Global Warming, Early Flowering, Increase In Allergy Cases And Ahpco To Improve The Indoor Air Quality

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Abstract

Global warming exerts substantial effect on flora and fauna. Increasing greenhouse gases causing accelerated pollinosis and fungal spore production, two major aeroallergens causing asthma and allergies. Recent reports show that the Texas Panhandle residents suffering from allergy and asthma has increased since 2007 and is twice that of the state rate. Climate change has effect on aeroallergens and allergies (Anglin, 2014). Early onset of spring and flowering season have been evidenced all over the world.The increasing trends of total pollen amounts, changing pollen seasons, and increasing carbon dioxide indicate there should be an increase in allergies and severity. The increasing trend of aeroallergen production will result in more cases of allergies throughout the coming years. We have been analyzing the daily aeroallergen by using Melinex tape from the Burkard Volumetric Spore Trap. Exposed, stained Melinex tape was observed under a BX-40 Olympus microscope. 16-years' aeroallergen data of Texas Panhandle revealed a gradual shift in aeroallergen index with the warmer climate and a shift in flowering seasons. A collaborative research between the West Texas A&M University and Air Oasis developed Advanced Hydrated Photo Catalytic Oxidation (AHPCO) Nanotechnology and Plasma Nanotechnology. We evaluated the AHPCO Nanotechnology as a safe and efficient way in reducing indoor aeroallergens, such as pollen, bacteria, fungal spores and hyphae, dust particles, fibers, animal dander and VOCs in the indoor air. There is an ongoing research to apply the AHPCO and Plasma Nanotechnology to develop commodities like air purification system, food preservation system, ice makers and cell phone sterilizers.

Keywords: Early flowering, allergy cases, AHPCO

Introduction

Aeroallergens cause serious allergic and asthmatic reactions. Allergy and Asthma cases have doubled in the Texas Panhandle area since 2007 (Ranaivo, 2011). Analysis of aeroallergen can help in diagnosis and treatment of allergic rhinitis. Global warming exerts substantial effect on flora and fauna. Increasing greenhouse gases causing accelerated pollinosis and fungal spore production, two major aeroallergens causing asthma and allergies. The level of atmospheric carbon dioxide (CO_2) is predicted to increase throughout this century, largely due to the burning of coal, oil, and natural gases. In addition to contributing to the global warming, higher concentrations of this greenhouse gas may also be increasing the incidence of allergies and asthma by raising pollen counts. Plants produce more pollen when grown under high levels of CO_2 which is the main fuel for photosynthesis. Plant pollens are ubiquitous and irritating allergens and allergies to pollen exacerbates asthma (Potera, 2002). Analyzing the aeroallergens with a Burkard Spore Trap provided information regarding the onset, duration, and severity of the pollen season that clinicians use to guide allergen selection for skin testing and treatment. We have been investigating the daily aeroallergen concentration in terms of the meteorological conditions such as daily temperature, wind speed and precipitation. For more than a decade we have been using a Burkard Volumetric Spore Trap to capture the significant aeroallergen in the texas Panhandle area and analyzing them with a microscope and software to determine the daily aeroallergen index. We used various techniques to collect aeroallergen samples and characterizing them with digital and fluorescence microscopy for 16 years. 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. We have assessed the Air Oasis air purifiers that utilize a new generation AHPCO (Advanced Hydrated Photo Catalytic Oxidation) nanotechnology and do not rely on filters or air passing through the air purifier. This new technology simply produces a blanket of redundant oxidizers that not only clean the surrounding air, but sanitize surfaces as well by targeting the particulate matters in the air as well as on the surface and sanitize the air eventually. Collaboration between the corporate worlds with academia has been proved to be beneficial in scientific inventions. New world trade and economy are based on the application of innovative technology developing 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. A collaborative research between the West Texas A&M University and Air Oasis developed Advanced Hydrated Photo Catalytic Oxidation (AHPCO) Nanotechnology (2005-2014) and Plasma Nanotechnology (2014-2015). AHPCO nanotechnology has been successfully applied to develop the air purification system, in food processing facility to reduce contamination and to developed cell phone doc and sanifier that makes the cell phone germ free while charging. A major group of microbes, including bacteria and fungi can cause food contamination during processing. This technology, if used will prove to be an efficient way of reducing the food contaminants, especially during meat processing that toll thousands of lives in the world. The AHPCO nanotechnology brought a new era in air purification, advanced contaminant free food processing and a mobile phone sanifier system that are being marketed in the United States, United Kingdom, China, Hong Kong, Singapore, Bangladesh, Dubai and Turkey. Aeroallergens are often the cause of serious allergic and asthmatic reactions, affecting millions of people each year (Nester, 2001). Aeroallergen sampling provides information regarding the onset, duration, and severity of the pollen season that clinicians use to guide allergen selection for skin testing and treatment (Dvorin *et al*., 2001). Aeroallergens include pollens, fungal spores, dusts, plant fibers, burnt residues and plant products like gums and resins. All these microscopic objects are captured from an urban locality using a Burkard Spore Trap. The types of pollen that most commonly cause allergic reactions are produced by the plain-looking plants (trees, grasses, and weeds) that do not have showy flowers. These plants manufacture small, light, dry pollen granules that are custom-made for wind transport; for example, samples of ragweed pollen have been collected 400 miles out at sea and 2 miles high in the air. Since airborne pollen is carried for long distances, it does little good to rid an area of an offending plant - the pollen can drift in from many miles away.

Fungal spores as allergens

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 (Helbling, 2003). Sensitivity to fungi is a significant cause of allergic diseases, and prolonged exposure to fungi is a growing health concern (Santilli, 2003). Bogacka *et. al* (2003) 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 (Beaumont, 1985; Solomon *et. al* 1988). 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 (Webster, 1970). 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. (Ogden, 1974). Airborne fungal spores are important allergens. These airborne spores come into contact with 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 (Gumowski *et. al* 1991). 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 (Moore-Landecker, 1996). 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 document a cause/effect relationship between the increase in the fungal allergens and the incidence of allergic rhinitis in this area. Our previous studies revealed the data on the pollen and spore composition in the air in the Texas Panhandle (Ghosh *et. al* 2003a, b 2011a,b). This investigation covered the survey on the aeroallergen present in the Texas Panhandle. The objective of this study was to collect, identify, enlist and characterize the pollen and spores of the local areas. Our study included the recording of the aeroallergen concentration in the air on a diurnal basis. We also tried to find out the relationship between these concentrations with both the weather on a particular day and the incidence of allergic reactions. The aeroallergen data were used to assess and enumerate the impact of airborne pollen and mold spores on the breathing and causes of allergic rhinitis in the susceptible individuals. This study was aimed to help to aid the diagnosis of allergic rhinitis by documenting the relation of pollen and fungal spore composition and concentration with the incidence of allergic rhinitis recorded in the Allergy A.R.T.S. Clinics at the Amarillo Center for Clinical Research (Web site for Allergy ARTS). Wet mounting for viewing the fluorescence in pollen was done following the technique developed in our laboratory (Ghosh et. al 2006) by using 2-3 drops of deionized water on the slides. On a few slides, we added 1-2 drops of 2%

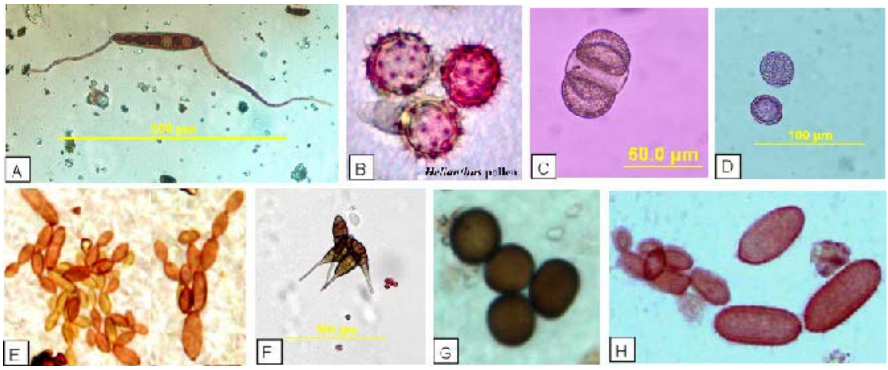
safranin for staining the pollen that improved the visibility of the pollen architecture. Pollen grains were extracted from the anthers of the flowers and half of them were mounted with deionized water and half of them were mounted with 2% safranin. The pollen grains were teased with a clean needle and the debris from the anthers was removed using a forceps. The slides were mounted and observed under the microscope.

Digital Microscopy on aeroallergens

Tapes were analyzed with five latitudinal traverses that correspond to specific hours, and the daily mean concentration was assessed. Daily mean concentration was determined mathematically by taking a sum total of all traverses and multiplying this sum by a correction factor. Correction factor is microscope-objective specific and is determined prior to the counting. It can be expressed as the total area sampled divided by the graticule width (Lacey, 1995). Samples were examined, counted, and photographed using a BX-40 Olympus microscope attached to a DP-70 Digital Camera. We also used an *Image Pro Plus* software to analyze the capture images. This assessment involved the optical counting of pollen grains and fungal spores through a microscope and the use of a micrometer scale and graticule (100 square microns). The graticule is an ocular grid consisting of a square area of 100 square microns. The graticule was calibrated using a stage micrometer. The pollens and fungal spores were identified using standard keys from literature and the websites (Ogden, 1974; Moore *et al.*. 1991, Horner *et al*. 2002, websites of AAAAI, Palynology, University of Arizona). The diurnal variation in aeroallergen count was determined by counting them from the corresponding traverse of the tape with the specific time period. The time of entrapment of a specific aeroallergen could be determined by placing a scale beside the slide.

Observation on pollen and fungal spores

The most significant aeroallergens recorded were the pollens like grass pollen (Poaceae), Short Ragweed (*Ambrosia artemisiifolia*) (Fig. 1D), Pine (*Pinus strobus*) (Fig.1C), Common Sunflower *(Helianthus annuus)*, Hairy Sunflower *(Helianthus hirsutus*) (1B), Buffalo Bur *(Solanum rostratum)*, Purple Nightshade (*Solanum elaeagnifolium*) and Lamb's Quarters (*Chenopodium album*) and the fungal spores like *Alternaria* (Fig. 1F), ascospores from Pezizales, *Dreschlera* (1A), *Stachybotrys* (1H), *Cladosporium* (Fig. 3E), *Curvularia*, Teliospores of *Ustilago* sp. (1G).



Figs. 1A-H showing the most frequent aeroallergens of the Texas Panhandle. A. *Drechslera* spore, B. Pollen from *Helianthus hirsutus* (Hairy sunflower). C. *Pinus strobus,* D. Ragweed (top) Grass (bottom) pollen, Spores from E. *Cladosporium*, F. *Alternaria alternata*, G. *Ustilago and* H. *Stachybotris.*

Effect of meteorological factors on distribution of spore and pollen

Temperature was found to have an inverse relationship with mold spore concentration. Rainfall was found to affect the mold count directly, with increases in precipitation bringing subsequent higher mold spore concentrations.

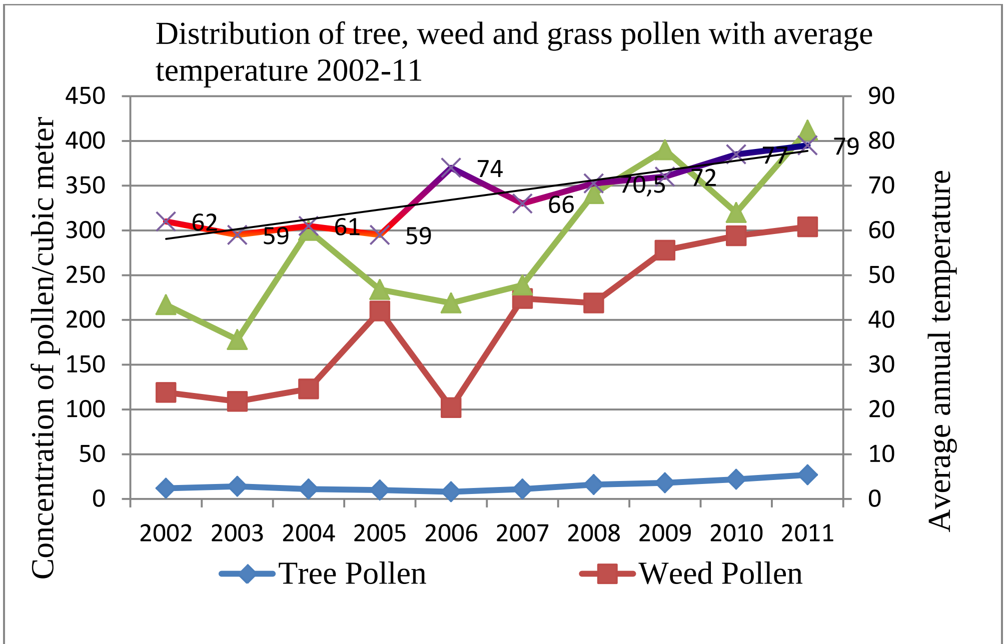


Fig.2.

Graph showing the distribution of tree, weeds and grass pollen with variation of temperature. Significant increases in fungal spores were observed in late summer following several inches of rain. Fungal spore concentrations did show more susceptibility to meteorological conditions on a daily basis than did pollen concentrations. Of all the airborne pollens observed, most significant was that of annual or short ragweed (*Ambrosia artemisiifolia* L.) pollen. It is characterized by a spherical morphology with a multi-porate surface and 16–27 micrometers in diameter (Fig.1D). Pores are geometrically arranged about the surface and can be seen easily using phase-contrast microscopy. *A. artemisiifolia* begins its pollination cycle in mid-August and continues until mid-October in the Texas Panhandle. Ragweed pollen is arguably the largest single seasonal allergen in North America (Knox, 1979). Grass (*Poaceae*) pollen was constant component of the pollen count throughout the study, having peaks in mid-July and then again in late August. We observed different types of grass pollens that are allergenic to many patients as they exhibit sensitization on challege tests at the Allergy ARTS clinic. Most grass pollens were similar in morphology. Grass pollen has an ovate morphology with a single pore (Fig. 1D). Sizes range from 7 micrometers to over 75 micrometers, as in the case of corn (*Zea maize*) pollen. Significant smooth cell walls were observed on grass pollen, with little ornamentation being present on the surface. Specifically, the mean concentration of tree pollen over the study period was 2 grains/cubic meter of air. The mean concentration of grass pollen was 6.0 grains /cubic meter of air, and of weeds the mean concentration was 33.2 grains/cubic meter of air. For molds, the mean was 713.7 spores/cubic meter of air over the study period. Mold spore concentration varied the most, followed by weed pollen. Tree pollen varied in concentrations and were present in great amount during Mid August till September. Weed pollen increased drastically in mid-August. Grass pollen concentrations remained steady throughout the season. The comparative collected pollen and spore data and the weather information revealed that specific weather variants could influence dispersal and concentration of a specific aeroallergen. We have recorded the phenomenon of early flowering all over Texas covering Amarillo-Canyon metroplex, Denton, Dallas metroplex, Houston and Galvaston. Many studies have already shown that flowering times have come earlier as a result of recent global warming, but what's unknown is how long the plants will be able to "keep up" by budding earlier and earlier (National Geographic, 2016). The mean maximum temperature for this survey was 31.4°C, and the mean minimum temperature was 18.2°C. Temperature was found to have an inverse relationship with mold spores. As the temperature rose, mold spore concentrations would decrease to a great extent. We observed a significant reduction in the ascospore concentration with the increase in temperature. The count of ascospores during the wet weather could surpass the total concentration of dry conidia measured on a typical summer day. There was a great variation in the occurrence of spore species in different times of the day. Ascospores, although observed throughout the day, were in greater concentration in the early morning hours. *Alternaria* conidia were present in greater quantities during the warmer, dryer afternoon and evening hours. The effect of temperature on pollen concentration is not as clear, though there does appear to be a long-term relationship. Temperature variations as they relate to seasonal changes have been shown to affect primarily the types of pollens observed, not necessarily the concentrations. It was observed that precipitation increased the number of mold spores, but there was no direct correlation between number of spores and amount of rainfall. As noted earlier, certain genera of fungi, such as the Ascomycetes, require raindrops to initiate their active dispersal mechanism. Corresponding to this knowledge, it was found that Ascomycetes concentrations significantly increased in the hours just following a rain shower. Precipitation in general affected mold spore concentrations directly by increasing the daily concentrations, due to an increased relative humidity and to the availability of moisture. It was noted that in the hours just following precipitation, pollen concentrations were observed to drop drastically, as the particles were washed from the atmosphere. In the Texas Panhandle wind speed is an important factor that controls the aeroallergen concentration. Peak wind speed showed some direct correlation with mold spore or pollen concentrations. The mean peak wind speed over the study period was 5.4 m/s. It was observed that sustained windy or windless periods did have an effect on pollen and spore concentrations. Wind speeds over 8.0 m/s increased pollen and spore concentrations on average. Due to smaller size and less mass, mold spores were more directly influenced by wind speeds. Possibly a more representative comparison would be to compare average daily wind speed to the concentration of aeroallergens. Overall, the most prevalent aeroallergens present during the summer months were *Alternaria*, short ragweed (*Ambrosia artemisiifolia*) and grass (*Poaceae*) pollen. During the summer months the most dominant pollen was the grass (*Poaceae*) pollen, which peaked in July and then dropped off in August. Grass pollen count has been increased in the city of Hisai in Mie Prefecture in a period of 15 years and that caused the increase in sensitization to the allergi rhinitis (Ito Y, Kimura T, Miyamura T. 2002). In mid-August, the dominant pollen changed to ragweed (*Ambrosia artemisiifolia*.), corresponding to the beginning of the flowering season for short ragweed (Muilenberg *et al*., 1996). As evidenced earlier, the presence of pollen in ambient air is significantly influenced by physiological functions of the plant’s flower that interact with various meteorological parameters (Bush, 1989). As noted earlier, certain genera of fungi, such as the Ascomycetes, require raindrops to initiate their active dispersal mechanism. Corresponding to this knowledge, it was found that Ascomycetes concentrations significantly increased in the hours just following a rain shower. Precipitation in general affected mold spore concentrations directly by increasing the daily concentrations, due to an increased relative humidity and to the availability of moisture. It was noted that in the hours just following precipitation, pollen concentrations dropped drastically, as the particles were washed from the atmosphere. From the analysis of the ten years aeroallergen data from Texas Panhandle region it can be concluded that there was a gradual shift in the aeroallergen index and that caused the increased cases of allergic rhinitis (Fig. 2, 3).

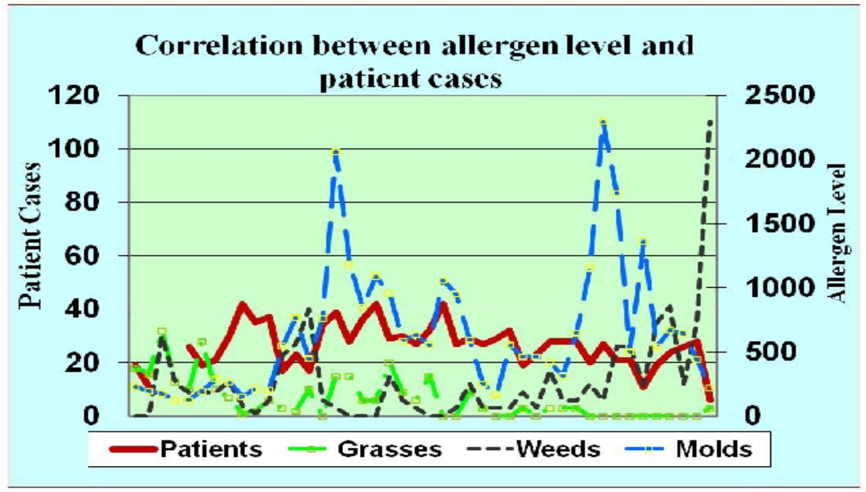


Fig. 3

Correlation between allergen level and cases of allergy and asthma (data analyzed from Allergy A.R.T.S Clinic, 2001-2014). A gradual shift was noticed in the aeroallergen concentrations with the increase in temperature (Fig. 2). Even this slight change reflects the impact of global warming amongst the aeroallergens. From the analysis of aeroallergen data it is very clear that the concentration of pollen from the trees, grass and weeds have a significant correlation with the number of patients suffering from allergy and asthma. The peaks in pollen and mold concentration match with the peak of the number of patients visited the allergy clinics. Fig. 3 shows the graphical representation of the aeroallergen and patients' data analyzed from Allergy A.R.T.S Clinic, for the period of 2001-2014.

AHPCO Nanotechnology to improve indoor air quality (IAQ)

The implications of nanotechnology can improve the quality of life and add new features to the original functions of the product. Improving the quality of life of individuals is imperative in business because it will improve the well-being of the society as a sum. Health professional in all the countries expressed their concerns on the increasing trend of allergy and asthma cases. Allergies are caused by a hypersensitive reaction of the human body's immune system to the allergen. Global warming exerts substantial effect on flora and fauna. Increasing greenhouse gases cause accelerated pollinosis and fungal spore production, two major aeroallergens for asthma and allergies. Research collaboration for a decade between the West Texas A&M University and the Research and Development division of Air Oasis on aerobiology and biotechnology developed an air purification system that uses Advanced Hydrated Photo Catalytic Oxidation (AHPCO) Nanotechnology to reduce the airborne aeroallergen and VOCs. Air Oasis1 air purifiers utilize a new generation AHPCO technology that does not rely on filters or air passing through the air purifier. 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 these unique air purifiers that target the particulate matters in the air as well as on the surface and sanitize the air eventually. We assessed the capacity of AO 1000 G3 model of air purifier, Inducts, Wall Mounts and Air Oasis Mobile Sanifier in reducing the aeroallergen: pollen, bacteria, fungal spores and hyphae, dust particles, fibers, animal dander and VOCs in the indoor air. We have been working in developing an efficient device to reduce the indoor aeroallergen to alleviate the symptoms of allergy and asthma. AHPCO has been used in reducing indoor aeroallergens, MRSA in the hospitals, and microflora that cause contamination during food processing. These air purification systems were evaluated in the Microbiology and Mycology laboratories of the BSA Hospital laboratory in Amarillo, Texas in terms of the net reduction of bacteria in a negative pressure laboratory and the specific effect on isolates identified to be methicillin resistant *Staphylococcus aureus*, MRSA. Bacteria isolated from the room air exposure were gram positive bacilli such as *Bacillus* sp. and *Coryneform* (diptheroids) sp., coagulase negative *Staphylococcu*s sp., *Micrococcus* sp., and encapsulated gram negative bacilli. We recorded an average of 68.5% reduction of bacterial population on the TSA plates when running the Air Oasis air purifiers. The AHPCO nanotechnology has been used to develop an efficient air purification system, devices to ensure the safety in food processing chambers and charging docks for the mobile phones. AHPCO nanotechnology has been proved to reduce allergy and asthma symptoms by reducing the indoor VOCs and aeroallergens, such as air-borne pollen, bacteria, fungal spores and hyphae, dust particles, fibers and animal dander. Evaluations on safety measures of the AHPCO nanotechnology showed no side effect on the human cell cultures. The Air Oasis units were exhibited at the world trade show of China Clean Expo 2013 and are being marketed in China, Hong Kong, Singapore, Bangladesh, Dubai, USA and UK. Air Oasis, USA is developing strategies to promote small businesses in Southeast Asia and all over the world.

Conclusion

Allergy and Asthma cases have been doubled in the Texas Panhandle area since 2007. The aeroallergen data that we collected using a Burkard Spore Trap for 15 years showed a steady increase in aeroallergen concentration in the Texas Panhandle area. A fluctuation and gradual shift in aeroallergen index with the warmer climate and a shift in flowering seasons were noticed that contributed to the increased allergy cases. Analysis of aeroallergen can help in diagnosis and treatment of allergic rhinitis. Analyzing the aeroallergens with a Burkard Spore Trap provided information regarding the onset, duration, and severity of the pollen season that clinicians use to guide allergen selection for skin testing and treatment. We have been investigating the daily aeroallergen concentration in terms of the meteorological conditions such as daily temperature, wind speed and precipitation. We used a Burkard Volumetric Spore Trap to determine the daily aeroallergen index by collecting aeroallergen samples and characterizing them with digital, fluorescence microscopy for 15 years. The most significant aeroallergens recorded were the pollens from Asteraceae, Chenopodiaceae, Poaceae and spores from *Alternaria, Stachybotrys, Aspergillus* and *Curvularia*. The characterization and analysis of microscopic aeroallergens was accomplished using Fluorescent Microscopy. Aeroallergens were viewed, recorded, and analyzed with fluorescent microscopy exhibited storage protein, oil granules, and the layer of sporopollenin, along with additional ultra-structural details like concordant pattern, exines, pores, colpi, sulci, and other ornamentations. The digital micrographs provided micro-measurements and additional views of the detailed ultra-structural morphology. Analyzing the aeroallergens collected and sampled with the Burkard Spore Trap provided information regarding the onset, duration, and severity of the pollen season that was compared to the number of patient cases seen over a 15 year period. The data accumulated from these studies can be utilized for the forecasting the types and duration of the pollen season. Temperature was found to have an inverse relationship with mold spore concentration. Rainfall had a direct correlation with the mold count directly, increase in precipitation resulted in subsequent higher mold spore concentrations. Early flowering has been recorded from different parts of the United states that produced more pollen and hence resulted increased allergic rhinitis and asthma cases. From the analysis of aeroallergen data it is very clear that the concentration of pollen from the trees, grass and weeds have a significant correlation with the number of patients suffering from allergy and asthma. The implications of nanotechnology can improve the quality of life and add new features to the original functions of the product. AHPCO Nanotechnology has been used in reducing indoor aeroallergens, MRSA in the hospitals, and microflora that cause contamination during food processing.

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