PHYS ORG

Air pollutants could boost potency of common airborne allergens

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A pair of air pollutants linked to climate change could also be a major contributor to the unparalleled rise in the number of people sneezing, sniffling and wheezing during allergy season. The gases, nitrogen dioxide and ground-level ozone, appear to provoke chemical changes in certain airborne allergens that could increase their potency. That, in combination with changes in global climate, could help explain why airborne allergies are becoming more common.

The findings will be presented today at the 249th National Meeting & Exposition of the American Chemical Society (ACS).

"Scientists have long suspected that air pollution and climate change are involved in the increasing prevalence of allergies worldwide. But understanding the underlying chemical processes behind this phenomenon has proven elusive," says Ulrich Pöschl, Ph.D., of the Max Planck Institute in Germany. "Our research is just a starting point, but it does begin to suggest how chemical modifications in allergenic proteins occur and how they may affect allergenicity."

About 50 million people in the United States suffer from nasal allergies, according to the American College of Allergy, Asthma and Immunology. And those numbers are on the rise.

In previous work, Pöschl; Christopher Kampf, Ph.D.; Manabu Shiraiwa, Ph.D.; and colleagues at the Max Planck Institute explored how allergy-causing substances are altered in the air. Building on that work, they decided to dig deeper into how that happens and examine how traffic-related air pollutants could increase the strength of these allergens.

In laboratory tests and computer simulations, they studied the effects of various levels of ozone and nitrogen dioxide on the major birch pollen allergen called Bet v 1.

The researchers determined that ozone—the main component of smog—oxidizes an amino acid called tyrosine that helps form Bet v 1 proteins. This transformation sets in motion a chain of chemical reactions that involves reactive oxygen intermediates and can bind proteins together, altering their structures and their potential biological effects. When this occurs, Kampf says the cross-linked proteins can become more potent allergens.

Pöschl's team also found that nitrogen dioxide, a component of automobile exhaust, appears to alter the polarity and binding capabilities of Bet v 1 allergenic proteins. This, in conjunction with the effects of ozone, the researchers predict, may enhance the immune response of the body to these particles, particularly in humid, wet and smoggy environments.

The scientists plan to identify other modified allergenic proteins in the environment and hope, in collaboration with biomedical researchers, to study their effects on the human immune system, which may also be affected by other physiological factors.

"Our research is showing that chemical modifications of allergenic proteins may play an important role in the increasing prevalence of allergies worldwide," Kampf says. "With rising levels of these pollutants we will have more of these protein modifications, and in turn, these modifications will affect the allergenic potential of the protein."

More information: Effects of air pollution and climate change on allergenic protein containing aerosols in the anthropocene, 249th National Meeting & Exposition of the American Chemical Society (ACS).

Abstract
Increasing temperature, relative humidity, ozone, nitrogen dioxide, particulate matter and soot concentrations, arising from human activities in the

Anthropocene, i.e., the era of the human dominated environment, have multiple consequences for airborne allergenic proteins (aeroallergens) in the atmosphere. These consequences include among others: An altered bioavailability and allergen content of pollen due to longer pollination seasons and higher temperature, and chemical modifications of the allergenic proteins, which are found both in fine and coarse mode particles, by air pollutants. Thus air pollution and climate change are potential key factors for the increasing prevalence of allergies. In laboratory and numerical simulation studies we have examined the chemical transformation of proteins by the air pollutants ozone and nitrogen dioxide depending on the pollutant concentrations and relative humidity (RH). Further, the phase state of the proteins was varied between solid (low RH experiments), semi-solid (high RH experiments), and liquid (bulk solution experiments) to account for the differences in phase state of atmospheric particulates, e.g., aerosol particles and cloud droplets. In a recent paper, we report the efficiency and site-selectivity of protein nitration for the major birch pollen allergen Bet v 1. The kinetics and site-selectivity of nitration by ozone and nitrogen dioxide were found to be strongly dependent on protein phase state as outlined above. In recent experiments we were also able to show that protein ozone expo sure at atmospherically relevant concentration induces oligomerization processes, which likely affect the immune response in the human body towards the respectively modified allergenic proteins. For these first experiments, we used bovine serum albumin (BSA), which contains 21 tyrosine residues in the amino acid sequence, as a model protein. We were able to show that the cross-linking upon ozone exposure is caused by the formation of covalent dityrosine species. In this presentation, experimental design, analytical methods, results, and conclusions will be discussed.

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