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CONSUMPTION OF BARBECUE FOODS AND THE PREVALENCE OF CANCER

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ABSTRACT

Polycyclic aromatic Hydrocarbons (PAH) which are Hydrophobic Organic compounds consisting of Carbon & Hydrogen atoms and contain two or more Aromatic rings in their structure. This group consists about 200 different PAH compounds. These are highly lipid soluble and thus have high absorption from the gastrointestinal tract of Mammals. Metabolism of PAH occurs via CYP-450 mediated Mixed function oxidases. These compounds are harmful to the human body and are produced when food is cooked at high temperatures. They appear in grilled, smoked food and are known to cause damage to DNA and thereby increase the risk of Cancer. The economic conditions, diversity of processed foods and ever-changing consumer habits have increased the consumption of barbecue foods by several folds. Apart from human beings, these compounds possess equal hazard to the environment too. They are removed from the Atmosphere by wet and dry deposition processes. Various remediation techniques are being tested which are known to have the potential for removing these hazardous environmental chemicals. The aim of this review is to discuss the impact of PAH on human body and how its long time exposure could be fatal and can cause Cancer.

INTRODUCTION

Polycyclic aromatic Hydrocarbons which are Hydrophobic Organic compounds consisting of Carbon & Hydrogen atoms and contain two or more Aromatic rings in their structure. This group consists about 200 different PAH compounds.[1]

The International Agency for Research on Cancer, defines the simplest PAHs as Anthracene & Phenanthrene, both of which contain three fused aromatic rings. Whereas other small molecules like Benzene are not considered as PAHs.[2]

The incomplete combustion of Organic materials like wood, oil and coal is known to be the Major source of Polycyclic aromatic hydrocarbons. They are not synthesized for any industrial use but however a few commercial uses of PAHs are known. They are used in Chemical industries, Pharmaceuticals, photographic products, agricultural products and lubricating materials. The general use of the simplest PAHs is given below-

Phenanthrene- For manufacturing resins and pesticides.

Anthracene- Manufacturing of pigments and dyes, used as a diluent for wood preservatives.[3]

The toxicity is attributed due to their ability to interfere with the cellular membrane function and the enzyme systems associated with the membrane.[4] Studies have proved that these substances are potent carcinogens, immune-suppressants and have mutagenic effect. The development of Immune system, Host resistance & humoral immunity is affected as a result of exposure to these substances.[5]

The importance on PAHs have increased due to large number of sources of transmission. Humans are exposed to PAH mostly through diet. There are two possibilities by which PAHs are transmitted to food. First is due to contamination by environment (Air, soil and water), or the second one maybe when the food is being cooked and processed. Cooking at high temperatures (roasting, grilling) or processing of food (smoking and drying) is the main reason for the PAHs formation.[6]

From nutritional point of view, meat & meat-products are proven to be essential to human bodies.[7] The economic conditions, diversity of processed foods and ever-changing consumer habits have increased the consumption of barbecue foods by several folds.[8]

Sources of PAH- There are three major sources of PAH in the environment. These are Biological, Petrogenic & Pyrogenic. Pyrogenic PAHs are formed when the Organic substances under low or no oxygen levels are exposed to High temperatures, this process is known as Pyrolysis. The formation of PAHs during crude oil maturation process is known as Petrogenic. Such PAHs are common during the storage, transportation & use of crude oil &

its products. It's also likely that PAH can be produced biologically, by certain plants or bacteria or during degradation of vegetative matter. This mode of production is either natural or anthropogenic.[9] The natural sources include Volcanoes, Petroleum seeps, sedimentary rocks erosion and brush fires. Anthropogenic sources include incomplete combustion (Large point source), dispersed sources like automotive emissions, jet aircraft exhaust (Small point source) & other sources like sewage sludge & petroleum product spills.[10]

Occurrence of PAHs in food- Food cooked at high temperatures (roasting, frying, grilling) and Processed food (smoking & drying) are known to be the major sources of PAH.[11] The Standing Committee on Foodstuffs in 2001 reported that barbecued meat contained 130 µg/kg of PAHs. Higher levels (200 µg/kg) were found in meat & smoked fish.[12]

PAHs containing 5 or more aromatic rings occur predominantly on particulate matter like soot & fly ash. PAHs with 2-3 aromatic rings are in vapor phase whereas PAHs with 4 aromatic rings are in intermediate position.[13] Through the phenomenon of surface adsorption low molecular mass PAHs may concentrate on the waxy surface of fruits & vegetables. The PAH concentration is usually greater on the surface of plants like leaves and peels than on the internal tissue. Careful washing may help in removing 50% of total PAH. Various processing procedures like smoking, cooking and drying of food is the major source of contamination by PAH.[14]

Effect on Humans- The effect of PAHs on human body will be governed by three factors-

- Quantity of PAHs that has entered the body
- For what duration they remained inside the body
- How did the body responded to the PAHs

The effects due to exposure to PAHs can be either short term or long term. The short term effects are however unclear but studies have shown that it may produce symptoms like confusion, NVD and irritation to eyes.[15] Whereas Long-term exposure is reported to cause liver damage, kidney damage, cataracts and jaundice. A repeated dermal exposure of Napthalene may result in inflammation of skin & redness. Swallowing or inhaling large amounts of Napthalene may result in the lysis of RBCs. Studies have shown that a Long-term exposure to even low doses of PAHs can result in Cancer.[16] Animal studies have shown that PAHs are known to affect the immune system, hematopoietic system, reproductive and neurologic system, and can also alter the developmental processes.[17]

The International Agency for Research on Cancer has classified PAHs to be probably, or possibly Carcinogenic to humans. These are classified into Group 1,2A & 2B.

Benzo[*a*] pyrene belongs to Group 1. Whereas Chrysene, naphthalene, benz[*a*] anthracene, benzo[*k*] fluoranthene and benzo[*b*] fluoranthene belongs to Group 2B.[18]

PAHs are known to be potent teratogens, mutants & carcinogens and are known to have significant adverse effects on Humans. The most serious effect is after Inhalational exposure of PAHs is Lung Cancer.[19] The most common PAH known to cause cancer in animals is Benzo(a) pyrene . Studies on workers who were exposed to a mixture of PAHs revealed a high incidence rate of lung, bladder, skin & gastrointestinal Cancers. The data supporting this is however limited as the workers were exposed to other potent Carcinogenic Chemicals besides PAHs.[20]

Effects of pah on immune system:- Studies have shown that PAHs cause suppress immune reaction in the rodents.[21] PAH when taken in diet may result in DNA adducts in the lungs.[22] Most of the immune toxic effects of PAH are not due to the parent compounds but their reactive metabolites or epoxides.[23]

Genotoxic effects of pah:- Geno-toxic effects have been reported in both rodents as well as in-vitro cell lines.[24] Genotoxicity is an important step in the development of Carcinogenicity& some forms of developmental toxicity.[25] Chromosomal alterations, base-pair substitutions, frame shift mutations, deletions, strand breakage & S-phase arrest are the various Genotoxic effects reported.[26]

Teratogenicity:- Experimental animal studies have shown Embryotoxic effects due to exposure to PAHs.[27] The occurrence of these effects in Humans is not clear. However, it was shown that exposure to PAHs during pregnancy may result in birth defects like premature delivery, low birth weight and heart malformations.[28] The cord blood of the exposed babies have shown damage to the DNA that maybe linked to Cancer.[29] A high prenatal exposure may result in Childhood Asthma, increased behavior problems and low IQ levels during the age of 3-8.[30]

Routes of exposure- Major Routes of exposure include-

- Eating food which contains PAHs

- Cigarettes smoking
- Breathing indoor air
- Breathing smoke from fireplaces[31]

Tobacco smoke is known to contain many PAHs like benzo(a)pyrene and about 40 or more suspected human carcinogens.[32] Airborne fallout may also result in deposition of PAHs into the soil.[33] Route of exposure in both occupational & non-occupational settings include dermal, inhalational and ingestion.[34]

Metabolism:- PAHs are highly lipophilic compounds and therefore their bioavailability after inhalation & ingestion is significant. Studies have shown detectable levels of PAH in all internal organs especially those that are rich in adipose tissue.[35] These organs will serve as storage depots that would gradually release the PAHs later.[36] Once PAHs have entered the organism, they undergo a multi-step metabolic activation catalyzed by various enzymes. The mixed-function oxidase system usually carries out this process. First reaction is of Epoxidation and the epoxides formed are then conjugated with glutathione, whereas the ones which are not conjugated will be converted to diols and phenols. Such metabolites are not sufficiently polar to be excreted and thus are conjugated with glucuronic acid or Sulfuric acid to enable excretion. Most of the metabolites are excreted into the urine or feces.[37]

Removals of PAHs:- PAHs are removed from the environment by several methods like photochemical degradation & biodegradation.[38] Whereas, removal of PAHs from the atmosphere is carried out by processes like wet or dry deposition or other pathways.[39,40]

Prevention:- The greatest source of exposure to PAHs is by inhaling these compounds in tobacco smoke. Giving up smoking will not only reduce the exposure of PAHs for an individual but also his/her family. Following additional steps may prove to be effective in decreasing the exposure of PAHs-

- Decrease the consumption of charbroiled and smoked food
- Substituting coal-tar-based cosmetics
- While handling creosote-treated wood products, wear protective clothing
- To reduce fireplaces and wood burning stoves
- Avoid exposure to fumes and dusts
- Wearing appropriate respirator[41]

CONCLUSION

PAHs are organic compounds that are formed due to incomplete combustion or Pyrolysis of Organic material. They are transported & deposited in the atmosphere by wet or dry deposition. They also significantly affect the health of organisms. They may be found into food substances by either deposition from the air or manufacturing processes of food like smoking, drying and roasting. Many of the PAHs are known to be human carcinogens. These compounds are harmful to the human body and are produced when food is cooked at high temperatures. They appear in grilled, smoked food and are known to cause damage to DNA and thereby increase the risk of Cancer. The economic conditions, diversity of processed foods and ever-changing consumer habits have increased the consumption of barbecue foods by several folds. Apart from human beings, these compounds possess equal hazard to the environment too.

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