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MOLD GUARD, A NOVEL AIR PURIFIER: ASSESSMENT ON THE REDUCTIONOF THE MOLD AND PARTICULATE MATTER 2.5 (PM 2.5)

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A Novel Air Purifier: Assessment on the Reduction of the Mold and Particulate Matter 2.5 (PM 2.5)

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Aerosols, including Particulate Matter 2.5, are the culprits of many allergic reactions and respiratory syndromes. Particulate Matter 2.5 is present in heavily polluted areas such as southern Californian cities, New Delhi, China and New York. Based on studies from clinics and hospital admissions, $PM_{2.5}$ has been positively correlated with increased cases of allergic rhinitis, asthma, bronchitis, allergic pharyngitis and many others. Due to having a diameter of only 2.5 micrometers, the particulate matter often is not visible to the human eye, will be inhaled and cause irritation to the lungs. Many big cities in the world contain $PM_{2.5}$ concentrations much higher than the permissible limit described by the National Ambient Air Quality Standards (NAAQS). Particulate Matter 2.5 is composed of metals and products from fuel combustion. The new world trade and economy are driven by new technologies that are based on the application of innovation of novel products that are in great demands. Global economies are so tightly interconnected that companies, governments and industries will soon be forced to cooperate in ways we could not have imagined just a few years ago. Innovations in technology continue to have massive effects on business and society. We're now seeing emerging markets become hotbeds of innovation, especially in efforts to reach the growing middle class and low-income consumers around the globe[1]. This report covers the information on how a research product was developed and marketed in many countries. Collaboration between the corporate worlds with academia has been proved to be beneficial in scientific inventions. With the increased population growth and industrial expansions, most cities are experiencing poor air quality. Global warming exerts substantial effects on flora and fauna all over the world. Increasing greenhouse gasses causes accelerated pollinosis and fungal spore production, two major aeroallergens that trigger asthma and allergy symptoms. We are in need of a much advanced air purifier that works more efficiently improving the air quality to a greater extent than existing air purifiers in the market. We have been analyzing the daily aeroallergen index by using the coated Melinex tape from the Burkard Volumetric Spore Trap. Exposed, stained Melinex tape was observed under a BX-40 Olympus microscope. Nineteen years of aeroallergen data of the Texas Panhandle revealed a gradual shift in the aeroallergen index with the warmer climate and a shift in flowering seasons. Research in aerobiology and Bi-Polar ionization technology helped us develop an air purification system. Air Oasis air purifiers utilize a new generation of technology that simply produces a blanket of redundant oxidizers that not only clean the surrounding air, but also sanitizes surfaces. We have assessed the new unique air purifier called the *Mold Guard* that targets the particulate matters in

the air as well as on the surface and sanitizes the mold and germs present in the air and sanitizes it efficiently. There is an ongoing research with the Bi-Polar ionization technology to develop commodities like air purification systems, food preservation systems and cell phone sterilizers. We assessed and evaluated the capacity and safety measures of the *Mold Guard* unit in terms of reducing the air borne particulate matters present in the room air. The fungal and bacterial colonies were analyzed from the tissues in room air after 24, 48, 72 and 120 hours. We also tested the efficiency of the *Mold Guard* in reducing the mold concentration in the room air and capacity of the two different filters in cleaning the air.

Key Words: *Mold Guard*, BI-POLAR IONIZATION, $PM_{2.5}$, air pollution, allergy, asthma

Mold Guard and testing on the reduction of the Mold and Particulate Matter 2.5 ($PM_{2.5}$)

In this experiment, we used dust containing Particulate Matters (PM) ranging 2.5-10 micrometers in order to measure particle concentration. The *Mold Guard* unit was used to assess the indoor air quality by reducing the particle concentration[2]. We placed the unit into a fiberglass chamber to exert its effects on the circulating dust. We measured the natural rate of decay and compared that to the *Mold Guard* unit to assess the proficiency of this newly developed air purification unit. We also assessed the efficiency of the Mold Guard in reducing the mold spore concentration in the indoor air by Petri-dish colony plating method.

Fungal spores as aeroallergens

For decades, airborne fungal spores have been implicated as the causative factors in respiratory allergy. Exposure to high atmospheric spore counts and sensitization to specific fungal allergens have been associated with severe asthma, mainly in young adults[3]. Sensitivity to fungi is a significant cause of allergic diseases, and prolonged exposure to fungi is a growing health concern[4]. Bogacka et al. (2003)[5] considers the allergy to mold allergens as a risk factor for bronchial asthma in patients suffering from allergic rhinitis. Most fungi commonly considered allergenic, such as *Alternaria* spp., *Cladosporium spp., Epicoccum nigrum, Fusarium spp., or Ganoderma* spp. Display a seasonal spore release pattern, but this is less well defined than it is for pollens[6,7]. Warm dry weather conditions promote passive dispersal of dry air spora, including *Alternaria, Cladosporium, Curvularia, Pithomyces* and many smut teliospores. Diurnal levels of these spores usually have peaks during the afternoon hours under conditions of low humidity and maximum wind speeds[8]. Moist weather conditions promote the active dispersal of moist air spora, such as the explosive release of ascospores from Pezizales, and the expulsion of basidiospores from the gills of the Basidiomycetes. Often, the two most encountered mold spores in atmospheric sampling are ascospores from different species of Pezizales and spores from *Alternaria* sp.[9]. Airborne fungal spores are important allergens. These airborne spores encounter the eye or enter the body as the air is breathed. Allergic reactions to fungal spores fall into two distinct groups, based on whether the hypersensitive response is immediate or delayed[10]. Individuals are exposed to fungal spores every day. About 20– 30% of the population can develop an allergic response shortly after exposure to dust that contains allergens such as fungal spores[11]. Many studies have been reported on the role of fungi in allergic disease, but none that systematically documented such a role for the fungal species that are responsible for allergic rhinitis in the Texas Panhandle. Many case studies were found, but none of these unequivocally documents a remedial measure for the increased allergy and asthma cases. Our previous studies revealed the data on the pollen and spore composition in the air in the Texas Panhandle.[12-15] The present study was designed to assess and evaluate the efficiency of the *Mold Guard* high output air purifier in its ability to reduce the indoor mold or fungal spore concentrations.

Current aspects of $PM_{2.5}$

$PM_{2.5}$ refers to a mix of tiny invisible solid and liquid particles that are in the environment. If in abundance in a particular environment, we can only see the haze that blurs the spread of sunlight. The size of these particles are 2.5 microns in diameter or smaller. These particles are so tiny that even some bacterial strains have larger sizes than those particulate matters. The bacterial cell size ranges between 0.5-5.0 microns in length. No matter what the size, particles can harm our health. It is so dangerous that it can shorten our life. Our natural defenses help us to cough or sneeze particles larger than 10 microns out of our bodies but $PM_{2.5}$ penetrates deeply into the alveolar region of the lung and may even be able to cross into the blood just like the essential oxygen molecules we need to survive. Evidence suggests that $PM_{2.5}$ triggers an inflammatory response and causes oxidative damage, among other organs[16].

Indoor Air Quality and the Volatile Organic Compounds

The indoor air surrounding us plays an extremely important role in our well-being and efficiency. Breathing pure and clean air allows us to think more clearly, sleep soundly, and stay healthier. Studies show that we receive 56% of our energy from the air we breathe, more than from water and food combined. On average, we breathe 37 pounds of air a day (equivalent to volume of an Olympic sized pool). Many types of Particulate Matters are composed of the VOCs. VOCs or the Volatile Organic Compounds can cause serious health hazard known as the Sick Building Syndrome (SBS). It is a combination of ailments associated with an individual's place of work or residence. A 1984 the WHO report investigated the syndrome and suggested that up to 30% of the buildings worldwide are linked to symptoms of SBS. Most of the sick building syndrome is related to poor indoor air quality[15].

Introduction to the *Mold Guard*

A decade of research in aerobiology and the Bi-Polar ionization technology developed an air purification system that uses Bi-Polar ionization technology to reduce the indoor aeroallergen improving the air quality and better food preservation. Air Oasis air purifiers utilize a new generation technology. This new technology simply produces a blanket of redundant oxidizers that not only clean the surrounding air, but sanitize surfaces as well. We have assessed the unique air purifier that targets the particulate matters, including the fungal and bacterial spores in the air as well as on the surface, to sanitize the air efficiently.

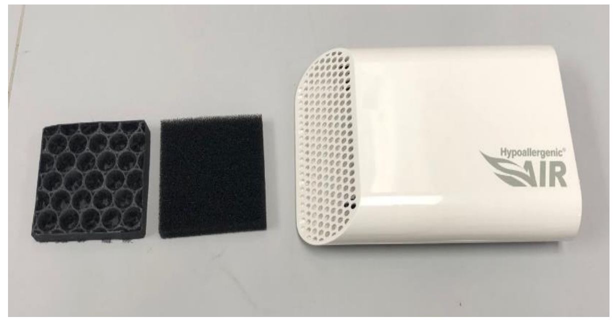

Fig. 1. *Mold Guard* unit was created to sanitize the surface by removing the fungal spores and bacteria. It can use two different types of filters. The extremely compact design (6.5″ x 4″ x 1.5″) acquires very littles space with high output.

Mold Guard Unit

The *Mold Guard* unit was built to sanitize the surface by removing the fungal spores and bacteria. It is safe and hypoallergenic which means it does not produce any allergenic chemical, deodorizer or Ozone (Fig.1). The *Mold Guard* is an air purified that covers almost 100 sq. ft. area for sanitization. It uses very little amount of electric energy less than a lightbulb (2 watts) and it plugs directly into the outlet without any messy wires. It has additional benefits as it removes the static electricity and it has a built-in nightlight. There are two different filters; it comes with a washable pleated filter.

The versatile novel Bi-Polar Ionization technology sanitizes the allergens and deactivates contaminants in the air and on the surfaces. Installation of this unit is very easy to have an efficient air purification system (Fig.2).

Fig. 2. Bi-Polar ionization technology simply produces ions on two different poles that not only clean the surrounding air, but sanitize surfaces as well. It removes the allergens and deactivates contaminants in the air and on the surfaces.

Fig. 3. Testing the Mold Guard unit in the AO fiberglass chamber.

Indoor air quality testing:
We built a fiberglass chamber to assess and evaluate the efficiency of the *Mold Guard* high output air purifier in its ability to reduce the indoor mold or fungal spore concentrations. We followed the following procedures:

1. Before any testing, we wiped the entire chamber with Clorox wipes to remove all forms of impurities and allowed the chamber to dry up for two days.
2. We purchased the ISO 12103-1 Ultrafine Dust Particle with an average size of 2.75 micron (PTI Powder Tech., Minnesota). We have calculated the rate of natural decay of the particulate matters by placing the meter in the empty chamber after the aerosol saturation in 24 hours (Table.1).
3. We placed the sponge filter in the Mold Guard unit.
4. We placed both the Mold Guard unit and the *Dylos* air quality monitor in the chamber. We also used a *Garosa Air Quality Monitor* Formaldehyde Detector Accurate PM2.5 Micron Particulate Matter Dust Pollution Multi Tester.
5. Using four fans, we spread the Particulate Matter 2.5 ($PM_{2.5}$) in the chamber uniformly and waited for 72 hours to develop an equilibrium in the indoor aerosol. We secured all chamber doors making them air tight so the PM does not disperse out of the chamber.
6. Once all the equipment were placed inside the AO chamber and the aerosol equilibrium was achieved, we began recording the air quality readings from the *Dylos* and *Garosa Air Quality Monitor* at 24 hrs., 48 hrs., 72hrs. and 120hrs.
7. We repeated steps 1-6 with the carbon filter.
8. We compared efficiency of the two filters with the natural decay rate of the PM.

Fig.4. Steps of testing the *Mold Guard* unit: A. Weighing the Particulate Matter. B. PM2.5 testing Dust. C. Uniform spreading of the Particulate Matter in the AO Fiberglass chamber. D. Meter readings.

Result and Discussion

In the next part of our experiment, we have calculated and compared the rate of the PM 2.5 decay with the rate of decay on using the *Mold Guard*. Our data showed that on using the *Mold Guard*, the concentration of $PM_{2.5}$ decreased considerably in the first 24hour time period concluding thereby that the *Mold Guard* is very efficient in reducing the airborne particulate matters including the Mold Spores that are of the same size or larger. (Fig.5). The sharp decline of the PM 2.5 concentration in the first 24 Hour of usage of the *Mold Guard* definitely prove that the *Mold Guard* is highly efficient in reducing the airborne particles in the indoor air (Fig.5).

Multiple smaller fans divided equally across the fiberglass chamber were more efficient in dispersing the dust uniformly. The initial reading was taken after the first 72 hours to achieve an aerosol equilibrium. The *Mold Guard* unit was very efficient in reducing the particulate matter ranging from 2.5 micron to 10 micron floating in the experimental fiberglass chamber. We have conducted the present research to detect the PM 2.5 reduction in terms of the number of PM.

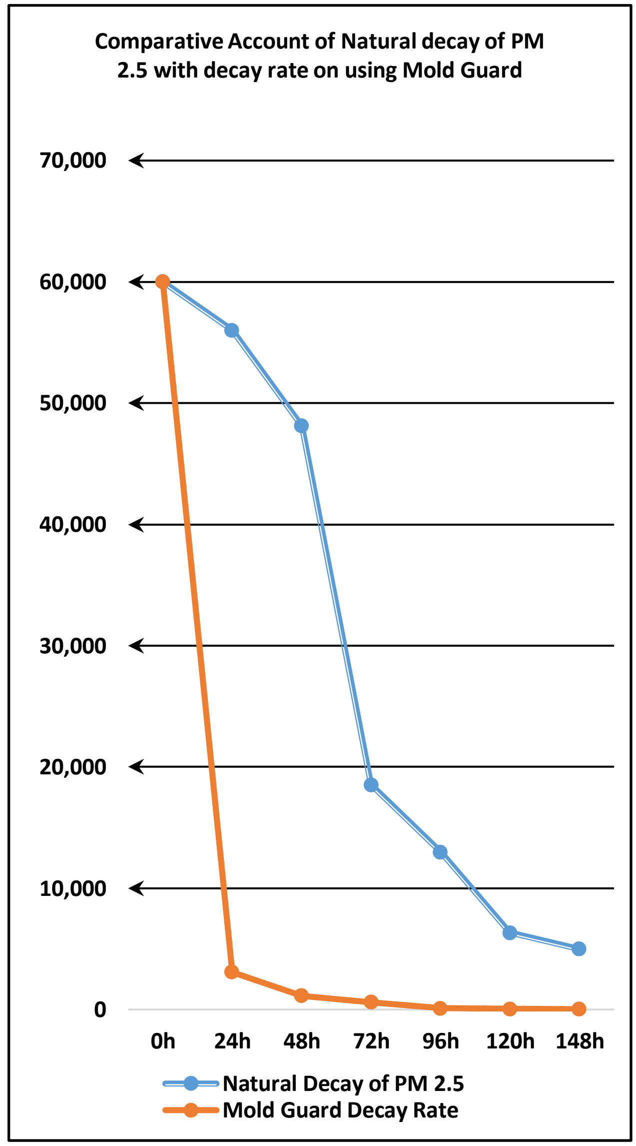

Fig. 5. The Graph shows comparison of the rate of the Natural Decay of the PM 2.5 with the Decay Rate on using the *Mold Guard with a Carbon Filter*.

Assessing the reduction in Microbial Spore Concentration in the Air:

In the next part of the experiment, we exposed the petri-plates prepared with Brain Heart Infusion Agar (DIFCO) in a room with the size of 100sq. ft. (NSB 215). The exposure periods were 48hrs. 72hrs. and 120hrs. We found the development of colonies of fungi and bacteria distributed on the petri plates on incubation for 24 hours in the incubator at 37°C. (Fig.6A). In the next step, we ran the *Mold Guard* for 48hrs. 72 hrs. and 120 hrs. and placed the petri plates for exposure in the closed room. We restricted the entrance in the room to avoid any external contamination into the room. We found development of no colonies after the stated exposures. (Fig.6B). Bi-polar ionization technology proved to be a very efficient in sanitizing the indoor air, reducing the $PM_{2.5}$ and the mold concentration. This ionization technology could be promising to decrease the incidence of allergic rhinitis, asthma and other more extensive lung conditions in the future.

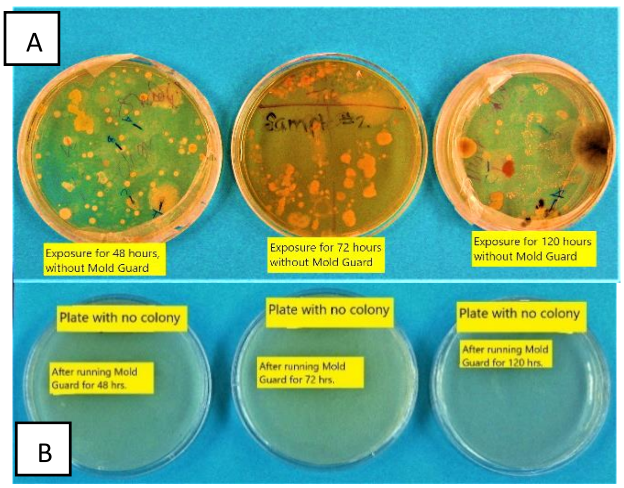

Fig.6A. The development of colonies of fungi and bacteria distributed on the petri plates. B. We found development of no colonies after running the *Mold Guard* for 48, 72 and 120 hours.

Our data, as observed in the Aerosol decay rate are highly significant with our assessment of the microbial spore reduction on the petri-dishes in the first 24-48 hours of exposure with the Mold Guard.

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