaped and inflated at the base, with very short collarettes	Conidiophore stipes smooth-walled; phialides mono- or bi-verticillate, flask-shaped. Phialides do not show long pointed extensions at the tips	Rhizoids occur at the junction of stolon and sporangiophore	sporangia are produced on the tips of sporangiophores. The sporangia contain spores, which are the reproductive units of Mucor
Class of fungi	Ascomycetes	Ascomycetes	Ascomycetes	Zygomycetes	Zygomycetes
Possible Identity	*Aspergillus niger*	Trichoderma sp.	Penicillium sp.	*Rhizopus arrhizus*	*Mucor mucedo*

4.3 LT Isolation Data

Table 4.4a: Fungal count of CDs placed at the Lecture Theatre on Week 1

SAMPLE CODES		Log$_{10}$ (cfu/g)	Log$_{10}$ (cfu/g)	Mean	SD
LTO1	Open CD	_	_	_	_
LTO2	Open CD	-	-	-	-
LTC1	Closed CD	2.00	2.00	2.00	0.00
LTC2	Closed CD	2.48	2.30	2.39	0.12
LTB1	Burned CD	3.08	3.08	3.08	0.00
LTB2	Burned CD	3.11	3.08	3.10	0.02

Table 4.4b: Fungal count of CDs placed at the Lecture Theatre on Week 2

SAMPLE CODES		**Log_{10} (cfu/g)**	**Log_{10} (cfu/g)**	**Mean**	**SD**
LTO1	Open CD	_	_	_	_
LTO2	Open CD	2.48	2.30	2.39	0.12
LTC1	Closed CD	_	_	_	_
LTC2	Closed CD	_	_	_	_
LTB1	Burned CD	_	_	_	_
LTB2	Burned CD	2.48	2.48	2.48	0.00

Table 4.4c: Fungal count of CDs placed at the Lecture Theatre on Week 3

SAMPLE CODES		**Log10 (cfu/g)**	**Log10 (cfu/g)**	**Mean**	**SD**
LTO1	Open CD	3.20	3.04	3.12	0.12
LTO2	Open CD	3.11	3.08	3.10	0.02
LTC1	Closed CD	_	_	-	-_
LTC2	Closed CD	_	_	-	-
LTB1	Burned CD	2.85	3.18	3.01	0.23
LTB2	Burned CD	2.90	2.85	2.87	0.04

Table 4.4d: Fungal count of CDs placed at the Lecture Theatre on Week 4

SAMPLE CODES		Log_{10} (cfu/g)	Log_{10} (cfu/g)	Mean	SD
LTO1	Open CD	3.04	3.08	3.06	0.03
LTO2	Open CD	2.95	3.34	3.15	0.27
LTC1	Closed CD	2.48	2.90	2.69	0.30
LTC2	Closed CD	2.00	2.60	2.30	0.43
LTB1	Burned CD	2.48	3.28	2.88	0.57
LTB2	Burned CD	3.26	3.40	3.33	0.10

Table 4.4e: Mean Data on The Fungal Load on CD Placed in Lecture Theatre

	WEEKS			
	1	2	3	4
Open CD	-	-	3.11	3.10
Closed CD	2.19	-	-	2.50
Burned CD	3.09	-	2.94	2.59

Table 4.3f: Fungal identification of Lecture Theatre CD plate samples

Cultural Morphology					
Color of mycelium on an agar plate	Dark colored growth	Brown colour	Army green and entire, non-luxuriant with concentric ring	Initially white, with age turning gray and developing black dots	grey to off-white or white
Colour of plate culture reverse	Dark	Black	Orange	light gray	black
Microscopic characteristics					
Nature of hyphae	Septate	Septate, hyaline hyphae	Septate	Non- septate	Non- septate
Type of Spore	Conidiospore	Conidiophore	Conidiospore	Sporangiophores	Sporangiophores
Spore structure/Attachment	*A. Niger* consists of a smooth and colorless conidiophores and spores.	Conidia are asexual spores that are formed directly on the hyphae, typically darkly pigmented, ranging in color from olive green to brown or black	clear (not pigmented) hyphae with smooth-walled conidiophores, stipes are rather long and are bi-verticillate	single and unbranched sporangiophore	sporangiospores
Rhizoids	Absent	Absent	Absent	Present	Absent

Appearance of special structure	Conidial heads radiate, becoming columnar when mature; conidiophores are long and smooth-walled; biseriate; two rows of phialides cover the entire vesicle.	Conidia **are produced in chains and they are typically dark-colored**	Conidiophore stipes smooth-walled; phialides mono- or bi-verticillate, flask-shaped. Phialides do not show long pointed extensions at the tips	Rhizoids occur at the junction of stolon and sporangiophore	sporangia are produced on the tips of sporangiophores. The sporangia contain spores, which are the reproductive units of Mucor
Class of fungi	Ascomycetes	Ascomycete	Ascomycetes	Zygomycetes	Zygomycetes
Possible Identity	*Aspergillus niger*	Cladosporium spp.	Penicillium sp.	*Rhizopus arrhizus*	*Mucor mucedo*

4.4 Supervisor's Office Isolation Data

Table 4.5a: Fungal count of CDs placed at Supervisor's Office on Week 1

SAMPLE CODES		Log_{10} (cfu/g)	Log_{10} (cfu/g)	Mean	SD
SOO1	Open CD	2.30	2.30	2.30	0.00
SOO2	Open CD	2.00	2.00	2.00	0.00
SOC1	Closed CD	2.90	2.78	2.84	0.09
SOC2	Closed CD	2.78	2.78	2.78	0.00
SOB1	Burned CD	3.36	3.26	3.31	0.08
SOB2	Burned CD	3.34	3.32	3.33	0.01

Table 4.5b: Fungal count of CDs placed at Supervisor's Office on Week 2

SAMPLE CODES		**Log_{10} (cfu/g)**	**Log_{10} (cfu/g)**	**Mean**	**SD**
SOO1	Open CD	-	-	-	-
SOO2	Open CD	-	-	-	-
SOC1	Closed CD	-	-	-	-
SOC2	Closed CD	-	-	-	-
SOB1	Burned CD	2.30	2.30	2.30	0.00
SOB2	Burned CD	2.30	2.30	2.30	0.00

Table 4.5c: Fungal count of CDs placed at Supervisor's Office on Week 3

SAMPLE CODES		Log_{10} (cfu/g)	Log_{10} (cfu/g)	Mean	SD
SOO1	Open CD	2.30	2.30	2.30	0.00
SOO2	Open CD	3.08	2.70	2.89	0.27
SOC1	Closed CD	3.51	3.63	3.57	0.09
SOC2	Closed CD	2.78	2.30	2.54	0.34
SOB1	Burned CD	2.78	2.48	2.63	0.21
SOB2	Burned CD	2.90	2.70	2.80	0.14

Table 4.5d: Fungal count of CDs placed at Supervisor's Office on Week 4

SAMPLE CODES		**Log_{10} (cfu/g)**	**Log_{10} (cfu/g)**	**Mean**	**SD**
SOO1	Open CD	3.11	3.18	3.15	0.04
SOO2	Open CD	3.20	3.62	3.41	0.30
SOC1	Closed CD	-	-	-	-
SOC2	Closed CD	-	-	-	-
SOB1	Burned CD	2.85	3.04	2.94	0.14
SOB2	Burned CD	3.00	3.41	3.21	0.29

Table 4.5e: Mean Data on The Fungal Load on CD Placed in Supervisor's Office

	WEEKS			
	1	2	3	4
Open CD	2.15	-	2.60	3.28
Closed CD	2.81	-	3.05	-
Burned CD	3.32	2.30	2.71	-

Table 4.4f: Fungal identification of Supervisor's Office CD plate samples

Cultural Morphology					
Color of mycelium on an agar plate	Dark colored growth	Brown colour	Army green and entire, non-luxuriant with concentric ring	Initially white, with age turning gray and developing black dots	grey to off-white or white
Colour of plate culture reverse	Dark	Black	Orange	light gray	black
Microscopic Characteristics					
Nature of hyphae	Septate	Septate, hyaline hyphae	Septate	Non- septate	Non- septate
Type of Spore	Conidiospore	Conidiophore	Conidiospore	Sporangiophores	Sporangiophores
Spore structure/Attachment	A. niger consists of a smooth and colorless conidiophores and spores.	Conidia are asexual spores that are formed directly on the hyphae, typically darkly pigmented, ranging in color from olive green to brown or black	clear (not pigmented) hyphae with smooth-walled conidiophores, stipes are rather long and are bi-verticillate	single and unbranched sporangiophore	sporangiospores
Rhizoids	Absent	Absent	Absent	Present	Absent

Appearance of special structure	Conidial heads radiate, becoming columnar when mature; conidiophores are long and smooth-walled; biseriate; two rows of phialides cover the entire vesicle.	Conidia **are produced in chains and they are typically dark-colored**	Conidiophore stipes smooth-walled; phialides mono- or bi-verticillate, flask-shaped. Phialides do not show long pointed extensions at the tips	Rhizoids occur at the junction of stolon and sporangiophore	sporangia are produced on the tips of sporangiophores. The sporangia contain spores, which are the reproductive units of Mucor
Class of fungi	Ascomycetes	Ascomyce	Ascomycetes	Zygomycetes	Zygomycetes
Possible Identity	*Aspergillus niger*	Cladosporium spp.	Penicillium sp.	*Rhizopus arrhizus*	Mucor mucedo

CHAPTER FIVE

DISCUSSION AND CONCLUSION

5.1 Discussion

The growth and multiplication of microorganisms are greatly influenced by environmental data, especially those related to temperature and relative humidity. Over the four-week study course, we noticed differences in temperature and relative humidity at various sampling sites. The temperature varied between 26°C and 35°C, and the relative humidity varied between 56% and 82%. These differences might have had an impact on the microbial populations found in the investigated habitats. For example, high humidity promotes the growth of some fungi, and temperature changes can influence the kinds and rates of microorganisms that are present. Environmental conditions have an impact on indoor microbial ecosystems, as previous studies have shown. Higher relative humidity levels, for instance, were linked to greater fungal variety in indoor environments, according to a study by Adams et al. (2015). In a similar vein, Hospodsky et al. (2012) found that temperature changes had an impact on the makeup of fungal populations in dust samples collected indoors. The idea that environmental factors are important in determining indoor microbial ecology is reinforced by these results. The effect of four weeks of microbial load on CD plates was shown by the laboratory isolation results. Colony-forming units (cfu/g) varied between samples and weeks, as we saw. For instance, a large variety of microbial contamination levels were shown by the mean cfu/g, which varied from 200 to 2900. Additionally, there appeared to be a variety of fungal species which includes; *Rhizopus arrhizus*, *Mucor mucedo, Aspergillus niger, Trichoderma* sp. present in the laboratory setting based on the differences in the morphological and microscopic features of the isolated fungi. Understanding the possible effects of these fungi on indoor air quality and human health requires their identification. The significance of microbial surveillance in laboratory settings has been emphasized by earlier research. For example, Kembel et al. (2014) observed considerable differences in microbial communities between different laboratory locations when they studied the microbial diversity in laboratory spaces. Furthermore, the significance of laboratory ventilation systems in forming indoor microbial populations was highlighted by Meadow et al. (2014). These results highlight how crucial it is to put in place efficient microbial control procedures in laboratory settings to preserve a secure and healthful working environment. The LT isolation data showed variations in the fungal load throughout the four-week timeframe, which was consistent with the laboratory isolation data. The range of the mean cfu/g was 100 to 2500, suggesting notable fluctuations in the amounts of microbial contamination across the various sampling weeks. Furthermore, the isolated fungi's microscopic features and cultural morphology varied, indicating the existence of a variety of fungal species; *Aspergillus niger, Cladosporium* spp*., Rhizopus arrhizus, Penicillium* sp*., Mucor mucedo* in the lecture hall setting. Previous research has highlighted the presence of indoor fungi in educational environments and its potential impact on occupant health. For example, a study by Pasanen et al. (2000) investigated the fungal flora in Finnish schools and found that certain fungal species were associated with respiratory symptoms among students and staff. Similarly, a study by Eduard et al. (2008) reported a higher prevalence of respiratory symptoms among teachers working in schools with high fungal spore levels. These findings emphasize the importance of maintaining adequate indoor air quality in educational settings to promote occupant health and well-being. Similar to the LT and lab settings, the supervisor's office isolation data revealed variations in the fungal load over four weeks. There were different levels of microbial contamination indicated by the mean cfu/g, which varied from 100 to 3750. Different sampling periods showed differences in the microscopic features and cultural morphology of the isolated mushrooms, indicating the presence of a variety of fungal species of the specie *Aspergillus niger, Rhizopus arrhizus, Mucor mucedo, Cladosporium* spp., *Penicillium* sp. in the office setting. To preserve a healthy indoor environment and lower the danger of fungal contamination, effective ventilation and cleaning techniques are crucial. Microbial contamination is a possible health risk that has been highlighted by research on indoor air quality in office spaces. Mendell et al. (2008), for example, showed that there was a correlation between poor indoor air quality and a higher incidence of respiratory symptoms and sick building syndrome in their investigation of the association between workplace characteristics and employee health. In a similar vein, Li et al.'s (2019) study found that office buildings with subpar ventilation systems had greater levels of fungal contamination. The readability of the data recorded on the disks may be impacted by dust, dirt, and microbiological contaminants. A computer system was used to view the burned CD plates to verify that the data on them was still accurate. When watching the videos on these disks, there were visual errors. Although the raw data documents on some CD plates were still intact and readable. Data corruption is thus caused by fungi contamination on the burnt disks. This condition is due to the fungal enzymes and by-products produce on CD's surface which can be corrosive or harmful (Lear et al., 2021).

5.2 Conclusion

Conclusively, the findings of this investigation offer significant perspectives on the types and extent of microbial contamination present in various interior settings, such as labs, lecture halls, and office spaces. The four weeks' variations in temperature, relative humidity, and fungal load highlight the dynamic nature of indoor microbial communities and the significance of routine monitoring and management techniques. One of the most important things to accomplish when creating strategies to preserve indoor air quality and reduce health concerns related to fungal contamination is to recognize and comprehend the characteristics of indoor fungi. It is necessary to conduct more research to find out the precise causes and contributing variables behind indoor fungal populations and how they affect human health.

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