Overview of Food Safety

Ka-sing LEUNG
BSc, PhD, CChem, FRSC, CFS
Adjunct Associate Professor
Department of Applied Biology & Chemical Technology
cum Advisor, Food Safety and Technology Research Centre
HONG KONG POLYTECHNIC UNIVERSITY
March 2019 · Hong Kong
Contents

• Introduction

• Food-borne Hazards
  • Biological Hazards
  • Chemical Hazards
    • Food Additives and Standard Setting

• Nutrition and Health
Food Incidents Involving High Health Risks

- Cases requiring clinical treatment or with casualties
- Methamedophos residue in vegetables (1987 HK & China)
  - acute toxic effect of pesticide residue at high levels
- Mad cow disease (90’s UK, 2005 USA)
  - use of meat and bone meal as feed banned
- Clenbuterol in pig liver (late 90’s HK & China)
  - acute toxic effect of veterinary drug residue at high levels
- Melamine in milk products (2008 China)
  - adulteration of infant formula
- E Coli O104:H4 in vegetables (2011 Germany)
  - micro-organism
- Food poisoning cases
  - microbiological agents (pathogens), toxins
Food Incidents Involving Health Risks Not High

- Perceived of posing potential chronic health effects
  - toxic chemicals at very low levels due to contaminated feed
- Malachite green in fish and fish products (2005 China)
  - suspected carcinogen used as veterinary drug in aquaculture
- Sudan dyes in egg and egg products (2006 China)
  - non-permitted dye added to feed for colouring the egg yolk
- Radiological contamination in food (2011 Japan)
  - Japan 311 aftermath: radioactive contaminants into food chain
- Plasticizers in beverages (2011 Taiwan)
  - plasticizers used as clouding agent
- Pesticide residues in fruits and vegetables
  - low levels, likely due to environmental contamination
- Food fraud cases
  - horse meat in beef, “trench” oil, etc.
Health Risk vs. Risk Perception

• Health risk
  • science-based risk assessment
  • food-borne hazards: toxicity, concentration, food consumption

• Risk perception of general public
  • demanding hazard not present, i.e. “zero risk”
  • chemical/radioactivity detected ⇒ food cannot be consumed
  • toxic chemical detected ⇒ unsafe food
  • exceeding standard ⇒ harmful/toxic/carcinogenic food

• Misconception on hazard and risk
What is food safety?

Assurance that food will not cause harm to the consumer when it is prepared and/or eaten according to its intended use

Codex Alimentarius Commission
Food-borne Hazards

- Potential to cause adverse health effect
- Biological hazards
  - bacteria, viruses, toxins
- Physical hazards
  - extraneous objects, radiological contaminants
- Chemical hazards
  - additives: preservatives, antioxidants, processing aids
  - residues: pesticides, veterinary drugs
  - contaminants: toxic metals, persistent organic pollutants
Health Risk from Food-borne Hazards

- **Food-borne hazard**
  - intrinsic property of food-borne agent with potential to cause adverse health effect

- **Health risk**
  - consequential to presence of food-borne hazard
  - probability of causing adverse health effect and the severity of that effect

- **Health risk from chemical agent**
  - quantity intake and toxicity
    - concentration of chemical agent in food and amount of food consumed
    - toxicology data
Food Poisoning Outbreaks

- **Seasonal pattern:** peak in summer
- **Bacteria**
  - most common culprit
  - examples of high risk food
    - sushi & sashimi, cold dishes, salads, buffet
- **Norovirus**
  - food in contact with sewage-contaminated water
    - shellfish, vegetables, ice
- **Toxins**
  - ciguatoxins in fish, shellfish toxins
- **Chemicals (in the 90’s)**
  - high levels of methamedophos (pesticide) in vegetable and clenbuterol (veterinary drug) in pig liver
Bacterial Hazards

- **Health risk: bacterial food poisoning**
  - major cause of food poisoning cases
  - from food establishment, at home

- **Food contamination by bacterial pathogens, e.g.**
  - salmonella: inadequately cooked meat, egg
  - staphylococcus aureus: manually handled food without subsequent reheating
  - vibrio parahaemolyticus: inadequately cooked marine products

- **Gastrointestinal symptoms in general**
  - nausea, abdominal pain, diarrhoea, vomiting
  - incubation period: hours to days
Bacterial Food Poisoning:
Common Causes

- Contamination and cross-contamination of cooked food
  - due to food handling, raw food, environment, pests
- Improper storage of cooked food
  - between 4°C and 60°C for prolong period
- Inadequate cooking of food
  - raw food not cooked thoroughly to reduce pathogens
- Consumption of raw food
  - raw food with pathogens eaten without cooking
Bacterial Food Poisoning: Preventive Measures

- Observing good hygiene practices
- Food purchasing: smart consumers
  - from hygienic food establishments
  - notice physical conditions of packaging; read the label
- Hygienic handling of food
  - wash and cook food thoroughly
  - wash hands thoroughly
- Proper storage of food
  - separate cooked and raw food: cooked food at upper level
  - below 4°C or above 60°C if not consumed at once
  - minimize exposure to room temperature
Case Study: Enzymatic Browning

- Browning of cut fruits and vegetables
  - e.g. apple, potato, lettuce, mushroom
  - cell breaking and exposing to air leading to enzymatic oxidation forming reddish-brown traces
  - not food spoilage, but appearance unappealing

- Enzymatic oxidation of polyphenols
  - catalysed by polyphenoloxidase
  - to melanin
    - reddish brown polymer
Prevention of Enzymatic Browning

- **Oxygen barrier**, e.g. salad dressing
- **Changing temperature**
  - inhibition of enzyme activity by blanching, freezing, refrigeration, etc.
- **Changing acidity**
  - inhibition of enzyme activity at lower pH
- **Food additives**
  - antioxidant: removal of oxygen (sulphites, ascorbic acid)
  - acid: reducing pH (citric acid)
  - chelating agent: removing metal of enzyme (phosphates)
Appearance, Odour, Flavour and Texture of Food

- Quality indicators of food for enjoyment
- Addition of flavouring and other additives during food preparation
  - improving attractiveness and organoleptic properties of food
    - appearance, odour, flavour, texture
- Everyday use of additives
  - cooking food
    - soy sauce, salt, sugar, spices
  - making bread and cakes
    - baking powder, sugar, colouring
Food Additives

- **Natural or synthetic substances added to food**
  - improving food quality, stability and organoleptic properties
  - facilitating food manufacturing, processing, preparation, packaging, transportation and storage

- **Specific technological function**
  - fit for intended purpose when appropriately used
  - improving organoleptic properties
    - appearance, odour, flavour, texture
  - food stability
    - preventing deterioration, spoilage
    - prolonging shelf-life
  - processing aid
Common Food Additives (1)

- **Flavour enhancer**
  - enhances existing taste and/or odour of food
  - monosodium glutamate (INS621), aspartame (INS951)

- **Sweetener**
  - imparts sweet taste to food
  - acesulfame potassium (INS950), sodium saccharin (INS954)

- **Bulking agent**
  - contributes to bulk of food without contributing significantly to its available energy value
  - sodium carbonate (INS500ii), ammonium bicarbonate (INS503ii)

- **Emulsifier**
  - forms or maintains a uniform emulsion of two or more phases in food
  - alginic acid (INS400), sucroglycerides (INS474)
Common Food Additives (2)

- **Colour**
  - adds or restores colour in food
  - turmeric (INS100ii), amaranth (INS123)

- **Preservative**
  - prolongs the shelf-life of food by protecting against deterioration caused by microorganisms
  - benzoic acid (INS210), sorbic acid (INS200)

- **Anticaking agent**
  - reduces the tendency of particles of food to adhere to one another
  - magnesium carbonate (INS504i), calcium silicate (INS552)
How can I know additives in my food?

- Read the label of the prepackaged food
  - composition table: ingredients
    - sulphur dioxide
    - acid (E296): malic acid
    - acidity regulator (E331): sodium dihydrogen citrate
    - colour (E102): tartrazine
    - colour (E123): amaranth
Basic Principles for Using Food Additives

- NOT posing hazard to health
- NOT masking evidence of deterioration or quality defects
- NOT deceiving consumers
- NOT lowering the nutritional value of food
- Use level in food as low as practicable in achieving intended purpose
  - good manufacturing practice (GMP)
- Complying with food regulations
How does a substance become injurious to health?
“Father of Toxicology”
Paracelsus

“All substances are poisons; there is none which is not a poison. The right dose differentiates a poison and a remedy.”

Paracelsus (1493 – 1541)
What is meant by poisonous?

- Excessive intake of any substance may pose health risk
  - e.g. breath in 40% oxygen, excessive intake of water
- Toxicity
  - assessment by experts: dosage posing adverse health effect
  - indicator: acceptable daily intake (ADI)
    - life-long exposure dose without observable health effect
- Quantity intake from food
  - concentration of substance in food
  - food consumption data
- Standard setting: considering toxicity and possible quantity intake
International Standard

- **Codex Alimentarius Commission**
  - Joint FAO/WHO Food Standard Programme
    - Food and Agriculture Organization of the United Nations (FAO) and World Health Organization (WHO)

- **Codex Alimentarius**
  - international food standards, guidelines, codes of practice

- **Food standard setting through risk analysis**
  - science-based, risk-based
  - risk assessment by international experts
    - Joint FAO/WHO Expert Committee on Food Additives (JECFA)

- **Reference for local food regulations**
Standard Setting for Food Additives

- **Use level of additive in specified food**
  - technological requirement based on GMP
    - controlling amount added to food
    - as low as practicable in achieving intended purpose

- **Possible intake of additive**
  - evaluate intake based on use level and food consumption

- **Toxicity of additive**
  - acceptable daily intake (ADI): no adverse health effect

- **If no health risk, use level set as maximum permitted level**
Exceeding Regulatory Limit Implying Toxic or Harmful Food?

- **Maximum permitted level in food**
  - use level based on GMP and no adverse health effect
  - much lower than dosage for observable health effect

- **Exceeding regulatory limit** ⇒
  - additive in food exceeding maximum permitted level
  - food not produced according to GMP

- **Adverse health effect?**
  - requiring further assessment
    - occasional intake: no adverse effect
    - long term intake: may pose risk

Exceeding limit NOT necessarily imply toxic
Food Safety Control

- **Control throughout the food supply chain**
  - from farm to table
- **Control of hazards at source**
- **Control of risk**
  - science-based risk analysis
    - risk assessment, risk management, risk communication
- **Tripartite collaboration**
  - food trade/industry: compliance with legislation and standards
  - government: laws/standards, surveillance and enforcement
  - smart consumer
Food and Nutrition

- **Food**: source of energy and nutrients
  - essential for human life
  - energy supports activities of human body
  - nutrients essential for growth, maintenance and repair of body tissues, maintenance of good health

- **Nutrients**
  - macronutrients, micronutrients

- **Under-nutrition**: not enough nutrient intake
  - retarding growth and development, injurious to health

- **Over-nutrition**: excessive intake of nutrients
  - chronic non-communicable diseases
Nutrition and Stages of Life

- **Infants**
  - energy and nutrients for growth and development

- **Children and adolescents**
  - adequate energy and nutrients for healthy growth, learning as well as physical and other activities

- **Adults**
  - different nutrients in balanced amount to maintain good health and prevent diseases

- **Pregnant women and lactating mothers**
  - additional nutrients to support pregnancy and lactation for babies
Types of Nutrients

**Macronutrients**
- provision of energy
- protein: used for growth and body repair
- carbohydrate: major energy source
- fat: concentrated energy source, carrier for fat-soluble vitamins, preventing heat loss and protecting organs from shock

**Micronutrients**
- enabling human body to produce enzymes, hormones and other substances essential for proper growth and development
- minerals: regulate many body functions
- vitamins: participate in different body metabolism
Over-nutrition

- Prolong excessive intake of macronutrients leading to unhealthy conditions
  - mainly due to sugar, salt and fat
- Excessive intake of energy
  - overweight, leading to obesity
- Excessive intake of salt
  - hypertension
- Non-communicable diseases
  - diabetes and complications
  - stroke, cardiovascular diseases
Information Sources for Nutrient Composition of Food

- **Food composition databases**
  - e.g. Nutrient Information Inquiry System of the Centre for Food Safety
    - nutrient information on general and indigenous foods
    - Food Nutrient Calculator for estimating daily nutrient intake

- **Nutrition labelling on prepackaged food**
  - Food and Drug (Composition and Labelling) Regulation
    - nutrient contents for energy, protein, carbohydrate, total fat, saturated fat, *trans*-fat, sodium, sugar
    - nutrient contents of the nutrition claim
    - cholesterol content for nutrition claim on fats
Examples of Nutrition Labelling

- Based on weight or volume
- Based on % nutrient reference value
- Based on per serving
Healthy Eating

- Select variety of foods and quantity appropriate to individual needs
  - different foods have different nutritional values
  - energy and nutrient requirements vary with individuals
    - age, physical activities

- Balance diet
  - nutrient intake from variety of foods
  - eat appropriate amount of foods
    - most grains
    - more fruits and vegetables (dietary fibre)
    - moderately milk, fish, meat, egg
    - less salt, sugar and fat
Food Quality and Safety Issues

- **Nutrition**
  - sufficient nutritious food to support life

- **Convenient and delicious**
  - fast pace of living, quality food for enjoyment

- **Health concern**
  - food safety: risks from food-borne hazards
  - over-nutrition

- **Consumer’s right: food fraud**
  - adulteration, counterfeit, misrepresentation, misbranding, misleading information

- **Food security and sustainability**
  - adequate supply of safe and nutritious food affordable to all

- “One Health”: antimicrobial resistance issue
How to eat safely and healthily?

- **Smart consumer**
  - purchase food from reputable retailers and suppliers
  - check physical conditions, read the label
    - shelf-life, ingredients, nutrients, storage conditions

- **Appropriate handling of food**
  - washing, preparation, heat treatment, storage temperature, storage duration, prevention of contamination

- **Personal and environmental hygiene**

- **Balance diet**
  - excessive intake of food considered good to health may pose health risk

- **Beware of over-nutrition**
Thank You

ka-sing.leung@polyu.edu.hk