unit-11: RECENT CONCERNS ON FOOD SAFETY

The variety of foods available in the country is expanding significantly and food no longer needs to be seasonal or locally grown. Food is often transported over long distances, domestically and internationally. In past, most food was prepared in the home but now ethnic foods and foods prepared and / or consumed outside the home are gaining in popularity and consumption of fresh fruits and vegetables is increasing.

Further, globalisation of the world's food supply is also contributing to changing patterns in food consumption. It is also minimizing traditional geographic barriers to existing and emerging food safety hazards. The rising worldwide human travel and global distribution of foods is facilitating the introduction and flow of pathogens and other hazards into human and animal populations. Moreover, global sourcing also can move pathogens and toxins from areas in which they are indigenous to places in which they have not previously existed. Highly publicised food safety issues such as the ongoing debate over emerging pathogens organic foods, genetically modified foods, the incidence of Bovine Spongiform Encephalopathy (BSE) and dioxin-contaminated food are causing heightened consumer concern about food safety worldwide.

THIS COMBINATION OF FACTORS POSES NEW FOOD SAFETY CHALLENGES TO NOT ONLY OUR COUNTRY BUT ALSO THE DEVELOPED WORLD. HAZARDS ARE NOW TRULY MOBILE AND OUR FOOD SAFETY PROGRAMS MUST BE VERY AGILE TO REDUCE OUR RISK. WHILE THERE ARE SEVERAL FOOD SAFETY ISSUES, ONLY THE SALIENT ONES ARE BEING DWELT UPON HERE.

11.1 emerging pathogens of concern

From a global viewpoint, there are a number of pathogens which are causing severe human suffering around the world. Some can be termed as 'old enemies', i.e., those pathogens which used to cause diseases to human in the past and still do so, while others are recently recognised pathogens or 'newly emergent pathogens'.

In US, the Centre for Disease Control and Prevention estimate that food borne microbial pathogens account for 33 million cases of food borne illness each year, and upto 9000 deaths.

Today, we are finding pathogens on foods initially thought of as 'safe' such as eggs and fruit juices and therefore, it is essential to focus on emerging pathogens such as *Salmonella thyhimurium* DT104 and new strains of *E. Coli.* What is adding to this problem is the fact that most of these emergent pathogens have antimicrobial resistance and detecting them in ordinary laboratory is not possible.

We must recognise the fact that there is considerable diversity of pathogenic organisms. The cause of infection is never identified in 50% of reported food poisoning outbreaks. Emerging and Re-emerging pathogens undoubtedly contribute to these undiagnosed illness. These emergent pathogenic organism range from

- ***Bacteria :*** antibiotic resistant *Staphylococcus aurens* and *E. coli* serotype 0157:H7
- ***Viruses :*** Ebola and influenza virus
- ***Protozoa :*** *Cyclospora* and *Cryposporidium*
- ***Prions :*** BSE-vCJD

The reasons why we see more emerging pathogens are :

- Microbial adaptation

- Changes in food and agricultural production
- Increasing use of commercial food services
- Eating habits
- Social behaviour

Another important factor could be due to 'species jumping' of certain pathogens that are infecting organisms not normally its host own but in most cases humans. For example, it has been observed that population increase of four species of fruit bats in Australia greatly affect occurrence of Equine paramyxovirus.

Let us now look at some emerging pathogens.

- ***E. coli 0157:H7 :*** It was first recognised as a human pathogen in 1982 when found to contaminate certain meat products. It is the most common cause of Hemolytic uremic syndrome. It is also a leading cause of acute kidney failure in children. It colonise the large intestine causing blood diarrhoea and releases a verotoxin (therefore also known as verocytotoxigenic *E. coli*) into the blood stream which targets the cells of the kidney, and large intestine, potentially resulting in renal failure or damage to the nervous system and death. Its infection dose is very low (about 10 cells). Its sources are animal food especially beef.

- ***Calciviruses :*** These are responsible for etiological agent in many waterborne disease outbreaks and probably account for the majority of outbreaks where the etiological agents have not been identified. They are also responsible for greater than 90% of all non-bacterial gastroenteritis in the US and worldwide.

- ***Cryptosporidium parvum :*** This is a coccidian protozoan parasite that has gained much attention as a clinically important human pathogen. This parasite has been linked to water and food borne illness. Its infection dose is

low (around 30 00 cysts). Little is known about the pathogenesis of the parasite and no safe and effective treatment has been developed (no specific antibiotics/drugs) to combat cryptosporidiosis. Symptoms include frequent watery diarrhoea, nausea, vomitting, abdominal cramps, low grade fever. In immunocompressent person, it has a much pronounced effect causing debilitating cholera like diarrhoea, severe abdominal cramp, malaise, low grade fever, weight loss, and a anorexia.

It is transmitted through faecally contaminated food and water, from animal to person contact (very rare) and via person to person contact (rare).

- ***Salmonella typhimurium DT 104 :*** It has attracted attention from the public health authorities in the UK and the media because it is responsible for the rising number of cases of salmonellosis in man. Contaminated meat products are the main source (and cereals in rarer circumstances) of food borne infection especially sausage and burger. The organism is resistant to a wide range of anti-infectious agents and as a result, the illness is more difficult to treat. Relatively high mortality rate (3%) is associated with infection by this organism.

Other emerging pathogens include:

Bacteria : *Enterobacter sakazakii* (found in dried milk powder)

Acrobacter butleri (recently recongised vetinary pathogen and a possible human pathogen)

Mycobacterium chelovae and *Mycobacterium non-chromogenicum* (Both able to survive 75% alcohol, spreads after acupuncture)

Campylobacter jejuni

Listeria monocytogenes

Clostridium perfringes

Viruses : Adenovirus serotype 22 (Its strain is undetermined and culture host is A549 cells)
Hanta Virus
Human metapneumovirus

Norwalk like viruses (also known as small round structured viruses-SRSV)

Protozoa : *Cyclospora cayetanensis*
Toxoplasma goudi

Helminths : *Anisakiasis simplexii*
Pseudoterranora decipieus

Diatoms : *Nuschia pengens* (causes shellfish poisoning)

Fungal toxins : *Fumonsins*
Zearelenone
Trichothecenes
Ochratoxins

11.2 GENETICALLY MODIFIED FOODS

Every cell of living organisms, be they be plants, microorganisms, animals or humans contain thousands of genes, which are made up of DNA or Deoxyribonucleic acid. DNA carries the information that allows organism to function, repair and reproduce themselves. Genetic modification is the technique of changing by inactivating, deleting or inserting genes to produce a desired characteristic. In this technique selected individual genes are transferred from one organism (microbe, plant or animal) to another organism. When genes are transferred from one species to another transgenic organisms is produced. Foods produced by genetically modified technique are called

Genetically Modified or GM Foods. The term `Recombinant technology'/ `Biotechnology' is often used to describe genetic modification process. The first GM plants were created in 1983. Since then a variety of crop plants such as Maize, Soybeans, rice, rapeseed (mustard), tomato, cotton, potato etc have been modified by this technique. They have been modified to make them resistant to particular insects or virus attack, tolerate to herbicides or nutritional enhancement like containing more carotene or iron.

Genetically modified crops are cultivated in 12 million hectares in countries like USA, Canada Argentina, Australia, Mexico and China. The four crops that dominate the GMO market in the world Soybeans, maize, cotton and canola. Seventy percent of the GM crops raised were meant for herbicide tolerance, 15% were aimed at resistance to insects, 8% were stated varieties containing both traits. Only less than 1% of the crop were aimed at other characteristics like yielding improvement and vitamin enrichment. Although the cultivation of GM crops has been claimed to be profitable to the farmers, the impacts vary by year, location, crop etc. From the Indian point of view, more than the herbicide resistance, stress resistance to drought, temperature and poor soils, nutritional enrichment, more production and increased productivity and pest resistance are important.

11.2.1 LABELING

THE RISKS AND UNCERTAINTIES SURROUNDING THE PROCESS OF GENETIC ENGINEERING AND THE RESULTING GM PRODUCTS HAS RESULTED IN CONSIDERABLE PUBLIC DEBATE AND CONSUMER GROUPS HAVE BEEN VOCIFEROUS IN DEMANDING LABELING OF GM PRODUCTS. POLICIES ON LABELING OF GM FOODS DIFFER FROM COUNTRY TO COUNTRY BUT THE CONSUMER'S RIGHT TO ENABLE THEM MAKING INFORMED CHOICE IS GENERALLY RECOGNIZED. LABELING IS COMPULSORY IN EU COUNTRIES, JAPAN, SWITZERLAND AND AUSTRALIA

WHILE IN THE USA THERE IS NO OBLIGATION TO LABEL UNLESS THERE IS SUBSTANTIAL CHANGES IN THE COMPOSITION. IN INDIA SO FAR NO REGULATION ON LABELING HAS BEEN PROMULGAMATED. INFACT THE POLICY ON GM FOODS IS UNDER ACTIVE CONSIDERATION BY THE GOVERNMENT OF INDIA AT THE HIGHEST LEVEL AND IS LIKELY TO EMERGE SOON.

11.2.2 GM WORK IN INDIA

IN INDIA SO FAR 3 HYBRIDS OF COTTON CONTAINING BT GENE PRODUCED BY MAHYCO / MONSANTO WAS APPROVED FOR COMMERCIALIZATION BY GEAC IN 2002. ONE VARIETY OF COTTON, AGAIN CONTAINING *BT GENE* PRODUCED BY RASI SEED WAS ALLOWED SEED PRODUCTION FOR ONE HYBRID. OTHER GM CROPS UNDERGOING FIELD TRIALS INCLUDE:

- **MUSTARD CONTAINING *BARNASE-BAR STAR GENE* , PRODUCED BY THE COMPANY PROAGRO AND ANOTHER VARIETY PRODUCED BY JAWAHAR LAL NEHRU UNIVERSITY, DELHI;**
- **RICE AND BRINJAL WITH BT GENE AND TOMATO BY THE INDIAN AGRICULTURAL RESEARCH INSTITUTE, NEW DELHI;**
- **POTATO CONTAINING LYSINE PROTEIN GENE FROM AMARANTH PLANT BY JAWAHAR LAL NEHRU UNIVERSITY, DELHI;**

11.3 Food labelling

FOOD LABELLING IS THE PRIMARY MEANS OF COMMUNICATION BETWEEN THE PRODUCER AND SELLER OF FOOD ON ONE HAND, AND THE PURCHASER AND CONSUMER OF THE OTHER.

11.3.1 Definition

LABEL **MEANS ANY TAG, BRAND, MARK, PICTORIAL OR OTHER DESCRIPTIVE METHOD WRITTEN, PRINTED, STENCILED, MARKED, EMBOSSED, OR IMPRESSED ON, OR ATTACHED TO, A CONTAINER OF FOOD.**

AS A MATTER OF FACT, LABEL IS A WINDOW OF THE PRODUCT THROUGH WHICH A CONSUMER MAY PEEP INTO THE PRODUCT TO ASSESS ITS DETAILS. IT SHOULD CONTAIN ALL THE MATERIAL FACTS ABOUT THE PRODUCTS.

LABELLING **INCLUDES ANY WRITTEN, PRINTED OR GRAPHIC MATTER I.E. PRESENT ON THE LABEL, ACCOMPANIES THE FOOD, OR IS DISPLAYED NEAR THE FOOD, INCLUDING THAT FOR THE PURPOSE OF PROMOTING ITS SALE OR DISPOSAL.**

11.3.2 GENERAL PRINCIPLES OF LABELING

PREPACKAGED FOOD SHALL NOT BE DESCRIBED OR PRESENTED ON ANY LABEL OR IN LABELLING IN A MANNER THAT IS FALSE, MISLEADING OR DECEPTIVE OR IS LIKELY TO CREATE AN ERRONEOUS IMPRESSION REGARDING ITS CHARACTER IN ANY RESPECT.

PREPACKAGED FOOD SHALL NOT BE DESCRIBED OR PRESENTED ON ANY LABEL OR IN LABELING BY WORDS, PICTORIAL OR OTHER DEVICES WITH REFER TO OR MORE SUGGESTIVE EITHER DIRECTLY OR INDIRECTLY, OF ANY OTHER PRODUCT WITH WHICH SUCH FOOD MIGHT BE CONFUSED, OR IN SUCH A MATTER AS TO LEAD THE PURCHASER OR CONSUMER TO SUPPOSE THAT THE FOOD IS CONNECTED WITH SUCH OTHER PRODUCT.

Label in prepackaged foods shall be applied in such a manner that they will not become separated from the container. Contents on the label shall be clear, prominent and readily legible by the consumer under normal condition of purchase and use.

11.3.3 MANDATORY LABELING REQUIREMENTS OF PRE PACKAGED FOODS

Every package of food shall carry the following information on the label

1 The Name of the Food

2 List of Ingredients

3 Declaration of Food Additives

4 Name and Address of the manufacturer

5 Country of Origin

6 Net Contents and Drained Weight

7 Lot/Code/Batch Identification

8 Date of Manufacture or Packing

9 Date Marking

Date Marking are of two forms:-

(i) Expiry Date and

(ii) Best Before Date

10. Instructions for Use

Instructions for use, including reconstitution, where applicable, shall be included on the label, as necessary, to ensure correct utilization of the food.

11.3.4 Additional mandatory requirements

a. Irradiated Foods

(i) The label of a food, which has been treated with ionizing radiation, shall carry a written statement indicating the treatment in close proximity to the name of the food. The use of the international food irradiation symbol, as shown below shall be in close proximity to the name or brand name of the food.

(ii) When an irradiated product is used as an ingredient in another food, this shall be so declared in the list of ingredients.

(iii) When a single ingredient product is prepared from a raw material which has been irradiated, the label of the product shall contain a statement indicating the treatment.

b. Nutrition Labelling

NUTRITION LABELLING SERVES THE FOLLOWING PURPOSE :

(I) IN PROVIDING THE CONSUMER WITH INFORMATION ABOUT A FOOD SO THAT A WISE CHOICE OF FOOD CAN BE MADE

(II) IN PROVIDING A MEANS FOR CONVEYING INFORMATION OF THE NUTRIENT CONTENT OF A FOOD ON THE LABEL.

(III) IN ENCOURAGING THE USE OF SOUND NUTRITION PRINCIPLES IN THE FORMULATION OF FOODS WHICH WOULD BENEFIT PUBLIC HEALTH

(IV) IN PROVIDING THE OPPORTUNITY TO INCLUDE SUPPLEMENTARY NUTRITION INFORMATION ON THE LABEL.

11.4 LATEST TRENDS IN PACKAGING AND TECHNOLOGY

11.4.1 Food Packaging

A common combined packaging system consists of cartons to contain multiple packs of food in flexible film. These in turn are shrink wrapped or placed in corrugated board shipping containers. The rapid growth of chilled, MAP/CAP, and minimally processed foods during the 1990s has been accompanied by a number of developments in packaging technologies, which may be grouped under the term 'active'. Active packaging technologies include :

- oxygen scavenging
- CO_2 production
- preservative release (e.g., ethanol production)
- antimicrobial action
- aroma release
- moisture removal
- removal of odours, off-flavours or ethylene
- time-temperature indicators
- gas indicators
- edible coatings and films
- films to slow moisture transfer between ingredients that have different water activities
- microwave 'susceptor' films that create high temperature treatments
- infrared films that radiate energy to inactivate micro-organisms

- steam release films
- time-temperature indicators to display loss of shelf life and extreme-temperature indicators to display temperature abuse conditions.
- indicator labels that change colour when a specified level of CO_2 is attained in a modified atmosphere package
- tamper-evident labels that change colour when they are removed and leave behind a message on the pack that cannot be hidden.

11.4.2 HURDLE TECHNOLOGY

Several years ago, hurdle technology was developed as a new concept for the realization of safe, stable, nutritious, tasty, and economical foods. It employs the intelligent combination of different preservation factors or techniques to achieve multi-target, mild but reliable preservation effects.

a. Mild processing of foods with hurdle technology.

Many promising hurdles have been identified so far, although application of the idea in the food industry has been largely restricted to the meat sector. Recent studies, however, emphasize a much wider potential application, e.g., in bakery products, fish, and dairy products. More specifically, the concept was introduced into mild processing of fruits and vegetables. The design of new hurdles such as gas packaging, bioconservation, bacterocins, ultra-high pressure treatment, and edible coatings aided this development.

b. Consumers want fresher food products.

Consumers demand fresher and more natural products. This prompts food manufacturers to use milder preservation techniques and could be stimulating the current trend to hurdle technology. There is an urgent need for new or improved methods producing stable and safe foods. The concept of hurdle technology addresses this need.

c. Preservation factors are hurdles to inhibit microorganisms. Hurdle technology deliberately combines existing and new preservation techniques to establish a series of preservative factors (hurdles) that the microorganisms in question are unable to overcome (jump over). These hurdles may be temperature, water activity, acidity, redox potential, preservatives, and others. A crucial phenomenon in hurdle technology is known as the homeostasis of microorganisms.

d. Hurdles disturb homeostasis.

Homeostasis is the constant tendency of microorganisms to maintain a stable and balanced (uniform) internal environment. Preservative factors functioning as hurdles can disturb one or more of the homeostasis mechanisms, thereby preventing microorganisms from multiplying and causing them to remain inactive or even die. Food preservation is achieved by disturbing the homeostasis of microorganisms. The best way to do this is to deliberately disturb several homeostasis mechanisms simultaneously.

e. Multiple hurdles affect product quality least.

This multi-targeted approach is the essence of hurdle technology. It is more effective than single targeting and allows hurdles of lower intensity, improving product quality. There is the further possibility that different hurdles in a food not only have an added effect on stability, but can act synergistically.

f. Extension of Shelf-life

Fermented sausage--an example.

Using hurdle technology, salami-type fermented sausages are produced that are stable at ambient temperature for extended periods. A sequence of hurdles is important at different stages of the ripening process. The first hurdles used are the preservatives, salt and nitrite, which inhibit many of the bacteria present in the batter. Other bacteria multiply, use up oxygen and thereby

cause a drop in redox potential, which inhibits aerobic organisms and favors the selection of lactic-acid bacteria. These bacteria then proliferate, causing product acidification and an increase of the pH hurdle. During the long ripening process of salami, the initial hurdles gradually become weaker: nitrite is depleted, the number of lactic-acid bacteria decreases, redox potential and pH increase. However, since water activity decreases with time it becomes the main hurdle.

G. AN INCREASING LIST OF HURDLES.

UP TO NOW, ABOUT 50 DIFFERENT HURDLES HAVE BEEN IDENTIFIED IN FOOD PRESERVATION. APART FROM THE MOST IMPORTANT AND COMMONLY USED HURDLES SUCH AS TEMPERATURE, PH, AND WATER ACTIVITY, THERE ARE MANY OTHERS OF POTENTIAL VALUE. OTHER HURDLES INCLUDE: ULTRAHIGH PRESSURE, MANO-THERMO-SONICATION, PHOTODYNAMIC INACTIVATION, MODIFIED ATMOSPHERE PACKAGING OF BOTH NON-RESPIRING AND RESPIRING PRODUCTS, EDIBLE COATINGS, ETHANOL, MAILLARD REACTION PRODUCTS AND BACTERIOCINS. EXAMPLES OF FOODS PRESERVED BY COMBINED PROCESSES ARE FRUIT JUICES AND HEAT-PROCESSED, CURED MEAT PRODUCTS.

11.5 PRIONS

Prions, the cause of BSE and vCJD, are an entirely new source of food borne diseases. Prions (abbreviation for proteinaceous infectious particles) are modified forms of a normal protein called as P_rP^c which is referred to as P_rP^* or P_rP^{sc}. The proteins accumulate in the brain causing holes or plaques and the subsequent clinical symptom leading to death.

Transmissible spongiform encephalopathics in animals and humans are caused by prions. These conditions include Scrapie in sheep, Bovine Spongiform Encephalopathy in cattle and Creutzfeldt- Jakob disease in humans. It is commonly accepted that BSE was first caused in Britain when

cattle were fed carcass meal from scrapie infected sheep. Humans contracted the nonclassic form of CJD, called new variant CJD (vCJD) after consuming cattle meat, in particular the nerve tissue. This resulted in the specified offal ban which stopped the recycling of potential infectious material (such as the spinal cord) to cattle through food supplements and required more inspections of abattoirs.

11.5.1 Bovine Spongiform Encephalopathy (BSE)

Bovine spongiform encephalopathy (BSE) is a progressive neurological disorder of cattle that results from an infection by an unconventional transmissible agent. BSE is one of a group of diseases that affect a number of different mammals. These diseases, known as Transmissible Spongiform Encephalopathies (TSEs), or Prion Diseases, result from the build-up of abnormal prion proteins in the brain and nervous system. BSE attacks the brain and central nervous system of the animal and eventually causes death. Research has shown that TSEs have two characteristics in common: they can be transmitted between animals, and they cause the same spongy decay of brain tissues. A commonly occurring prion disease is scrapie.

Commonly known as 'Mad-Cow Disease', BSE has a long incubation period. This means that it usually takes four to six years for cattle infected with BSE to show signs of the disease, such as disorientation, clumsiness and, occasionally, aggressive behaviour towards other animals and humans.

BSE was first confirmed in cattle in 1986 in U.K. Since 1999, other countries in Europe, besides the UK, have reported confirmed cases of BSE. These include Belgium, Denmark, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain and Switzerland. Currently, UK has the highest level of BSE in the world with just over 179,500 cases confirmed since 1988.

Despite much research, however, no one can say with certainty where BSE came from, although several theories exist. Cattle are grazing animals that do not naturally eat meat. Most experts agree that BSE was spread by cattle eating feed that contained Meat-and-Bone Meal (MBM), which contained BSE-infected parts of other grazing animals. MBM is produced in a process called rendering, this is where otherwise unused meat products are taken from the animal carcass and turned into cattle feed. Experiments have shown that cattle can contract BSE if they are fed infected brain tissue. This seems to support the idea that BSE was transmitted to cattle through their animal feed.

11.5.2 Creutzfeldt-Jakob Disease (CJD)

BSE only develops in cattle, but it belongs to a family of prion diseases, several of which can affect humans. The most commonly known disease in this group among humans is Creutzfeldt-Jakob Disease (CJD). This is a rare and fatal form of dementia that mainly occurs in individuals between the ages of 40 and 80. In 1996, scientists discovered a new strain of CJD that occurs predominantly in younger people.