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Food and Food Toxins: An Overview

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Abstract

The paper is an effort to educate masses regarding food and food toxins and how these toxins have helped food organisms to survive through ages.Most of the food organisms have toxins that help them fight against their enemies. Man however, is unique and has evolved methods , described in this paper,which render these food organisms palatable. The paper also embodies information on ; i. The food toxins ; ii. Selection and treating species to render them palatable ; iii. Adoption of methods for ensuring food preservation for off season use and iv. Enhance their nutritive quality and shelf life for ensuring all season availability.

The contents of paper also highlight how growth in science has created an impact on production for ensuring food for every mouth and the indent of science has inadvertently casted with deleterious effects that have been set forth with production of GMOs or excessive use of chemical fertilizers, insecticides, pesticides and weedicides.

Introduction

All living organisms, including man depend on factors outside their bodies for materials necessary to undertake life processes like growth ,development ,reproduction and well being .Hence man has also to direct himself for food supply to environment and this has always been his concern so that a balance could be stuck between food production and reproduction. Over the years, what appears to have happened is that birth rate is on rise and death rate considerably falling. Statistical figures evince that world human population took nearly hundred years to

double from 1850 to 1950 (changing from 1.27 to 2.51 billion).In next twenty five years, from 1950 to 1975,the population redoubled and by the turn of 2000 reached a figure of 6 billion. Today, we have reached an exceptional number of 7 billion. This geometric rate of population increase in comparison to food production which is rising at arithmetic rate is expectedly heading us towards a danger of outrunning our food supply. Our former President late Dr. Abdul Kalam and Rajan (2002) in book entitled, "India 2020:A vision for the new millennium" , has aptly raised an alarm that our consumption style because of economic growth shall further aggravate the crisis. Fact remains that famine has already began and what Scrimshaw (1963) referred as,"Hidden hunger", is already with us. The hidden hunger has casted its influence on man whose brain development before birth and protein deficiency later limits both intelligence and gain in height leading to an overall improper development of human beings (Scrimshaw,1968). Health deteriorations through use of fast foods is also on record and has often been linked to addition of spurious and or irrational use of preservatives and taste and flavor enhancers. Hence , getting educated and becoming knowledgeable about food is a concern of everybody .

What is Food?

Any substance that is ingested by an organism and results in the net addition of material substance or energy constitutes food. The term was further expanded to include those substances which are of non caloric or of cosmetic function and defined as, organic and inorganic substances that are taken into body in a way that these enter into metabolic process (Segall,1971). Thus in certain situations food may have substances which are indigestible but enter digestive mechanism intentionally, incidentally or accidentally except in cases where these are added as food additives (non food substances added to increase shelf life of food , improve its taste and change its texture or colour for better palatability).

Thus food in a simple way may be referred as all materials whether useful, unutilized or harmful taken into a cell or organism. This wide generalized definition for purposes of better understanding has even been divided into three broad categories.

Metabolic Food: Materials synthesized by certain cells and used by other cells in the body, to explain one may cite example of skin cells which synthesize vitamin D to be used by skeletal tissue in the body or synthesis of material by intestinal micro-organisms and subsequent absorption of body. Thus included in this category are also organisms that live as commensals and synthesize food to be used by the host. For example mammalian gut , the site of digestion and nutrients absorption,harbours 1000 to 5000 microbes (bacteria) which are key participants in digestion of food and extraction and synthesis of nutrients /metabolites, vitamins and amino acids, to be used by the host (Bresttoff and Artis, 2013). Protozoan ,Trichonympha,living in the gut of termite digests wood(cellulose) which task termite is otherwise incapable of doing or Lichens, a symbiont of algae (cynanobacteria) living amongst filaments of a fungus,prduce food by photosynthesis to be used by fungus using moisture and nutrients which fungus gathers from environment or mycorrhiza (fungus-plant root) are some other good examples (Odum,1971).

Unintentional Food: It includes waste materials which inadvertently pass from one cell to another. For example, inactive and noxious gases from air and materials other than water and oxygen which are absorbed by skin.

Intentional Food : It includes solids , liquids or gaseous which is purposefully taken into body.

So as to provide an acceptable definition for human food and resolve ambiguity, The Codex Alimentarious Commission or Food Code Commission was established by F A O and the World Health Organization in 1963 to develop harmonized international food standards, which protect consumer health and promote fair practices in food trade.Tho Codex Alimentarius Commission, where in 50 countries participated defined food in 1966 as:

Food means any substance ,processed, semi processed or raw which is intended for human consumption and includes drinks, chewing gums, and any substances which have been used in manufacture, preparation on treatment of food but does not include cosmetic, tobacco or substances used only as drugs.

Food Preservation:

Adequate amount of food supply has always remained a major concern right from days of yore, when man was a hunter gatherer and this persisted through his being agriculturist or animal husbanderist to till date. Even during the present days of technical advancement and much celebrated green and white revolution, vagaries of pests and problems of bad weather together with issues associated with food supply and distribution have impelled man to develop reasonably reliable methods of food preservation. Man's initial efforts were limited to food preservation for a period extending from one harvest to the next. History stands witness to that only those populations whose techniques of food preservation were successful survived to pass on the method.

To one's utter surprise, through a long history of human development only three fundamental techniques of food preservation have evolved and these have been classified as:

Moisture Solid Balance: This is the oldest technique and includes methods like dehydration, sugaring and salting.

Controlled Microbial Action (Fermentation): Like dehydration it is also an old method and concerns deliberate inoculation of food with microorganisms so as to prevent spoilage and produce products which are consumable and may or may not resemble the original food.. The examples include various forms of cheese, beer, wine and alcohol. This method offers high degree of hygiene safety, helps refining of raw materials, sieving toxic or harmful substances (cyanids, hemogglutinins & giotrogens etc), enhances shelf life and even makes some foods more digestible (Caplice and Fitzgerald,1999)

Chemical Additions : This method is recent, widely accepted and applied despite being controversial. Included under this method are preservation processes like, smoking, curing and pickling, additions of preservatives (antioxidants and sequestrates), moisture and pH control etc. This method has undergone rapid changes and list of chemical additives is long and an additive has been defined as a substance or mixture of substances other than basic food stuff which is

present in food as a result of any aspect of production, processing, storage or packing (Mark,1967)

All permitted food additives are subject to restrictive use as per the law enforcing agency. The overall usable additives list is long and some like salt,sugar, vinegar, spices, baking soda and monosodium glutamate are one's that have been in use perhaps for a period as long as man has been eating cooked food. Even so their use has been under review. Therefore thoughtful use of new additives and their constant evaluation in light of human health save guards is important.

Food Toxins

Food toxins are products of ordinary metabolism and growth of certain microorganisms, higher plants and animals. The toxins are primarily produced by organisms for self defense against predators either to kill or immobilize them. Man has selected hardly 100 out of 300000 species of plants as food yet many of these become toxic when consumed in excess or are not properly treated or cooked before consumption.

A. Microbial Toxicity

Microbial food toxicities are caused by deposits of toxins in food resulting from growth of microorganisms. Such foods when ingested transfer microorganisms and toxins to human victims where these cause ill health/illness. These microorganisms include Staphylococcus, E.coli, Aspergillus, Ergot, and Salmonella etc.

I. **Staphylococcus:** Staphylococcus causes more than 80 % of food poisoning outbreaks and the victim develops symptoms like nausea, vomiting, diarrhea, gastrointestinal pain which may extend from 24 to 48 hours.

II. **E. coli :** Of the several strains of E. coli, hardly a few are that contaminate food and beverages and produce shiga toxin. The toxin is so named because it is identical to that produced by *Shigella dysenteria*. *E.coli* 0155 :H7 is a strain that caused as many as 100000 illnesses including 300 hospitalizations and 90 death annually in United States and costs to the state $405 million.

In dogs, *E.coli* causes calibacillosis that often leads to a condition called septicemia or blood poisoning.

III. **Clostridium botulinum :** The species so named because it causes a disease called " Botulism". Botulism accounts for 60 to 80 % mortality once toxin is ingested. The microorganism can produce toxin at exceptionally low temperature and one man lethal dose is less than 0.2 ug. The symptoms of the disease include gradual impairment of peripheral nerve activities, difficulty in swallowing, vision problem (double vision), constipation and sometimes respiratory failure. It takes 12 hours to 10 days for symptoms to appear after ingestion of toxin and by the time these appear treatment becomes difficult. The main source of disease is inadequate sanitation, improper thermal processing and upkeep of canned food.

IV. **Aspergillus :** *Aspergillus* is a fungus (mold) that produces toxins, the aflotoxins which are a group mycotoxins. The species of this genus infest food grains such as ground nuts, maize , parboiled rice , cotton seeds , wheat etc under improper conditions of storage. In

animals the toxins are reported to have caused liver damage, hemorrhaging and even mortality. The preventive measures include good sanitary practices in handling, adequate temperature and humidity control of raw material.

Aflotoxins B and G are most potent hepatotoxins and are a serious health problem. In India during 1975 four hundered cases of its poisoning including one hundred deaths were reported from Banswara and Panchmahal districts of Rajasthan. The toxins cause comparatively more serious problems with animals.

V. **Ergot :** Unlike *Aspergillus* , Ergot is not a storage fungus but a field fungus. Food grains such as bajra, rye, soraghum and wheat etc get infested during flowering stages by Ergot fungus, *Claviceps fusiformis*. Fungus grows as blackish mass and seeds become irregular shaped and black in colour and get harvested along with the normal crop seeds. Consumption of these Ergot infested seeds causes Ergotism ,a disease which is not fatal but causes nausea , repeated vomiting and giddiness. The symptoms may extend upto 48 hours and in chronic cases appear painful cramps in limbs and in very rare cases even peripheral gangrene due to vasoconstriction of capillaries .The remedial measure is hand picking of infested seeds.

VI. ***Fusarium*** : Species are other field fungi that infest food crops like sorghum and rice and pose health problem to both man and animals.

VII. **Salmonella :** Food is vehicle for carrying *Salmonella* (bacteria)into the human body where then these multiply and cause problems. There are about ten serotypes of *Salmonella* identified from man. Their infestation symptoms appear within twenty four hours and include fever ,vomiting ,dizziness , cramps and diarrhea. The main source of its contracts is from egg and poultry products but serotypes of *Salmonella* have also been isolated from vegetables, dry coconut , cocoa, milk and its products, meat and backed foods.

To prevent ,Therefore, there is a need to maintain sanitary control and personal hygiene besides avoidance of thermal incubation zone (50 to 120F) of microbe.

B. Non-microbial Naturally occurring Food Toxins Food that man consumes so as to satisfy his nutritional needs is derived from other living resources (Plants and animals). It is thus expected that along with desired components, man may ingest other material which may be harmful to him. Man , however has deviced reasonably good and adequate cooking methods to destroy harmful properties of these materials much before being consumed and thus these hardly exhibit their affects (Coon,1966) . Needless to say probability still exists that diet could result in serious mishaps, if ignored . Some sea food toxins, mushroom toxins and unusual individual susceptibility often remain as live problems. Sometimes in individuals where there is inborn error of metabolism, even normal diet can be toxic. Similarly, persons with kidney disease become more sensitive to dietary toxins. Therefore what is needed is awareness of the essentials of this problem of naturally occurring toxicants.

Plant poisons

Many of the plants that man and his animals use as food have the capability of producing poisons and when eaten cause illness. Some important poisons produced by plants are :

I. **Goitrogens :** These are chemical substances which interfere with iodine utilization by thyroid gland and result in development of goiter . Foods which have been identified as goitrogenic include , spinach ,cassava, soyabeen, stroberries, sweat potato, peach, pear and vegetables of Brassica genus,*broccoli,* Brussels, sprouts, cabbage, canola, cauliflower, muster greens, radish and rape seed etc. These chemicals have also been reported in red skin of some nuts. Goitrogens have also been reported to get transferred via milk to human beings from cows feeding on above cited cruciferous plants. Fortunately, much of of the activity of goitrogens is inhibited by heating and cooling of milk and its product which is regularly being done in our kitchens.

II. **Erucic Acid :** It is a long chain fatty acid with one unsaturated carbon –carbon bond. It is present on rape seed (*Brassica napus* L and *B.compestris* L)oil being used as cooking oil since 1940 (Park,2009). The acid increases cholastral level in adrenal gland and causes lipidosis in cardic tissue. In animals it was found to retard growth ,cause epicardium thickening and increase in fibrous tissue often resulting in mortality.

III. **Furrocoumarins** : These are organic chemical compounds produced by plants belonging to families, Apiaceae, Fabaceae, Rutaceae and Moraceae and inhibit enzymes in gut as a result of which metabolism of drugs is stalled and also cause Bartenders itch i.e.,skin hyper pigmentation and in severe cases blister.

IV. **Phytohemoglumarins (P H A)**

a) **Lectin :** It is present in red kidney beans, soya beans , green peas and mushrooms. It has a property of stimulating lymphocytes to undertake mitosis

b) **Lathyrus :** It is present in peas of genus *Lathyru*s and when raw peas are consumed these cause Lathyrism , a disease that carries weakening of limbs leading even to paralysis of lower limbs.

c) **Gossypol :** Gossypol is found in pigments of cotton seed ,therefore is a problem of animal feed. Cotton seed flour for human consumption must be controlled.It is known to cause loss of appetite and weight , hemolysis and hemolytic anemia leading to death.

Foods like oil of bitter almond , sorghum and lima beans contain compounds which on hydrolysis yield hydrogen cyanide , a cynogen precursor.s

Toxicity Through Adulterated Food:

There are some plant toxins which ordinarily are not part of animal or human food but when added work as contaminants. Some that need mention are :

I. **Argemone oil :** The contamination of mustard oil or any other oil with *argemone* oil may be accidental or deliberate . Seeds of *argemone* closely resemble mustard seeds.*Argemone* (prickly poppy)is wild in nature but often invades mustard crop fields

and then both crops mature simultaneously and thus there is a likelihood of their getting harvested together.There are also recorded evidences that *argemone* seeds are added to mustard seeds deliberately and therefore oil when extracted is contaminated mustard oil. This oil when used causes " Epidemic Dropsy ". The cause of this recurring epidemic in India was not known till 1926, when Sarkar (2009) ascribed it to contamination of mustar oil and Raj and Roy (1939) experimentally proved .The symptoms of disease are sudden non-inflammatory bilateral swelling of legs , diarrhea , cardiac failure and death. The disease often claimed 5 to 50 % of mortality.

II. **Endemic Ascites :** This is another similar case of contamination which exhibited its otheroutbreak in Kusmi Bloock of Sanguja District of Madhya Pradesh in 1973 & 1976 (Park,2009). The staple food constituent of local population is millet ,*Panicum miliare* locally knwn as Gondhii which gets contaminated with weed seeds of Crotalaria , locally called Jhunjhuniia . The JhunJhunia seeds on analysis were found to contain alkoids which are hepatotoxic and cause ascites and jaundice and claimed 40 % mortality as when outbreaks took place.

Animal Poisons

Animals (some) are both venomous and poisonous. Venomous are one's that inject venom into other organisms including man for their own defence or to intoxicate and capture the prey as food. While the poisonous or toxic animals are ones which when taken as foot prove poisonous Poisoning after eating terrestrial animals is relatively uncommon and poisoning due to marine toxins occurs in many parts of the world. Toxins of animal origin may be produced as product of metabolism or a chemical that is passed along the food chain. . Sea food poisons are of major significance particularly in parts of world like Japan and United States of America.The toxic sea animals include fish (puffers ,90 species; lampreys; coral fishes , 300 species and eels), shell fish and crustaceans . Incase of animal food poisoning force removal of stomach contents is recommended , if vomiting has taken place. It is advisable to avoid gonads (particularly of mature fish) and skin of fish besides soaking and passing them through severasl washings before cooking.

Genetically Modified Organisms (G M O's)

There are two schools of thoughts concerning production and use of GMO's as food. One school claims production of better yeilding varieties through gene engineering which once adopted and commercialized could overcome the global food shortages besides exhibiting characters like insect resistance, stronger crops, larger production, more nutritious and environment friendly. Contrary to this , the opponent school advocates that GMO's have failed to yield expected returns on a sustained basis rather where tried have raised demand for pesticides for maintenance of production. To further negate, they loud the ills of GMO's like detection of multiple toxins and their link to gluten disorders like intestinal permeability , imbalance in gut bacteria ,impaired digestion and damage to gastric walls besides allergic reactions and risk of gene spilling, new diseases besides deleterious effects to biodiversity. Use of genetically modified corn as food has been reported to cause tumor in rats. GMO's have also

been linked with production of glyphosate which induces breast cancer, birth defects and also cause autism ,Parkinson and Alzheimer etc. Thus use of GMO's as food is still under scanner and more researches are needed before final acceptance is recommended ..

Conclusion

To conclude it will be worth recording that food selection process has been continuing ever since man started feeding himself. The sieving of natural organisms as food might have often been dearer ,costing even human life, yet the mode of approval and adoption through use of senses was an excellent fait accompli.

In the recent years, the period of scientific explosion, the rampant use of chemicals, pesticides and fertilizers was made to increase the yield through provision of nutrients for growth and protection against pests. This inadvertently marred the naturally evolved instinct in organisms which herein has been referred to as food toxins and worked against very specific pest and parasite . It needs to be understood that two ,host and its pest/parasite have coevolved through a long evolutionary history and have stuck an inbuilt mechanism of balancing each others population for a healthy and considerate operation of food chain (eat and being eaten) in nature. Man however had successfully learnt to do away with food toxins and their toxicity through adequate washings and his cooking practices.

Today, we have a credibility of food production for meeting food challenge of 7 billion mouths but are drenched neck deep and are struggling for survival against known and unknown health hazards that we contract through consumption of food treated with chemicals fertilizers , pesticides and radiations and or GMO's.

It may not be out of place to record , what used to be said as " an apple a day keeps doctor away" may today appear relevant as ,"An apple a day is a doctors hey".

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