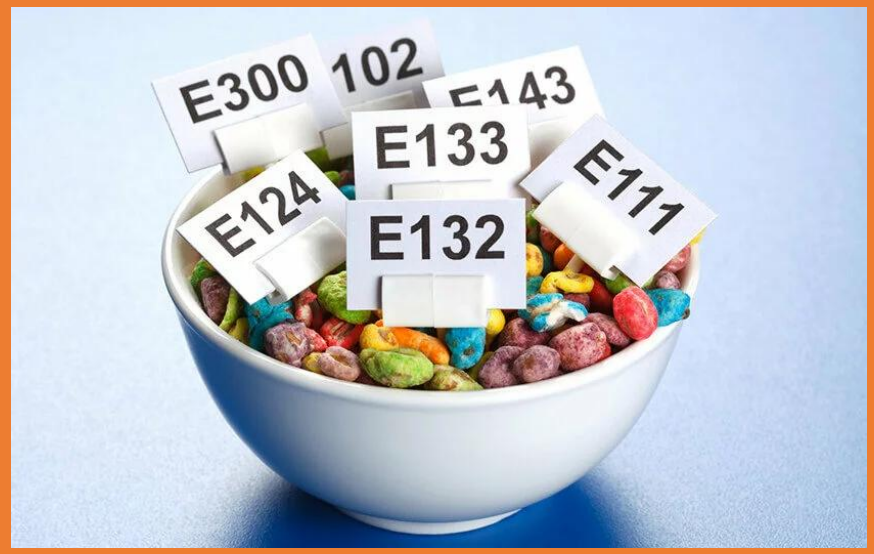
Good Morning ☺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VISAKHA DAIRY
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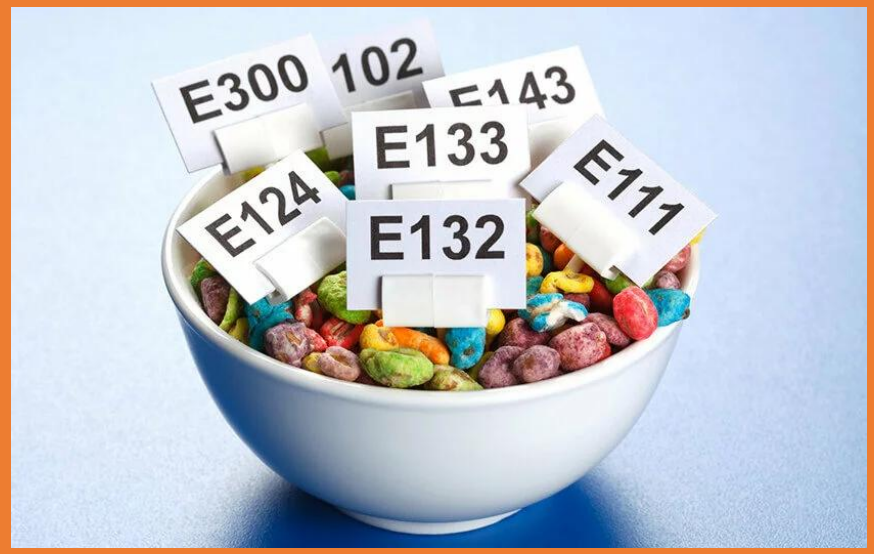
Food Toxicants

Food Additives



Food Adulteration

Food Fortification

FOOD TOXICANTS & ADDITIVES FOOD FORTIFICATION & ADULTERATION

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Specific Learning Objectives

At the end of the class the student should be able to

1. List the various food toxicants & food additives
2. Briefly describe the effect of each food toxicant on health
3. Define food fortification and food adulteration
4. Describe the laws related to the prevention of food adulteration
5. List out the various Food Standards

FOOD TOXICANTS

1. Neurolathyrism
2. Aflatoxins
3. Ergot
4. Epidemic Dropsy
5. Endemic Ascites
6. Fusarium Toxins

1. Neurolathyrism

- Lathyrism is a paralyzing disease of humans and animals.
- In the humans it is referred to as **neurolathyrism** because it affects the nervous system
- In animals as **osteolathyrism** (odoratism) because the pathological changes occur in the bones resulting in skeletal deformities

- Neurolathyrism is a crippling disease of the nervous system characterized by **gradually developing spastic paralysis of lower limbs**, occurring mostly in adults consuming the pulse, **Lathyrus sativus** in large quantities.

1. Neurolathyrism

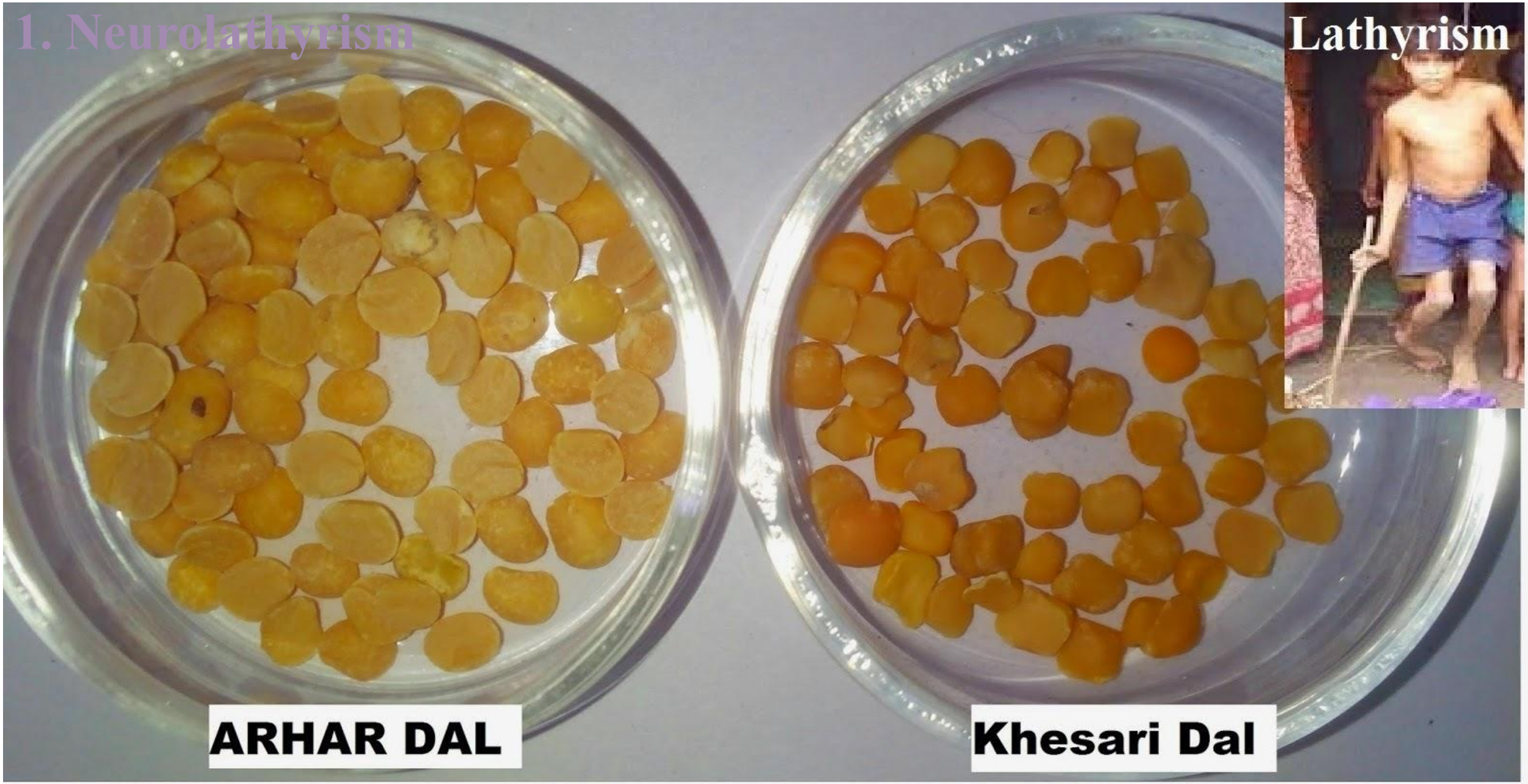
The Problem

- Neurolathyrism is prevalent in parts of Madhya Pradesh, Uttar Pradesh, Bihar and Orissa. It has also been reported in Maharashtra, West Bengal, Rajasthan, Assam and Gujarat where the pulse is grown.
- The magnitude of the problem can be assessed from the fact that at one time in Rewa and Satna districts of Madhya Pradesh alone, there were 25,000 and 32,000 cases respectively.
- According to reports, there are **no fresh outbreaks** of the disease in endemic areas. This is attributed to the shifting trends in agronomical practices in the region.
- Lathyrism has also been reported to occur in Spain and Algeria where Lathyrus is eaten

The pulse

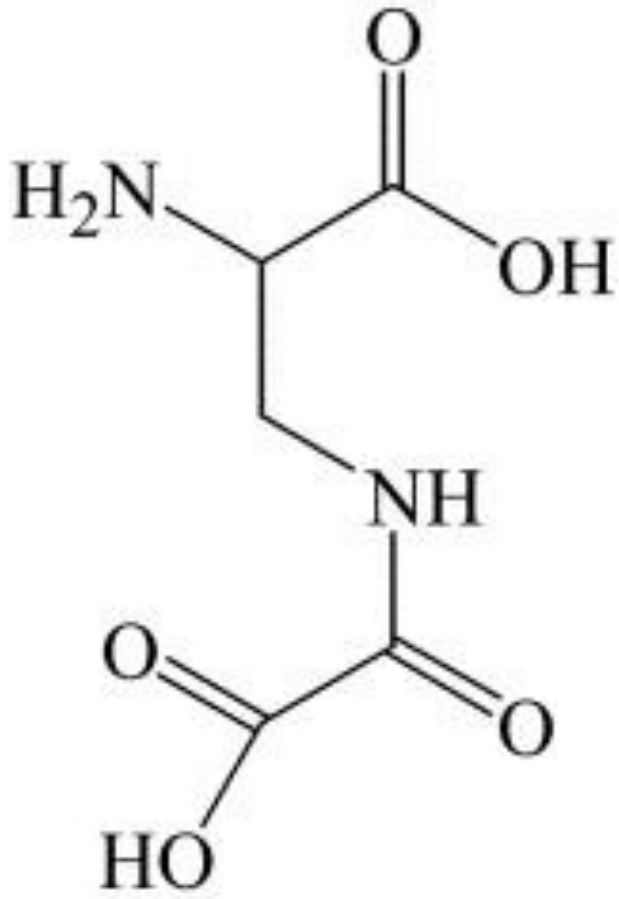
- Lathyrus sativus is commonly known as **“Khesari dhal”**. It is known by local names such as Teora dhal, Lak dhal, Batra, Gharas, Matra etc.
- The seeds of lathyrus have a characteristic **triangular shape** and **grey colour**.
- **When de-husked the pulse looks similar to Red gram dhal or Bengal gram dhal.**
- Like other pulses, lathyrus is a good source of protein, but for its toxin which affects the nerves
- It is eaten mostly by the -poor agricultural labourer because it is relatively cheap.
- **Studies have shown that diets containing over 30% of this dhal if taken over a period of 2—6 months will result in neurolathyrism.**

1. Neurolathyrism



The Toxin

- The toxin present in lathyrus seeds has been identified as **Beta oxalyl amino alanine (BOAA)**.
- It has been isolated in crystalline form and is water soluble; this property has been made use of in removing the toxin from the pulse by soaking it in hot water and rejecting the soak water.
- Studies indicate that there is a blood-brain barrier to this toxin. In order to overcome this barrier, the pulse must be eaten in large amounts over a period of time for 2 months or more.
- Besides BOAA several other toxins have also been reported



BOAA

The Disease in five stages

- Affects mainly young men between the age of 15 to 45 years

(a) Latent stage: The individual is apparently healthy, but **when subjected to physical stress exhibits ungainly gait**. Neurological examination shows characteristic physical signs. This stage is considered important from the preventive aspect, since at this stage, if the pulse is withdrawn from the diet, it will result in. **complete remission of the disease**.

(b) No-stick stage : the patient walks with short jerky steps without the aid of a stick. A large number of patients are found in this stage.

The Disease (2/2)

(c) One-stick stage : The patient walks with a crossed gait with a tendency to walk on toes. Muscular stiffness makes it necessary to use a stick to maintain balance:

(d) Two-stick stage : the symptoms are more severe. Due to excessive bending of knees and crossed legs, the patient needs two crutches for support. The gait is slow and clumsy and the patient gets tired easily after walking a short distance.

(e) Crawler stage : Finally the erect posture becomes impossible as the knee joints cannot support the weight of the body. There is atrophy of the thigh and leg muscles. The patient is reduced to crawling by throwing his weight on his hands

The Interventions for prevention/ control of Lathyrism

(a) Vitamin C prophylaxis

(b) Banning the crop

(c) Removal of toxin

(d) Education

(e) Genetic approach

(f) Socio-economic changes

Prevention/ control of Lathyrism

Vitamin C prophylaxis

- Although this condition is believed to be irreversible, in certain instances the damages could be repaired by the daily administration of 500-1000 mg of ascorbic acid for a week or so.
- The damage could also be prevented by generous provision of ascorbic acid in the lathyrogenic diet, as demonstrated in guinea pigs and monkeys.

Prevention/ control of Lathyrism

Banning the crop

- This is an extreme step not feasible for immediate implementation.
- The Prevention of Food Adulteration Act in India has banned lathyrus in all forms —whole, split or flour. But the ban is not operative where it is needed, viz. Madhya Pradesh, Bihar, Orissa and Gujarat where the pulse is widely grown.
- If however, it is not possible to avoid consuming 'khesari dhal, it is desirable that the proportion of the dhal should **never form more than a quarter of the total amount** of cereals and pulses eaten per day.

Prevention/ control of Lathyrism

Removal of toxin (1)

(1) **Steeping method** :

- Since the toxins are water soluble, they, can be removed by soaking the pulse in hot water.
- This method can be practised at home.
- A large quantity of water is boiled and the pulse is soaked in hot water for 2 hours; after which the soaked water is drained off completely.
- The pulse is washed again with clean water, then drained off and dried in the sun.
- The pulse is then used for consumption.
- The drawback with this method is that it entails loss of vitamins and minerals.

Prevention/ control of Lathyrism

Removal of toxin (2)

(2) **Parboiling:**

- An improved method of detoxicating the pulse is "parboiling" as is done in the case of parboiled rice.
- This technique is suitable for large scale operation.
- Simple soaking in lime water overnight followed by boiling is credited to destroy the toxin.
- This treatment also destroys trypsin inhibitiors. Lime is easily available as it is used with betel leaves.

Prevention/ control of Lathyrism

The Other Interventions

(d) Education: The public must be educated on the dangers of consuming this pulse and the need for removing its toxin before consumption.

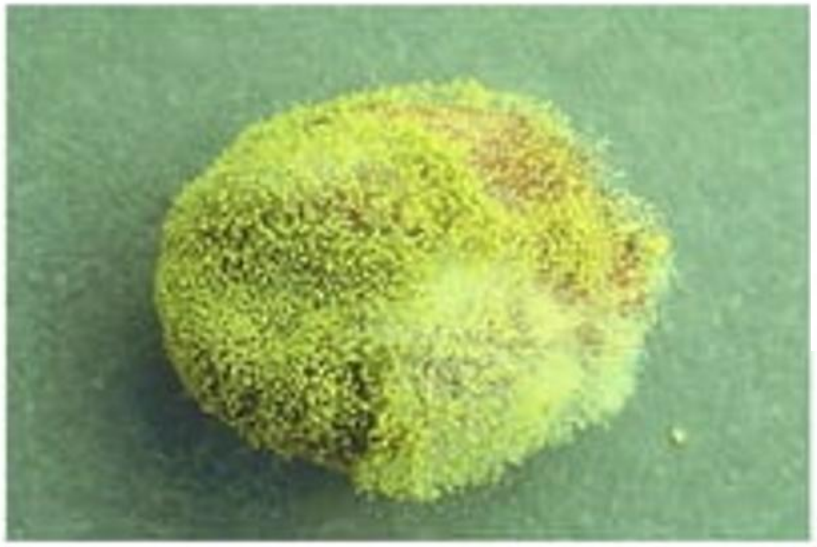
(e) Genetic approach : Certain strains of lathyrus contain very low levels of toxin (0.1%). The selective propagation and cultivation of such strains may be the most effective way to eradicate lathyrism without any drastic change in the food habits of the people. Low toxin varieties can be obtained from the Indian Agricultural Research Institute, New Delhi.

(f) Socio-economic changes : In the final analysis, it is only socio—economic changes or overall development that can root out lathyrism.

2. Aflatoxins

- Aflatoxins are a group of mycotoxins produced by certain fungi, ***Aspergillus flavus*** and ***A. parasiticus***.
- These fungi infest foodgrains such as groundnut, maize, parboiled rice, sorghum, wheat, rice, cotton seed and tapioca under conditions of improper storage
- They produce aflatoxins of which B1 and G1 are the most potent **hepatotoxins**, in addition to being **carcinogenic**.

Aflatoxins from infested Peanuts and Corn



Aspergillus Flavus sporulating on a peanut seed

A. Flavus and A. niger infested rotting Peanuts

A. Flavus infested Corn

Epidemiology

- The most important factors affecting the formation of the toxin are moisture and temperature.
- Moisture levels above 16 per cent and temperatures ranging from 11 to 37°C favour toxin formation.
- Aflatoxicosis is quite a public health problem in India.
- The latest report (1975) of 400 cases of aflatoxin poisoning including 100 deaths from Banswada and Panchmahal districts of Rajasthan and Gujarat respectively highlight the problem in India.
- Aflatoxin B1 has also been detected in samples of breast milk and urine collected from children suffering from infantile cirrhosis
- Attempts are also being made to relate aflatoxin with human liver cirrhosis.

Control and preventive measures for Aflatoxins

- A crucial factor in the prevention of fungal contamination of foodgrains is to ensure their **proper storage after drying**
- Moisture content should be kept below 10 per cent.
- If the food is contaminated, it must not be consumed.
- It is also essential to educate the local population on the health hazards of consuming contaminated foodgrains.

3. Ergot

- Unlike Aspergillus, ergot is not a storage fungus, but a field fungus.
- Foodgrains such as bajra, rye, sorghum, and wheat have a tendency to get infested during the flowering stages by the ergot fungus (***Claviceps purpurea***).
- Fungus grows as a blackish mass and the **seeds become black and irregular and are harvested along with food grains**.

- Consumption of ergot infested grain leads to ergotism.
- Sporadic outbreaks of ergot poisoning in human population have been reported from time to time in areas where bajra is consumed as a staple.

Symptoms of Ergotism

- The symptoms are acute but rarely fatal
- Nausea
- Repeated vomiting,
- Giddiness and
- Drowsiness
- Extending sometimes for periods upto 24 to 48 hours after the ingestion of ergoty grain.

Symptoms of Ergotism

- In chronic cases, **painful cramps in limbs and peripheral gangrene** due to vasoconstriction of capillaries have been reported.

- However, the long-term effects of consuming small amounts of the toxin are not known.
- A disquieting feature is that the recently introduced high-yielding varieties of bajra are more susceptible to infestation.

Control and preventive measures for Ergot

- Ergot-infested grains can be easily removed by **floating them in 20 per cent salt water**.
- They can also be removed by hand-picking or air floatation.
- The upper safe limit for the ergot alkaloids has been estimated to be 0.05 mg per 100 grams of the food material.

4. Epidemic dropsy

- From time to time, outbreaks of "epidemic dropsy" are reported in India.
- The cause of epidemic dropsy was not known until 1926, when Sarkar ascribed it to the contamination of mustard oil with argemone oil.
- Mukherji et.al., (1941) isolated a **toxic alkaloid, sanguinarine** from argemone oil and found out its chemical formula.
- This toxic substance interferes with the oxidation of pyruvic acid which accumulates in the blood.

Symptoms of Epidemic dropsy

- Sudden, non-inflammatory, **bilateral swelling of legs**

Symptoms of Epidemic dropsy

- Sudden, non-inflammatory, **bilateral swelling of legs**
- Often associated with **diarrhoea**
- **Dyspnea, cardiac failure** and **death** may follow
- Some patients may develop **glaucoma**
- The disease may occur at all ages except breast-fed infants.
- The **mortality varies from 5-50 per cent**.

Epidemic dropsy

- The contamination of mustard or other oils with argemone oil may be accidental or deliberate.
- Seeds of *Argemone mexicana* (prickly poppy) closely resemble mustard seeds. The plant grows wild in India.
- It has prickly leaves and bright yellow flowers.
- Crops of mustard are gathered during March, and during this period, the seeds of argemone also mature and are likely to be harvested along with mustard seeds.
- Sometimes unscrupulous dealers mix argemone oil with mustard or other oils.

Tests for detection of Argemone oil

- Argemone oil is orange in colour with an acrid odour.
- The following tests may be applied for the detection of argemone oil

(1) Nitric acid test : A simple test is to add nitric acid to the sample of oil in a test tube. The tube is shaken and the development of a brown to orange-red colour shows the presence of argemone oil. The nitric acid test is positive only when the level of argemone oil is about 0.25 per cent

(2) Paper chromatography test : This is the most sensitive test yet devised. It can detect argemone oil up to 0.0001 per cent in all edible oils and fats.

Prevention of Epidemic Dropsy

- The accidental contamination of mustard seeds can be prevented at the source by removing the argemone weeds growing among oil-seed crops.
- Unscrupulous dealers may be dealt with by the strict enforcement of the Prevention of Food Adulteration Act.

5. Endemic ascites

- In Kusmi Block of Sarguja district in Madhya Pradesh, during 1973 and again during 1976, an outbreak of rapidly developing ascites and jaundice was reported among the Nagesia tribals.
- Both the sexes and all the age groups, except infants, were affected.
- The overall mortality was 40 per cent.

The Cause of Endemic ascites

- Studies conducted by the National Institute of Nutrition, Hyderabad showed that the local population subsist on the millet ***Panicum miliare*** (known locally as Gondhli) which gets contaminated with weed seeds of ***Crotalaria*** (locally known as Jhunjhunia).
- On chemical analysis, Jhunjhunia seeds were found to contain **pyrrolizidine alkaloids** which are **hepatotoxins**.

Crotolaria affecting Panicum

Panicum affecting crops

Panicum seeds

Ascites

Prevention of Endemic ascites

- Educating the people in the affected areas about the disease,
- Deweeding of the Jhunjhunia plants which grow along with the staple
- Simple sieving of the millet at the household level to remove the seeds of Jhunjhunia which are considerably smaller than those of the millet

Jhunjhunia Seeds

Millet seeds

6. Fusarium toxins

- Fusarium species of field fungi are known to contaminate food crops and pose health hazards to livestock and man.
- The problem of fusarium contamination of sorghum is believed to be on the increase.
- Rice is also known to be a good substrate for fusarium.
- Work is now in progress at the National Institute of Nutrition to isolate, and identify the toxic metabolites produced by *fusarium incamatum*.

Fusarium toxins affected Maize and Wheat

Table. Chronology of investigations on food toxins at ICMR-National Institute of Nutrition since its inception

Phase	Number of years	Study focus and contributions
1 (1926-1963)	37	Lathyrism: Epidemiology, identification and isolation of toxic factor, reproduction of disease in experimental animals, methods of removal of toxic factor, adulteration issues
2 (1964-1980)	16	Aflatoxin: Biological effects in experimental animals, natural occurrence in groundnut, acute aflatoxicosis outbreak in human populations Ergot alkaloids poisoning in man Epidemic dropsy Disease outbreaks from adventitious contamination of food crops Toxins in edible oils Nutritional and toxicological evaluation of unconventional oils
3 (1981-2000)	19	Food safety for public health protection using risk-based approaches Evolving national strategies for food safety assurance and control Food contaminants monitoring programmes Capacity building/training in analytical methodology of food toxins/contaminants Foodborne diseases due to mycotoxins, bacterial pathogens, aquatic biotoxins, chemical toxicants, food adulterants Safety assessment of damaged/discoloured food grains Risk assessment of food contaminant exposure
2001-present	16	Food safety - newer issues Food safety assessment of genetically engineered foods Investigation on fungal and aflatoxin contamination of discoloured and stored rice for public distribution Information, exchange and communication strategies for ensuring food safety - KAP studies on foodborne pathogens Food contaminants and hazards in processed foods and exposure assessment: Mycotoxins in processed RTE groundnut snacks, RTE spice mixtures and botanicals Monitoring of pesticide residues in food and water and estimating human exposure

RTE, ready to eat; KAP, knowledge attitude and practices

Source: List of publications of ICMR-National Institute of Nutrition, Hyderabad from NIN library

Food additives

Food additives

- The concept of adding **"non-food" substances** to food products is not new.
- **Pickling** is an ancient culinary practice aimed at preserving food articles such as mango, lime, etc for fairly long periods by the addition of salt and spices.
- Modern science of food technology has revolutionized food processing with the introduction of chemical additives to increase the shelf-life of food, improve its taste, and to change its texture or colour.
- Majority of the processed foods such as bread, biscuits, cakes, sweets, confectionary, jams, jellies, soft drinks, ice creams, ketchup and refined oils contain food additives.

Food additives - Definition

- **Food additives are defined as non-nutritious substances which are added intentionally to food, generally in small quantity, to improve its appearance, flavour, texture or storage properties**
- This definition also includes animal food adjuncts which may result in residues in human food and components of packing materials which may find their way into food.

First Category of Food additives

- Colouring agents (e.g., saffron, turmeric)
- Flavouring agents (e.g., vanilla essence)
- Sweeteners (e.g., saccharin)
- Preservatives (e.g.,asorbic acid, sodium benzoate)
- Acidity imparting agents (e.g., citric acid, acetic acid), etc.
- These agents are generally considered safe for human consumption.

Second Category of Food additives

- Contaminants incidental through packing, processing steps, farming practices (insecticides) or other environmental conditions.
- Uncontrolled or indiscriminate use of food additives may pose health hazards among consumers.
- For example, certain preservatives such as nitrites and nitrates can lead to the production of toxic substances, e.g., nitrosamines that have been implicated in cancer aetiology.

Regulation of Food additives (1)

- The use of food additives is subjected to government regulations throughout the world.
- In India two regulations (viz. the Prevention of Food Adulteration Act and the Fruit Products Order) govern the rules and regulations of food additives.
- Any food that contains food additives that are not permitted is considered to be adulterated; if the permissible limit exceeds then also the food is considered adulterated.

Regulation of Food additives (2)

- The nature and quantity of the additive shall be clearly printed on the label to be affixed to the container.
- Whenever, any extraneous colouring matter has been added to any article of food, the words "Artificially Coloured" shall be written on the label.
- The ultimate effects of food additives on man is an important problem of public health and is therefore of great concern to the public and the health administrators.


+F
+F
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Food fortification

Food fortification

- Fortification of food is a public health measure aimed **at reinforcing the usual dietary intake of nutrients with additional supplies to prevent/control some nutritional disorders**.
- WHO has defined “food fortification” as “the process whereby nutrients are added to foods (in **relatively small quantities**) to maintain or improve the quality of the diet of a group, a community, or a population.”

Food fortification

Programmes of demonstrated effectiveness of fortification of food or water are :

- Fluoridation of water as a preventive of dental caries
- Iodization of salt for combating the problem of endemic goitre
- Food fortification (e.g., vanaspati, milk) with vitamins A and D.

Criteria for Food fortification (1)

(a) the vehicle fortified **must be consumed consistently as part of the regular daily diet** by the relevant sections of the population or total population;

(b) the amount of nutrient added must provide an effective supplement for **low consumers** of the vehicle, without contributing a hazardous excess to **high consumers**;

Criteria for Food fortification (2)

(c) the addition of the nutrient should not cause it to undergo **any noticeable change** in taste, smell, appearance, or consistency

(d) the **cost** of fortification must not raise the price of the food beyond the reach of the population in greatest need.

- Finally, an adequate system of surveillance and control is indispensable for the effectiveness of food fortification.
- Food fortification is a long-term measure for mitigating specific problems of malnutrition in the community.

Food Adulteration

Adulteration of foods

- Adulteration of foods is an age-old problem.
- It consists of a large number of practices
  - mixing
  - substitution
  - concealing the quality
  - putting up decomposed foods for sale
  - misbranding or giving false labels
  - addition of toxicants.

Adulteration of foods

- Adulteration results in two disadvantages for the consumer
- He is paying more money for a foodstuff of lower quality;
- Some forms of adulteration are injurious to health, even resulting in death
- Ex. adulteration of mustard oil with argemone oil causing epidemic dropsy or
- Ex. adulteration of edible oils with tricresyl phosphate (TCP) resulting in paralysis and death
- Food adulteration practices vary from one part of the country to another, and from time to time.
- Our knowledge about the current practices of food adulteration is by no means complete.

Adulteration of foods

Food material	Common adulterants
Cereals such as wheat, rice	Mud, grits, soapstone bits
Dals	Coal-tar dyes, khesari dal
Haldi (Turmeric) powder	Lead chromate powder
Dhania powder	Starch, cow dung or horse dung powder
Black pepper	Dried seeds of papaya
Chilli powder	Saw dust, brick powder
Tea dust/leaves	Blackgram husk, tamarind seeds powder, saw dust, used tea dust
Coffee powder	Date husk, tamarind husk, Chicory

Asafoetida (Hing)	Sand, grit, resins, gums
Mustard seeds	Seeds of prickly poppy-Argemone
Edible oils	Mineral oils, argemone oil
Butter	Starch, animal fat
Ice-cream	Cellulose, starch, non-permitted colours
Sweetmeats	Non-permitted colours
Fresh green peas in packing	Green dye
Milk	Extraction of fat, addition of starch and water
Ghee	Vanaspati

Some Commonly Adulterated Foods in the Market

Turmeric, dals and pulses

- Adulterant: Metanil Yellow and Kesari Dal
- Health hazard: Highly carcinogenic, stomach disorders.

Green Chilies, green peas & other vegetables

- Adulterant : Malachite Green, Argemone seeds
- Health hazard: Carcinogenic if consumed over a long period of time

Mustard Seeds and Mustard Oil

- Adulterant : Argemone seeds, Papaya seeds
- Health hazard: Epidemic dropsy and severe glaucoma

Paneer, khoya, condensed milk and milk

- Adulterant: Starch and water
- Health hazard: Stomach disorders

Ice cream

- Adulterant: Pepperonil, Ethylacetate, Butraldehyde, Nitrate, Washing powder etc
- Health hazard: Pepperonil is used as a pesticide and ethyl acetate causes diseases affecting lungs, kidneys and heart.

Coffee powder

- Adulterant : Tamarind seeds, chicory powder
- Health hazard: Diarrhea, stomach disorders, giddiness and severe joint pains

Prevention of Food Adulteration Act, 1954

- Enacted by the Indian Parliament in 1954, with the objective of ensuring pure and wholesome food to the consumers and to protect them from fraudulent and deceptive trade practices
- A minimum imprisonment of 6 months with a minimum fine of Rs.1,000 is envisaged under the Act for cases of proven adulteration,
- For the cases of adulteration which may render the food injurious to cause death or such harm which may amount to grievous hurt (within the meaning of section 320 of I.P.C.) the punishment may go upto life imprisonment and a fine which shall not be less than Rs.5,000.

Prevention of Food Adulteration Act, 1954

- Rules are framed which are revised from time to time by an expert body called the "Central Committee for Food standards" which is constituted by the Central Government under the provisions of the Act.
- Any food that does not conform to the minimum standards is said to be adulterated.
- Although it is a Central Act; its implementation is largely carried out by the State Governments and local bodies in their respective areas.
- However, the Centre plays a vital role in proper coordination, monitoring and surveillance of the programme throughout the country.
- A chain of food laboratories and four regional appellate Central Food Laboratories (Kolkata, Mysore, Ghaziabad and Pune) whose report is considered to be final have been established.

Prevention of Food Adulteration Act, 1954

- Training being an important component of the programme for prevention of food adulteration, the Directorate General of Health Services organizes in-service training programme for different functionaries responsible for implementation of the PFA Act.
- Food inspectors, analysts and the senior officers concerned with the implementation of the Act in States are provided training.

Prevention of Food Adulteration Act, 1954

- Food adulteration is a social evil.
- The general public, traders, and Food Inspectors are all responsible for perpetuating this evil —
  - The public, because of lack of awareness of the dangers of adulteration and their general disinterest;
  - The traders, for their greed for money,
  - Food Inspectors who find food adulteration a fertile ground to make easy money.
- Unless the public rises up against the traders and unscrupulous food inspectors, this evil cannot be curbed.
- It is here the voluntary agencies and consumer guidance societies can play a vital role.

Food Safety and Standards Act, 2006

- Food Safety and Standards Act, 2006 was enacted with the objective
- to consolidate the laws relating to food and for laying down science based standards for articles of food as well as
- to regulate their manufacture, storage, distribution, sale and import
- to ensure availability of safe and wholesome food for human consumption and for matters connected therewith or incidental thereto.
- The Food Safety and Standards Authority of India (FSSAI) was established in the year 2008.
- FSS Act 2006 is being implemented by all states/UT governments

Food standards

CODEX ALIMENTARIUS : The Codex Alimentarius Commission, which is the principal organ of the **joint FAO/ WHO Food Standards Programme** formulates food standards for international market. The food standards in India are based on the standards of the codex alimentarius.

Food standards

PFA STANDARDS: Under the Prevention of Food Adulteration Act (1954) standards have been established which are revised from time to time by the "Central Committee for Food Standards".

The purpose of the PFA standards is to obtain a **minimum level of quality** of foodstuffs attainable under Indian conditions.

Food standards

THE AGMARK STANDARDS :

Set by the Directorate of Marketing and Inspection of the Government of India.

The Agmark gives the consumer **an assurance of quality** in accordance with the standards laid down.

Food standards

BUREAU OF INDIAN STANDARDS : The ISI mark on any article of food is a guarantee of good quality in accordance with the standards prescribed by the Bureau of Indian Standards for, that commodity. The Agmark and ISI standards are not mandatory; they are **purely voluntary**. They express degrees of excellence above PFA standards.

Thank You ☺