Hazards Associated with Seafood Consumption

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Food safety is an important health problem of public significance both in developed and developing countries. Hundreds of millions of people worldwide suffer from diseases caused by consumption of contaminated foodstuffs. Annually 1.5 billion children below the age group of 5 suffer from attack of diarrhoea and 3 million die (World Health Statistics, 1997). Malnutrition also plays an important role contributing to the spread of many infectious diseases. Although food safety is a major public health issue, many developing nations show little importance to ameliorate the problems. Lack of education, finance and medical care are responsible for this. Most developing countries do not have public health insurance or free health care support. Poor clinical infrastructure is another drawback. Drugs are becoming increasingly expensive and many governments find it difficult to subsidize medical care. Compared to many other issues, food safety is often of a low priority. As governments find it difficult to feed masses even once in a day, the philosophy of politicians becomes 'to feed something and not to bother what is fed'.

Many developing nations have not prioritized the basic issue of supplying quality wholesome food to people. As a consequence food industries also show little responsibility. "While larger companies may be aware of their responsibility and committed to producing safe food, many smaller business houses are unaware of both their responsibility and best approaches to ensuring the safety of their products". (Kaferstein, 1997). But our experience in India tend to show that even larger companies do not observe proper care for food safety.

There is also difficulty in surveillance of food borne diseases at national level. Skill at clinical laboratory level in identifying food borne disease is weak in India, probably except in cities. All these contribute to lack of information on the real magnitude of the issue. A list of food borne hazards is presented in Table 1.

Major food borne diseases

Microbial: There are many food borne diseases occurring wide spread on a global basis. But developing nations like India bear the brunt of these problems. These diseases include Cholera, Campylobacteriosis, *Escherichia coli* disease, Salmonellosis, Shigellosis, typhoid and paratyphoid fevers, Brucellosis, Hepatitis A, Poliomyelitis and food borne parasitic diseases like amoebiasis, trematode infections etc.

Table 1. Food borne hazards

A	*Microbial*
A.1	*Viruses*
	Hepatitis A
	Norwalk
	Norwalk-type
A.2	*Bacteria*
	Aeromonas hydrophila
	Bacillus cereus
	Brucella abortus
	Campylobacter jejuni

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Clostridium botulinum
Clostridium perfringens
Coxiella burnetii
Escherichia coli
Listeria monocytogenes
Mycobacterium bovis
Salmonella spp.
Staphylococcus aureus
Vibiro cholerae
Vibrio parahaemolyticus
Vibrio vulnificus
Yersinia enterocolitica

A.3 Parasites

Anisakid nematodes
Cryptosporidium parvum
Diphyllobothrium spp
Entamoeba histolytica
Giardia lamblia
Taenia saginata
Taenia solium
Toxoplasma gondii
Trichinella spiralis

B. Toxins

Ciguatoxin
Diarrheic shellfish poisons
Domic acid
Histamine
Histamine like compounds (biogenic amines)
Paralytic shell fish poisons
Tetrodotoxin

C. Heavy metals

D. Pesticides

E. Antibiotics and antimicrobials

Reasons for increased incidence of food borne disease

- Population growth
- Increased tourism
- Ageing, immuno compromised people
- Pathogenic microorganisms
- Consumption of contaminated food
- Industrialization and urbanization
- Street vended foods consumption
- Increased food trade.

Health hazards due to food borne microbial infections

It is reported that chronic, secondary after-effect illness may occur in 2 – 3 % of case of food borne infections (Archer and Kvenberg, 1985). Several microbial pathogens are seen adapted to parasitation. This results in attachment, invasion and replication in host (Makalanos, 1992). Hence, it is now well established that microbial pathogenicity should not be viewed unidimensionally, that is, from only the microbes' perspective (Arecher and Young, 1988). Food borne pathogens serve as "triggers' in chronic disease pathology. Some specific well known cases are described below.

Septic arthritis

A number of food borne pathogens are known to induce septic arthritis. The visual observation is inflammation. The viable organisms can be isolated from the synovial fluid. Antibiotics can stop this infection effectively. But often if the diagnosis is incorrect it can result in permanent damage to joints.

Aseptic arthritis

A number of Gram-negative species of food borne pathogens appear to initiate aseptic arthritis in human. The commonly implicated organisms are *Y. enterocolitica, Y. pseudotuberculosis, Shigella flexneri, Salmonella spp; Campylobacter jejuni, Escherichia coli and Klebsiella pneumoniae.* Salmonella *and E. coli* are often encountered in processed fish and shrimp. This is one reason why importing nations are so scared of salmonella. Reactive arthritis (RA), an acute, non-perulant joint-inflamation followed by infection elsewhere in the body, particularly in the bowel, is seen in many food borne infections. Such chronic complications are often genetically linked. This means that people of some tribes or regions are more susceptible to this disease. It is seen that the relative risk of developing the sero-negative spondyloarthropathies after Gram-negative enterobacterial infection is high for individuals positive for MHC antigen B_{27} cross reacting MHC B_7 group (Bunning *et al.*, 1997).

Inflammatory Bowel disease (IBD)

IBD is a collective name for the Crohn's disease (CD) and ulcerative colitis (UC). When the disease is acute, usual symptoms are diarrhoea, abdominal pain, fever and weight loss. There is a constant flux of neutrophils into inflamed mucosa eventually penetrating the epithelium into the intestinal lumen. Pseudomonas, Mycobacterium, *Streptococcus faecalis* and *E.coli* are implicated in this disease.

Haemolytic Uraemic Syndromes (HUS)

HUS largely affects children and the leading cause is *E.coli* 0157:H7.This disease ultimately results in renal failure in children. HUS has now become a world wide problem indicating the existence of *E.coli* 0157:H7 and other shiga and shiga like toxin producing organisms in processed foods. This organism is often detected in potatoes, ground beef, unpasteurized milk etc. Report of occurrence of *E.coli* 0157:H7 in seafoods is very scanty.

Listeriosis

Listeriosis in man occurs usually as a food-borne infection or as a sporadic out-break. Seafoods are prone to contain *Listeria* spp. as a contamination from environments. This disease was very rarely diagnosed prior to 1960. This infection becomes common after the entry of processed foods in the diet menu. There are a number of species of Listeria. Among them *L. monocytogenes* is the bacteria identified responsible for infections. This organism affects more commonly people whose immune system is weak or disturbed eg., pregnant women, newborns or immuno-compromised patients suffering from cancer, AIDS and people who underwent transplants etc. In pregnant women, listeriosis can often cause abortion if not treated early.

It is an opportunitistic ubiquitous pathogen, which can even grow at a temperature as low as 3°C. Incubation period after infection varies from days to 2-3 months. The usual symptoms exhibited are diarrhoea.

L. monocytogenes was detected in unprocessed shrimp and fish. Estuary environments where sewage is discharged often harbour Listeria. The marine organisms get contaminated if they grow in such polluted waters. Even freezing at - 25°C has no influence on the Listeria concentration. Listeria has been reported in shrimp (raw and cooked), smoked fish, ready to eat lobster and shrimp and fresh fish also.

In India active surveillance is carried out on Listeria regularly by testing raw and processed marine products by Central Institute of Fisheries Technology. Samples containing Listeria are not allowed for export.

Hepatitis A and other viral diseases

Among the food-borne diseases hepatitis A is the fourth leading cause after Salmonella, Shigella and Clostridium. But it is not reported, although

existing in many countries due to various reasons. The main reasons are lack of clinical identification and recording the source of contamination from patients visiting hospitals in national way. Hepatitis A virus is transmitted via foods. Hepatitis A is listed as severe hazard in Appendix V of the 1995 USFDA Food Code. The structure of Hepatitis A virus is featureless spheres of size about 28 n m (diameter) and consists of single stranded RNA coated with protein. There are also a number of viruses identified capable of producing food borne infections in man. (Table 2)

Table 2 List of viruses (molluscan shell fish)

- Hepatitis A
- Norwalk-like (SRSV)
- Astrovirus
- Calicivirus

When ingested infection spreads from intestine to liver; incubation period varies from 15-50 days (mean 28 days). Normal symptoms of infection are fever, anorexia, nausea, abdominal discomfort and often accompanied with jaundice. The disease can be diagnosed by examination of patient's blood serum. Now a days, excellent commercial kits are available for diagnosis. After infection durable immunity, possibly life long, is obtained. Molluscan shell fish are often implicated as agents for infection. The British Government recommends heating of mollusks at 85-90°C for at least 90 seconds to destroy viruses. Virus cannot multiply in foods. Hence, their destruction is easy. They can be inactivated before being consumed. Thermal processing is the most effective method to prevent food infection via viruses.

Cholera

Cholera is an acute, watery diarrhoeal disease. Infection often comes from contaminated food. Several instances of occurrence of pandemics of cholera are reported. Major occurrences were reported from the Gangetic delta in Bengal. However, the most recently common pandemic cholera was reported in 1961 in Sulavesi, in Indonesia. The causative organism was identified as ElTor biotype of *V.cholerae* 01. In 1992 epidemic cholera was reported in Bengal. The organism was identified as a new species, *V. cholerae* 0139. Subsequently it has been isolated from a number of South East Asian countries. However, this is a minor problem and has not invaded other regions. Since 1995 only one incidence was reported.

V.cholerae 01 is often frequented in seafoods, particularly in molluscans and crustaceans. Fish harvested from water bodies where this organism grows naturally are likely to contain *V.cholerae*. Oysters and crabs can be very good host since *V. cholerae* can survive weeks inside them. Underprocessed crabs can harbour the organisms for several days and more than three weeks even under refrigeration (De Paola, 1981).

Food and water are the principal source of *V. cholerae* contamination. Good sanitation is a must to eliminate this disease. All our attempt to minimize *V. cholerae* contamination via food should be based on minimizing three factors viz contamination, survival and growth.

Chemical hazards

Use of chemicals as preservatives has resulted in a dramatic improvement in living condition of people all over the world. These include food additives and preservatives added to processed food with a view to improving shelflife and taste. A new variety of chemicals of wide spread use have entered the domestic sector. They are detergents of different trade names. Antimicrobial drugs and antibiotics have become an essential part of human life. Apart from this the use of chemicals in industries and agriculture is a major

source contaminating the environments. But only a few of these chemicals have been fully characterized in terms of their potential toxicities to man, particularly in terms of their long-term effects.

Prevention of food adulteration is a very complex and complicated issue. The estimation of residual limits in food is cumbersome. Often there are no satisfactory tests for routine analysis which is vital for a regular monitoring programmes. Even if methods are available the cost of equipment and reagents are so heavy that only developed nations with huge financial out-lay can implement such a system. Above all such a programme has to be conducted at national level. This needs technical cooperation of several agencies including medical authorities, analytical quality assessment studies and exchange of information. Above all such a system should have the support of the public and government. Specific laws should be formulated to punish offenders instantly. This needs a strong legal and institutional infrastructure like the USFDA of the United States of America.

According to GEMS (Global Environment Monitoring System) there are 18 priority contaminatns (Bhat and Moy, 1997). They are listed below:

Industrial chemicals (4)

Lead, Cadmium, Mercury, Polychrominated biphenyl (PCBs)

Organochlorine pesticides (8)

Aldrin/dialdrion, DDT-complex, heptachlor and heptachlor epoxide, hexachlorobenzene, total hexachlorohexane (HCH) isomers, gama HCH (Lindane), endosulphan and endrin

Organophosphorus pesticides (5)

Diazinon, fenitrothion, malathion, parathion, and pesathion-methyl.

Mycotoxins (I) –Aflatoxin

Origin of these contaminants

Many chemical contaminants occur in fruits, vegetables, meat and fish from the natural sources. Their limits vary depending on the conditions of environment from where they are harvested or processed. Vegetables and cereals grown with application of heavy amounts of synthetic fertilizers and insecticides are prone to contain these contaminants at varying levels. There can be no standard to state. Rather they do accumulate based on the load they are allowed to sustain. Similarly animals fed with green fodder containing pesticides and insecticides sprayed on them normally accumulate their residues upto tolerable limits. Fish grown in polluted waters naturally contain toxic residues. Often the host can tolerate a heavy load in their depot fat and organs like liver and kidney. In squid and cuttle fish cadmium can be stored in high levels than the permitted levels of 1- 2 ppm.

They can be generally listed, in terms of their source into five categories.

- Naturally present eg: soil

  eg. cadmium, lead, mercury, zinc, phosphorus etc.
- Spoiled food stuffs

  Mycotoxin (aflatoxin)
- Pollution (industrial and human activity)

  eg. lead, mercury, cadmium, polychlorinated biphenyls (PCBs)
- Agricultural Practices

  eg. pesticides, fertilizers, drugs used in animal husbandry, antibiotics in fish farming etc.
- Food processing and packaging industries

  eg. nitrosoamines, polycyclic aromatic hydrocarbons, dyes, food additives, preservatives, lead, adhesives used for laminations, biulphites etc.

It has been stipulated by International agencies like

Joint FAO/WHO Expert Committee on Food Additives (JECFA) or joint FAD/WHO meeting on Pesticide Residues that the levels of these contaminants should be well below the Acceptable Daily Intake (ADI) and Provisional Tolerable Weekly Intake (PTWI). International agencies, like the Codex Alimentarius, USFDA and European Union have also laid down permissible limits for all these items. It is stipulated that both in natural as well as processed food items the levels of these toxic chemicals should be well below the GRAS (Generally Reecognised As Safe) level.

Lead

There have been extensive studies on the daily intake of lead by human, both adults and infants. Studies so far conducted on industrialized nations have shown that infants and children are more prone to intake of lead since young ones can ingest substantial amounts of lead from paint, dust and soil by hand-mouth activities. Since lead can cross placental barrier in pregnant women, they should be very careful in consuming food which are likely to contain high amounts of lead. There is no data available in India on the lead toxicity on human being either at regional or national level. There is need to undertake such a study on a continuous basis.

Dietary intake of cadmium

The levels of cadmium in fish is stipulated to be less than 1 ppm. Canada, Denmark, Finland, the Netherlands and USA have identified cereals and cereal based products, potatoes and vegetables as the largest contributors to cadmium intake in man. In animals organs like kidney, liver and muscle of mollusks and crustaceans can accumulate large amounts of cadmium. The intake of cadmium in many countries like USA and UK is around 50% of the PTWI.

There is no specific information on levels of cadmium in human beings. It is likely that it could be high in view of the largely cereal based diet of Indian population. The amount and type of food consumed has profound influence on cadmium level in population.

Itai Itai disease

Cadmium related food poisoning was reported in Japan several years ago. In 1947 an unusual and painful disease was recorded of a "rheumatic nature" in 44 patients from a village on the bank of Jintsu River in Toyama Prefecture, Japan. This disease was named *itai-itai* disease (meaning *ouch-ouch)* in accordance with the patients shrieks resulting from painful skeletal deformities. More than 100 deaths were reported. The source of the disease was identified as cadmium containing fish eaten by the people. The fish were contaminated by the effluents discharged from a nearby factory.

From India all marine products exported particularly squid and cuttle fish, are regularly analysed for levels of cadmium by Central Institute of Fisheries Technology, Cochin. Squid and cuttle fish containing cadmium more than 2 ppm are not permitted for export.

Mercury

It is not the metallic mercury that causes toxicity. Infact traces of mercury are always retained for years from the silver-mercury amalgam used for filling dental carries. Toxicity is seldom observed or detected. Often the methylmercury (mercaptans) and akylated mercury are the real culprits of mercury poisoning. The PTWI for mercury is 3.3 mg/kg body weight of methyl mercury. Fish eating population are likely to contain higher doses of mercury in their body. In Sweden there is a regulatory advice for pregnant women not to consume fish containing high levels of mercury.

Minamata disease

Between 1953 and 1961 human poisoning by mercury in seafood occurred among fish eating population of *Minamata* region in Japan. The

mysterious neurological illness which later resulted in coma and death was identified due to mercury poisoning caused by methyl mercury. Since then this disease is called *Minamata* disease.

In India so far there is no reported case of mercury poisoning due to consumption of fish. The information from hospitals are neither recorded nor maintained by medical practitioners in India.

Strategies for prevention of food borne diseases

1. To start food surveillance in order to trace origin of contamination
2. To create consumer awareness on food quality and hazards associated with contaminated and adulterated food stuffs.
3. To improve infrastructure of food quality control systems in the country
4. To promote coordination of all departments and agencies implementing quality control.
5. Revise national standards on par with international standards
6. Introduce legal and institutional facilities and support for quality control agencies in the country.
7. To promote and upgrade manufacturing standards of food processing factories. Advise them to introduce Good Manufacturing Practices (GMP) and Hazard Analysis Critical Control Points (HACCP) in their plants.
8. Those who violate food laws must be punished without delay.
9. Develop an integrated information network through out the country for monitoring and dissemination of information to public.

Summary

Food borne diseases have become the most important hazards of human health. The incidence of food borne diseases are likely to increase in coming years in alarming state due to lifting trade barriers in international food trade. Countries which are ill equipped in handling infected foods are going to be at the receiving end compared to developed nations which have powerful agencies like the USFDA to monitor and police import of hazardous foods. Developing nations have to set up agencies and surveillance of the incidence of food borne diseases at national level. Asian countries have to set up a net-work to transfer information on food borne infection, the source of such foods and country of origin in order to prevent the wide spread occurrence and to detain the stuff at entry level in the country.

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