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Food Derivative Neurotoxins: A Silent Killer of our Well-Being

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Abstract: ***In the present scenario, due to the mass shift in food habits from natural and home-made fresh food to processed, canned and junk food – keeping a check on food derivative neurotoxin exposure especially among children and teenagers has become a huge challenge. This challenge gets amplified because people are mostly not aware of such danger that junk and processed food poses. Processed and junk foods contain various neurotoxins like Aspartame, Sucralose, Diacetyl, Monosodium Glutamate, Acrylamide, Aluminum etc. Consuming food loaded with such high content of neurotoxins leads to various mental problems like depression and even neural/ brain impairment. This article is an effort to collectively identify and understand the various food derived neurotoxins and their harmful effects on human body. This study has referred to multiple researches and finding in the area of various neurotoxins studies, medical reports and research findings on effects of food derived neurotoxins on human nervous system, brain cells and even DNA.***

Keywords: Food derived neurotoxins, msg, Aspartame, Diacetyl, fast food side effects

1. Introduction

In the last three decades food habits among Indian urban families have witnessed a massive transformation. The small structured nuclear family, time deprived working parents and massive advertisements pushed by global fast-food giants has drastically shifted the food preferences of young generation from homemade meals to fast/junk foods. Today every fast-foodjoint could be seen bursting with crowd of youngsters and kids at a very young age developing strong desire for commercially packed potato chips, synthetic-carbonated drinks and various other processed food.

Junk and fast foods are not only devoid of the basic food values, but also contains un-proportionate levels of fat and sugar. The harmful effects due to bad food habit is not only limited to this, rather they are a dangerous source of chemicals, that destroys brain cells and mutate our DNA. These harmful toxins present in processed and junk food are known as Neurotoxins.

Commonly found Neurotoxins in packed potato chips, carbonated drinks, commercially made burgers, pizzas and canned food are Aspartame and Monosodium glutamate (MSG). Both of these neurotoxins amplify depression symptoms, pain and damage "happy/feel good" molecules like serotonin and dopamine. Both the Aspartame and Monosodium glutamate (MSG) are excitatory neurotoxins or excitotoxins, hence they over stimulate brain cells, even to the point of cell death. The food derived neurotoxins even at smaller doses can alter normal brain functionality, alteration of certain molecules and hormones and even leads to addictions. At a higher dose they cause severe nerve damage and various mental disorders.

Neurotoxins: Exogenous and Endogenous

These are a group of toxins that acts on the nervous system, disrupting the normal functioning of nerve cells and damages the nervous tissues. These are the substances that alter the structure or function of the nervous system including brain. Many substances both natural as well as man-made chemical compound can have neurotoxic effects on humans and animals.

Neurotoxins are commonly exogenous or external in origin that enters the body fromenvironmental sources like snake venom, ethyl alcohol, heroin, cocaine, arsenic, fluoride, lead, manganese, mercury, toluene, pesticides like DDT, polybrominated diphenyl ethers (PBDEs), polychlorinated biphenyls (PCBs) etc.

Some neurotoxins are endogenous, that is they are produced within the body. One such example is neurotransmitter nitric oxide (NO) and glutamate that acts as endotoxins at higher concentration. However nitric oxide and glutamate in lower concentration is nontoxic in nature and plays an important role in physiological functions, has a strong therapeutic effect in the body. Only at a particular concentration, nitric oxide and glutamate can turn into neurotoxin. Some other examples of such endogenous neurotoxins are Glutamate, Vitamin A, Vitamin B6 etc. Sometimes neurotoxins are produced inside body of some animals by certain specific bacteria. One such example is the neurotoxins - Tetrodotoxin and Botulinum, produced by bacteria Clostridium Botulinum inside the body of Puffer fish (family Tetraodontidae, class Actinopterygii).

Food derivative Neurotoxins

Various neurotoxins found in processed, canned and junk food, are added in the form of food additives, coloring agents, taste enhancer, artificial sweeteners and also for increasing shelf life of processed food.

These are all laced with various harmful toxins that directly attack the nervous tissue including brain. They can easily defeat the blood brain barrier system, and hence can easily infiltrate the brain cells and deposits various toxins.

Types of Food Derivative Neurotoxins

Various types of food derived neurotoxins are:

1) Aspartame: Artificial Sweetener

Aspartame is one of the most popular artificial sweeteners that in used in various food across the world. It is found in diet soda and in processed food with "Sugar Free"labels.Aspartame constituents of three chemicals-aspartic acid (50%), phenylalanine (40%), and methanol (10%). when the concentration level of these chemicals increases within the body, they affect the brain cells.

- Aspartic Acid is a non-essential amino acid in humans and it does play an important role in the synthesis of other amino acids and in the citric acid and urea cycles. Aspartic acid also serves as a neurotransmitter and it support multiple metabolic pathways. But when Aspartic acid concentration level increases in the body it can indeed excite brain cells to their deathand this process is referred to as "excitotoxicity".
- Phenylalanine is also an amino acid present in the brain but higher concentration of phenylalanine disturbs the normal balance of an important neurotransmitter, serotonin. Serotonin is the key hormone for happiness, since it regulates mood and prevents depression, irritation and makes one happy and sociable.
- Methanol is alcohol, which is extremely poisonous to the body. Methanol, which forms 10% of Aspartame, is converted in the body to formate (salt/ester of formic acid), which can either be excreted or can give rise to formaldehyde, diketopiperazine (a carcinogen) and a number of other highly toxic derivatives. Damaging effect of excess concentration of Aspartame commonly results to various illness like - migraines, dizziness, anxiety, depression, memory loss, and severe disorders ranging from fibromyalgia to Alzheimer's disease.

2) Sucralose: Artificial Sweetener

Sucralose is also a chlorinated artificial sweetener in line with aspartame and saccharin, and with detrimental health effects to match. Sucralose is bonded to chlorine making it highly toxic chlorocarbon. Some of the common damaging effects of Sucralose isheadaches, migraines, dizziness, brain fog, anxiety, depression, and tinnitus.Another adverse effect of sucralose to human bodyis that it prevents nutrient absorption and reduces the total number of good bacteria in the intestines by 50%, which results an exponential increase in bad bacteria in the gut. Its further results in numerous negative effects on the brain including damage to the hippocampus, the part of the brain where memories are stored.

3) Diacetyl

It is an organic compound with a very strong buttery flavor. It is a yellow or green colored liquid.It is commonly added to commercially manufactured ready to cook "microwave popcorns". Diacetylcauses a serious condition called "microwave popcorn lung." associated with bronchiolitis obliterans, damaging smallest airways, resulting in cough and shortness of breath. Diacetyl is able to cross the blood-brain barrier and causes beta-amyloid clumping which is a significant indicator of Alzheimer's disease.

4) Monosodium Glutamate: Ubiquitous Flavor Enhancer

Monosodium glutamate (MSG) is an odorless white crystalline powder. It is sodium salt of glutamic acid, a non-essential amino acid. MSG is used in processed food as a flavor enhancer, it is commonly added to Chinese food, canned vegetables, soups and processed meats. MSG is a pure glutamate and a naturally occurring neurotransmitter and an excess concentration of MSG in the body causes headaches and dizziness,even leading toexcitotoxicityi.e., stimulates brain cells to death.A larger quantity of MSG can also cause arterial dilatation, migraines, upset stomach, fuzzy thinking, diarrhea, heart irregularities, asthma, and mood swings.

5) Aluminum

Aluminum in its free ionic form, Al^{3+} is biologically highly reactive and is capable of damaging the essential cellular (neuronal) biochemistry. Chronic exposure to even low levels of aluminum may lead to neurological disorders. These disorders result from defective phosphorylation--dephosphorylatingreactions, reduced glucose utilization and site-specific damage induced by free radicals produced due to altered iron metabolism. Aluminumis commonly used as an additive in firming and raising agent, stabilizer, baking powder andanticaking agents. It is also found in drinking water, antacids, deodorant, cans, foil, and is commonly used in cookware. Aluminum is suspected of causing Alzheimer's. In 1970, autopsy was conducted on people who suffered and diedwith Alzheimer's and the result showed a high concentration of aluminum in the brain. It is now known that aluminum enters the brain when it comes in contact with fluoride, a neurotoxin commonly found in drinking water. Together they form aluminum fluoride which can pass through the blood-brain barrier to enter the brain and causes neurological disorders.

6) Acrylamide/ Domoic acid

Acrylamidebelongs to a large class of toxic chemicals, 'type-2 alkenes'. It is classified as a neurotoxin and there are three important hypothesespertaining to acrylamide neurotoxicity: inhibition of kinesin-based fast axonal transport, alteration of neurotransmitter levels, and direct inhibition of neurotransmission. It is believed by many researchers that relatively low level of acrylamide exposure to humans through food may not result in clinical neuropathy, while within many neuro-toxicologists, there is a fear about the potential for the cumulative neurotoxicity associated with it.Various studies showed that both high and low doses of acrylamide have the same neurotoxic effect, only difference being longer exposure in case of low doses. Acrylamide is found in fired foods like potato chips and French fries, baked snack foods containing wheat and sugar, including cookies and crackers.Processed foods including toasted grains, toasted wheat cereals, roasted grain-based coffee substitutes, roasted cocoa bean, dehydrated soup mixes etc. also contain acrylamide.

2. Food Derivative Neurotoxins Defeating Blood-Brain Barrier Defense System

Nature has equipped human body with various defense systems to protect and heal itself.Similarly, when neurotoxins enter the body, a defense system comes into play. The Blood-brain barrier (BBB) is a critical mechanism for the protection of nerve tissues, which prevents toxins and other adverse compounds from reaching the brain.

The nervous tissue present in the brain, spinal cord, and periphery comprises of a highly complex system, and even a minute perturbations to its environment can lead to significant functional disruptions. Various reasons for the susceptibility of nervous tissue include a high surface area of neurons, a high lipid content which retains lipophilic toxins and a high blood flow to the brain, which together adds up to an increased effective toxin exposure. The persistence of neurons throughout an individual's lifetime, increases further the damageto one more level.

In order to cope up with the above stated limitations, the nervous system has a number of mechanisms designed to protect it from both internal and external assaults.The Blood-brain barrier is one such mechanism. It is an extremely selective semipermeable membrane barrier, formed by brain endothelial cells that separates the circulating blood from the brain and extracellular fluid in the central nervous system. The barrier occurs in the form of tightjunction in endothelial cells all along the capillaries. It also includes a thick basement membrane and Astrocytes. As the brain requires nutrient entry and waste material removal, it is perfused by blood flow. Blood can carryvarious type of ingested toxins, which would induce significant neuron death, if they reach nervous tissue. However, protective cells termed astrocytes surrounding the capillaries in the brain, absorbs nutrients from the blood and subsequently transport them to the neurons, effectively isolating the brain from a number of potential chemical assaults.

This barrier forms a tightly packed hydrophobic layer all around capillaries within the brain, preventing the transport of large hydrophilic molecules. The choroid plexus also provides a protection layer against absorption of toxins in the brain. Cerebrospinal fluid (CSF) is synthesized by choroid plexus, the vascularized tissue layers in third, fourth and lateral ventricles of the brain. This defense barrier maintains a highly regulated environment within the spinal cord and brain, establishing selective passage of ions and nutrients and preventing entry of heavy metals like lead etc.

The Blood-Brain barrier allows passage of water, few gases, lipid soluble molecules by passive diffusion along with selective transport of Glucose and amino acid which plays a vital role in neural function. It prevents entry of many lipophilic potential neurotoxins by active transport mediated by P-glycoprotein.

However, most of the Food derivative Neurotoxins can pass through the Blood-Brain barrier system. Such compounds are able to penetrate into the brain and induce significant damage, as they are small, hydrophobic and has the ability to inhibit astrocyte function. As neurotoxins are compounds which adversely affect the nervous system, a number of mechanisms by which they function are through the inhibition of neuron cellular processes. These inhibited processes can range from membrane depolarization mechanisms to inter-neuron communication disruption.

3. Harmful Effects of Food Derivative Neurotoxins

Junk food and fast food are the commercial food products that has little or no nutritional value instead contains plenty of calories, sugar, salt, and fats. It also contains the various food derived neurotoxins that are highly degenerative to human brain, posinga threat to human life.

The following are the harmful effects or symptoms of food derivative Neurotoxins:

- **Headache, Dizziness, Migraines and Brain fog**
  Gradual accumulation of food derived neurotoxins in the brain and other body parts leads to overall unwell symptoms like acid influx, gas formation and also disruption of nerve connections and signaling.This leads to head ache, dizziness and even brin fog.
- **Anxiety, Mood Swings and Depression**
  A study conducted at the University of Montreal showed that mice suffered with withdrawal symptoms after their regular junk food diet was discontinued. In a human body such withdrawal symptoms can lead to the inability to deal with stress and trigger depression.
- **Learning and memory impairment**
  The American Journal of Clinical Nutrition in 2011 conducted a study on effects of junk food and it was found that healthy people who ate junk food for only 5 days performed poorly on cognitive tests that measured attention, speed, and mood. The study concluded that eating junk food for just five days regularly can deteriorate a person's memory. Asdiet laced with neurotoxins causes inflammation in the hippocampus area of the brain which is responsible for memory building and special recognition. Since junk food is high in sugar and fat, it can suppress the activity of a brain peptide called BDNF (brain-derived neurotropic factor) that helps with learning and memory formation.
- **Increases risk of Dementia and Alzheimer's disease**
  In a research at the Brown University,it was found that the increase level of fatty food and sugar concentration in body due to consumption of junk can substantially increase the insulin levels in human body. Just like Type 2 Diabetes, with higher levels of insulin, the brain stops responding to this hormone and become resistant to it. This can restrict our ability to think, recall or create memories, thus increasing the risk of dementia at old age. Autopsy conducted on the patients who suffered with Alzheimer's showed presence of a high level of aluminum in brain cells.
- **Uncontrollable craving leading to obesityand other complications**
  Fast food is packed with refined carbohydrates, causing rapid fluctuation in blood sugar level in the body. When sugar levels dips to a very low level, it can cause anxiety, confusion and fatigue. With high content of sugar level, a person tends to eat too fast and too much to satisfy the constant cravings. It also leads to organ damage and prolonged effect can lead to organ failure.
- **Disrupt Digestive system**
  It results in disruption of various digestive enzymes and good bacterial population instomach, leading to various

gastrointestinal ailments. It causes frequent acid flux, constipation, diarrhea, gastritis etc.

- **Stroke and various Heart complications**
  The sugar and fat ladened fast food leads to gradual fat deposition within the blood vascular system and increase the risk of various heart related diseases. Food derivative neurotoxins further increases this risk to many folds.
- **Cancer**
  Food derived neurotoxins are also carcinogenic, that disrupt the normal cell cycle, including various cell cycle check points and arrest points. This leads to formation of cancerous cells within the body.

4. Conclusion

The conclusion that can be derived henceforth, is that various Junk food including processed-canned food and various food additives contains a high source of Food derivative Neurotoxins that leads to various health complications in the form of Neurological and Psychological issues like Depression, Anxiety, Dementia, Alzheimer's, Schizophrenia as well as risk of gastrointestinal ailments, diabetes, obesity, heart disease, stroke, cancer, osteoporosis etc.

With the exclusion of processed, junk food from the diet and inclusion of nutritious food containing lots of fruits, vegetables and fibers, one can restrict the risk of suffering from various health related ailments and hence can maintain a healthymind and body.

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