INCREASE IN ALLERGIC RHINITIS, ASTHMA AND RESPIRATORY AILMENTS, AHPCO® AND PLASMA NANOTECHNOLOGY AS THE REMEDY FOR IMPROVING THE INDOOR AIR QUALITY BY REDUCING THE INDOOR AEROALLERGEN AND PARTICLE COUNTS

[1]NABARUN GHOSH, [2]NELOFAR SHERALI MS, [3]JEFF BENNERT, [4]JAY VITALE

[1]PhD, MAAAAI, Sigma Xi
[1]Professor of Biology, West Texas A&M University, Canyon, Texas 79015
[1,2]Life, Earth and Environmental Sciences, West Texas A&M University, Canyon, Texas
[3]PhD, CTN[3]
[3]Air Oasis, Amarillo, Texas, United States of America
[4]Air for Life, Harrow Middlesex HA1 1PD, UK
E-mail: [1]nghosh@wtamu.edu, [2]nsherali1@buffs.wtamu.edu, [3]drj@airoasis.com, [4]jayvitale21@gmail.com

Abstract - Worldwide allergy and asthma cases are on the rise[1]. The primary concern of the present decade is air pollution as aerosols in the form of Particulate Matter (PM), also known as particulate pollution. The most dangerous particulate matters are those which are less than 10 micrometers, because when inhaled, they can reach deep down into the lungs and enter into the bloodstream. Studies on improvement of indoor air quality are extremely important to maintain a good health. This study focused on the identification and enumeration of aeroallergens in the outdoor air of the Texas Panhandle and on the efficiency of AHPCO®and Bi-Polar technologies on the decay of particulate matter[2]. The year-round aeroallergen data are important to aid in diagnosis of specific allergies and asthma cases. The aeroallergens were collected using a Burkard Volumetric Spore Trap (UK) placed on the third floor roof of the Agricultural and Natural Sciences building at the West Texas A&M University. The trap rotates with the direction of the wind and collects the aeroallergens on the Melinex tape placed on the drum. The tape was stained with 2% Safranin and mounted with PVA mountant. The samples were examined, counted, and photographed using a BX-40 Olympus microscope attached to a DP-70 Digital Camera. Image Pro Plus software was used to analyze the captured images allowing us to record the measurements (diameter and area) of the aeroallergens facilitating their characterization[1]. Particulate matters in the air, especially PM2.5, are a growing problem with the ever increasing atmospheric pollution. AHPCO®and Bi-Polar technologies from Air Oasis was tested against the decay rate, or the destruction of the particulate matter present in the chamber air per unit of time, of particulate matter to improve overall air quality. A fiber glass chamber was used to evaluate the rate of the decay of aerosol as a function of time before and after using the AHPCO®nanotechnology in an air purifier 3000 and the plasma nanotechnology in a Bi-Polar unit.Illite NX powder was used as a sample of aerosol since it has a similar mineralogical composition to atmospheric mineral dust. The 12 mg/cubic meter of powder was dispersed in the chamber through an inlet. A DustTrack 8520 spectrometer was connected to the chamber by an outlet through which it quantified the concentration and evaluated the rate of the decay of the dust particles over a time period. A DustTrack 8520 spectrometer evaluates the rate of decay of the particulate matters. The air purification system, developed with novel AHPCO® and plasma nanotechnology, efficiently reduced the indoor particulate matters in course of progressive time intervals. AHPCO® and Bi-Polar units degraded high and low concentrations of aerosol at approximately the same rate of decay. The high concentration rate of decay was faster by 0.00049mg/m3*s with the experimental trial with Bi-Polar unit compared to 0.0001mg/m3*s with AHPCO®thereby indicating that the Bi-Polar was slightly more efficient in terms of reducing the concentration of the particulate matter in the indoor air. This technology can be used at various facilities like residential homes, hospitals, offices and restaurants to improve the indoor air quality by reducing the concentration of particulate matters present in the air[2].

Index Terms - PM2.5, Advanced Hydrated Photo-Catalytic Oxidation (AHPCO®) nanotechnology, Bi-Polar plasma nanotechnology, IAQ, Air Oasis air purifiers, pollen and fungal spore Count.

I. INTRODUCTION

Air Pollution kills many people in the world

A major form of air pollution is aerosol; scientists describe it as tiny, airborne solid and liquid particles that are released by Earth's surface both naturally and as a product of human activities. Commonly called haze, air pollution has periodically dominated over Southeast Asia for the last 24 years. Asia Pacific is predominately affected, which has a population over 4.5 billion and a very high population density. With a combined population above 2.7 billion, China and India are both having enormous sources and victims of air pollution. Since 1997, haze episodes have occurred in Southeast Asia and lasts for months causing up to 30% spikes in hospital admissions[3]. According to World Health Organization (WHO), air pollution kills 7 million people every year causing at least one in eight deaths worldwide. The main cause of death in these people is respiratory diseases such as bronchial asthma, chronic obstructive pulmonary disease, and heart disease[4]. A survey published in Lancet in 2010 showed that 40% of the premature deaths in the world were caused by air pollution in China. Hong Kong's school of Public Health reported more than 3,000 premature deaths in the city in 2013.

PM2.5 concentration in Beijing, China has become a focus for government and common people. It has been explored through source apportionment that heating generates significant influence on PM2.5 concentration in Beijing. Air pollution is the fifth-leading cause of death in India. According to the Centre of Science and Environment of New Delhi, the annual number of premature deaths linked to air pollution rose six-fold to 620,000 between the year 2000- 2010. According to the WHO reports in 2014, New Delhi had the worst air of 1,600 cities surveyed worldwide, and the rising air pollution had increased the risk of strokes, cancers, and heart disease. One significant component of ambient air pollution is peat fires (burning of the leftover roots of the crops attached to ground) in the agricultural fields adjacent to Delhi (Haryana-Punjab). This results in significant PM2.5 seasonal pollutions in Delhi relating to seasonal crops. Furthermore, another 2014 study has linked a significant drop in India's wheat and rice crops due to rising levels of two air pollutants during 1980-2010. Black carbon from rural cooking stoves, ground level ozone formed from motor vehicle exhausts, industrial emissions, and chemical solvents serve as a factor in this quandary. In China, India, and entire Southeast Asia, air pollution is a consequence of a massive exodus from farm to city in recent decades resulting in rising emissions from vehicles and factories, especially coal fired power plants. According to the WHO's report, out of 3.7 million people who died in 2012 from ambient air pollution, one million belonged to Southeast Asia. In a study by MinamMarilier from American and British Institutions in 2012, revealed that 1-11% of Southeast Asia's population was reportedly exposed to pollution above the WHO's recommended air quality levels during sporadic haze episodes between 1997 and 2006. This resulted in 15,000 cardiovascular linked adult deaths per year in those nine years. Roughly two-thirds of those were linked to PM2.5 and the rest were linked to levels of Ozone. One important component of ambient air pollutions are Ozone, CO_2, CO, SO_2, NO_2, PM2.5, and PM10. Coal-fired power dominates SO_2 emissions in Southeast Asia causing 20,000 premature deaths in 2011 and projected 70,000 deaths by 2030. NO_2 emissions are dominated by power units, industry, and transport activity. In Southeast Asia, the overall death toll per day due to ambient air pollution increased 50% from 500 in 1990 to 750 in 2015. In comparison, during this period, the death toll in India increased approximately 62% from 2,100 to 3,400. The levels of the deadliest, tiny particulate matter — known as PM2.5, which lodges deep in a person's lungs causing various disorders. Apart from bronchial asthma, cardiovascular derangement in the form of increased risk of lung cancer and stroke, were determined in people living in polluted areas with PM2.5 concentrations[5]. Increased risk of lung cancer ranging from 40% in Mumbai, 45% in Lahore, 50% in Jakarta, 50% in Peshawar, 60% in Delhi, and 80% in Allahabad were observed. Increased risk of stroke due to PM2.5 exposures were also observed up to 170% in Allahabad to 160% in Peshawar and 130% in Mumbai. The effect of PM2.5 was believed to have more adverse effects with an increase of 10 micrograms per meter cube (including myocardial infarction/heart attack, and lung cancer) on human health than PM10.

A study from Malaysia presented by Chooi Yong How (2016) revealed that concentrations of both PM2.5 and PM10 were increased during haze periods in comparison to non-haze periods. PM2.5 was higher than PM10 in both periods. However, PM2.5 concentrations at ground level increased with atmospheric temperature, but in this situation, ground level of PM10 decreased. Atmospheric particle loading during smoke-haze episodes due to vegetation burning has occurred in South Asian countries, including Delhi, causing predominant increase of the fraction below or equal to 2.5 microns (PM2.5). This is the dominant respirable factor in the smoke-haze occurring in South Asian countries. So air quality based on measurement of total suspended material (TSP) or PM10 is inadequate to assess the health risk[6].

The haze crisis in Southeast Asia resulted in school closures in Delhi, Singapore, Malaysia, and Indonesia. A State of Emergency was declared in six Indonesian provinces. The swimming world cup was disrupted, and the Kuala Lumpur Marathon was cancelled[7]. Polluted by PM2.5 concentrations in order of most polluted are countries are Zabol in Iran, Gwalior and Allahabad in India and Riyadh in Saudi Arabia. From 5th position to 100th position, polluted countries include different cities of Southeast Asian countries like China, India, Iran, Saudi Arabia, Pakistan, Bangladesh, Kuwait, Afghanistan, and Qatar. China, India, Pakistan, and Iran have multiple cities involved.

II. CURRENT SCENARIO OF ALLERGIC RHINITIS, ASTHMA IN THE TEXAS PANHANDLE

Allergens may be something to sneeze at, but area residents should not underestimate them as higher moisture levels and higher temperatures have caused higher pollen levels, local allergy experts said. "People should not take allergies as something mild." Allergies can have serious ramifications. Serious allergy suffers face sinus infections that can lead to meningitis. People who suffer from asthma caused by allergies can suffer irreparable lung damage if their asthma goes untreated, Dr. Constantine K. Saadeh MD, FICP stated in an interview in 2016.[8]

Global climate change is prompting many plant species into a sort of species-survival mode in which they release more pollen. Plants cannot move themselves, so they are producing more reproductive

units and that is a gene-controlled phenomenon. Pollen grains can fly 300 to 400 miles. In the Texas Panhandle area, we receive pollen grains from Oklahoma, Colorado, New Mexico, all of the neighboring states of Texas. Ragweed is the most important pollen allergen that is causing allergies to 90 percent of people who are suffering from pollen allergies in the world. The major source of ragweed in the Texas Panhandle is the Palo Duro Canyon State Park;it is just like a funnel, continuously producing weed pollen, especially from the short ragweed. Fifteen years ago, researchers from Dr. Ghosh's Lab found scattered patches of ragweed in the Canyon, but due to recent rains, a "continuous trail" of ragweed littered the landscape this summer[8].

There is also a very high correlation of the incidence of the mold-related allergies and asthma cases with the increased concentration of Alternaria conidia which are produced from the local dryland-farms after harvesting.Recent data collected by scientists shows that state the average rate of people who suffer from allergies in Texas is 6.5% while the average for the Panhandle and Amarillo is 13%. A little moisture causes the high count of the Alternaria conidia due to the Panhandle's dry environment and agriculture-farming with the feedlots. For outdoor allergies it is recommended that one should limit the outside exposure, taking the prescribed allergy medicine regularly and clean the nasal passages frequently. Using an air purifier can reduce the indoor allergies and asthmatic symptoms.[9]Over-the-counter antihistamine medicine can help mild allergy sufferers, but people experiencing more serious symptoms should consult a physician. It's also a good idea to wash clothes in hot water to deal with pollens that stick to clothing. Allergy-sufferers also should consider wearing a face mask when working outdoors. Parents can help their children tolerate allergies by letting them play outside at an early age, and residents suffering from allergies should consider having their homes inspected for mold growing inside walls or air ducts.[9]

III. AHPCO® AND BI-POLAR AIR PURIFIERS

As air pollution has increased, may it be outdoors or indoors, the need for the clean air has risen; and companies are coming up with new products to meet public demands. A new technology has hit the market that can be the answer to a lot of indoor air pollution. Collaboration between the corporate worlds with academia has been proved to be beneficial in scientific inventions. A collaborative research between the West Texas A&M University and Air Oasis developed Advanced Hydrated Photo Catalytic Oxidation (AHPCO®) Nanotechnology and Plasma Nanotechnology. AHPCO®was applied to develop an air purification system to reduce the indoor aeroallergen to improve the air quality, better food preservation. Plasma nanotechnology is applied to sterilize the ice makers. Air Oasis air purifiers utilize a new generation AHPCO® technology that simply produces a blanket of redundant oxidizers that not only clean the surrounding air, but target the particulate matters in the air as well as on the surface and sanitize the air eventually. The following figure showing the application of the AHPCO® and Plasma Nanotechnologies to develop the equipment for air purification, food processing and preservation, abating the odor and commodities for daily use[10].

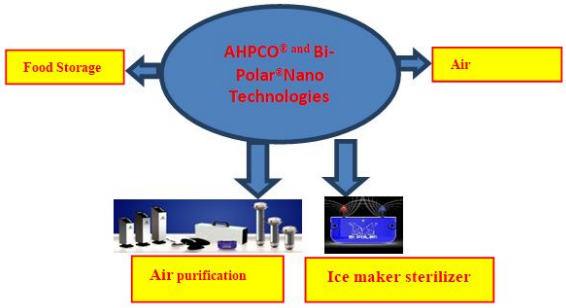


Fig.1 is showing the application of the AHPCO® and Plasma Nanotechnologies to develop the commodities for daily use. AHPCO® is very widely used for air purification, cell phone surface sterilization, to reduce contamination during the food processing.



Fig. 2 is showing on the making of a Bi-Polar® unit in the Air Oasis workshop. It creates cold plasma discharge which consists of positive and negative ions from water vapor in the air. Positive and negative ions attach to particles and allergens such as dust, smoke, pollen and dander. Particles cluster together to create larger particles and those larger heavy particles drop out of the air and are easily trapped in filters[2].



Fig.3 is showing different models of air purifiers that are marketed by the Air Oasis in the USA and Air for Life in the UK.

To test this theory, we have decided to do an experiment with the Advanced Hydrated Photo Catalytic Oxidation (AHPCO®) nanotechnology and Bi-polar unit a new filter-less air purifier by the Air

Oasis. The AHPCO® technology does not need a filter or air purifier for the air to pass through. The AHPCO® operates by creating ions from the UV light the UVC lamp destroys germs that pass by. Redundant air cleansing ions are then formed from water vapor when rays of light from the UVC lamp excite the AHPCO® catalyst when bacteria, viruses, VOCs and other pollutants are destroyed: Redundant ions actively seek out pollutants and break them down. They are neutralized as the contaminants are destroyed. Harmless By-products of Water Vapor: Ions revert back to harmless water vapor and the cycle repeats, thereby reducing additional contaminants. The AHPCO® nanotechnology proved to be efficient for net reduction of microbes, VOCs with the specific effect on Methicillin resistant Staphylococcus aureus, MRSA. A collaborative research is going on to apply these technologies to develop commodities like efficient air purification system, food preservation system, producing clean ice cubes in the ice makers and cell phone sterilizers. Air Oasis USA is developing strategies to promote small businesses all over the world.

CONCLUSION

AHPCO and Bi-Polar nanotechnologies have potential for worldwide applications for developing various commodities.

From the analysis of the indoor 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.



Fig.4. Assessment of AHPCO using Air-O-Cell technology showed a gradual reduction in fungal spores, dander and fiber counts.

We have recorded a significant reduction in the spore count per cubic meter or spores/m3 (Aspergillus/Penicillium) with increased intervals while running the AHPCO® Air Purification unit using the A-O-Cell technology (Fig.3). 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 and Dubai[10].

REFERENCES

[1] Ghosh, N., G. Estrada, Veloz, M., Bouyi, D., Bennert, J. Bennert, J., Saadeh, C. and Revanna, C. (2017). Meteorological and clinical analysis of aeroallergen data: Increase in allergy and asthma cases in Texas Panhandle. ALLERGY AND ALLERGEN IMMUNOTHERAPY: New Mechanisms and Strategies.101-124. Book Chapter, Apple, CRC Press, New York

[2] Sherali, Nelofar S. (2017).The Decay of Aerosol Concentration as a Function of Time Comparing the Effects of AHPCO and Bi-Polar and an Analysis of Aeroallergens, Fungal Spores and Pollen in the Texas Panhandle Area. MS Thesis, West Texas A&M University, Canyon, Texas, pp.1-49.

[3] Ives, M. (2015, January 30). Asia's air pollution haze. Retrieved February 06, 2018, from http://www.cnn.com/2015/01/27/asia/asia-air-pollution-haze/index.html

[4] The Guardian. (2014). Air pollution 'kills 7 million people a year' Web Link:

[5] https://www.theguardian.com/environment/2014/mar/25/air-pollution-kills-7m-people-a-year

[6] Myllyvirta, L. (2018). Air pollution in Asia: Trends, drivers and solutions. Retrieved February 6, 2018, Web Link: pubdocs.worldbank.org/en/438981496936069421/Lauri-AQA-DC-Vasudha.pdf

[7] How, C. Y., & Ling, Y. E. (2016). The Influence of PM2.5 and PM10 on Air Pollution Index (API). Retrieved February 6, 2018, from: www.civil.utm.my/wp-content/uploads/2016/12/The-Influence-of-PM2.5-and-PM10-on-Air-Pollution-Index-API.pdf

[8] The New York Times. (2015). Southeast Asia, Choking on Haze, Struggles for a Solution. https://www.nytimes.com/2015/10/09/world/asia/indonesia-forest-fires-haze-singapore-malaysia.html

[9] Saadeh, Constantine K. Experts: High pollen count increases medical dangers. Amarillo Globe news. Posted July 19, 2016

[10] Woksman, Blessing. (2017). Highest Rate of Allergy Cases This Year in the Texas Panhandle Than in the Last 5 Years, Channel 4 TV news, Myhighplains.com posted on Nov 16, 2017.

[11] Air Oasis (2018). Web link: Sanitize Air and Surfaces, Improved NASA developed technology http://www.airoasis.com/