Natural and residual contamination in vegetables & fruits





Asist. Prof.Dr.Pharrunrat Tanaviyutpakdee Institute of Nutrition Mahidol University

Outline

- The relationship between food nutrition and food safety
- Food guide and recommendations
- Food chain of fresh produce
- Some terminology for toxicology
- Hazards in fresh produce, natural and manmade sources: biologicals, chemicals, physicals.
- How to eat fresh produce with safety?

Food, nutrition and food safety

Food: stuffs that we eat and drink contain nutrients & (non-nutrients)

Nutrition: benefit and utilization of nutrient in human body





Food guide

The Thai food guide is a hanging flag, known as 'the nutrition flag'.

The four layers in the nutrition flag denote the type and amount of the food groups that are recommended for consumption.

Recommendations are as follows:

- (i) eat rice, rice products, other grains and starchy food groups in abundance;
- (ii) eat plenty of vegetables and fruits;
- (iii) eat meat, legumes, eggs and milk appropriately; (iv) eat limited amounts of oil, sugar and salt.

9 Messages

- Eat a variety of foods from each of the five food groups and maintain a proper weight.
- Eat adequate amounts of rice or alternate carbohydrate sources.
- Eat plenty of vegetables and fruits regularly.
- Eat fish, lean meat, eggs, legumes and pulses regularly.
- Drink in appropriate quality and quantity for one's age.
- Eat a diet containing appropriate amounts of fat.
- Avoid sweet and salty foods.
- Eat clean and safe foods.
- Avoid or reduce the consumption of alcoholic beverages.



USDA

The 5 Colors of Phytonutrients

Goals and recommendations for cancer prevention

- Be as lean as possible within the normal range of body weight
- Be physically active as part of everyday life
- Limit consumption of energy-dense foods and avoid sugary drinks
- Eat mostly foods of plant origin
- Limit intake of red meat and avoid processed meat
- Limit alcoholic drinks
- Limit consumption of salt, avoid mouldy cereals (grains) or pulses (legumes)
- Aim to meet nutritional needs through diet alone







→ Analysis and obtain insight into the different sources of contamination along the chain

Good agricultural practices (GAPs)



A collection of principles to apply for on-farm production and post-production processes, resulting in safe and healthy food.

Evaluate the whole operation

Pre-plant, Production, Harvest & Post-Harvest

- Irrigation and wash water sources
- Manure source, use, and handling
- Employee training and hygiene
- Farm and equipment sanitation



Five keys to growing safer fruits and vegetables: promoting health by decreasing microbial contamination



Trial edition for field testing June 2011



Five keys to growing safer fruits and vegetables

To promote safe food handling practices and prevent foodborne diseases.



Five keys to growing safer fruits and vegetables

To promote safe food handling practices and prevent foodborne diseases.





Good Hygienic Practices (GHPs)

- Reduce or slow the spread of infections
- Worker hygiene and sanitation practices during production, harvest, sorting, packing, and transport
- GHPs play a critical role in minimizing the potential for microbial contamination of fresh produce
- Careful handling and washing of all produce

Some terminology in toxicology & food safety

Toxicity : The degree to which a substance (a toxin or poison) can harm humans or animals

Hazards : Any source of potential damage, harm or adverse health effects

Biologicals Chemicals Physicals

Risk : The possibility of suffering harm or loss; danger





Management: consumer responsibility Washing properly Hand washing Clean kitchen wear

Hazards in fresh produce

Natural and manmade sources



Foodborne illnesses/ sickness

Foodborne illnesses/ sickness

- Foodborne illnesses are usually infectious or toxic in nature and caused by bacteria, viruses, parasites or chemical substances entering the body through contaminated food or water.
- Foodborne pathogens can cause infections, severe diarrhea and including meningitis.
- Chemical contamination can lead to acute poisoning or long-term diseases, such as cancer.
- Foodborne diseases may lead to long-lasting disability and death.
- Examples of unsafe food include uncooked foods of animal origin, fruits and vegetables contaminated with feces, and raw shellfish containing marine biotoxins.



- In the field
- During harvesting and transport
- During packing or processing
- In distribution and marketing
- In the restaurants and food service facilities and
- At home

Sources of pathogens on fresh produce

- Contaminated irrigation water
- Fresh or uncomposted manure/fecal material
- Wild or domestic animals
- Handling by infected workers







Sources of pathogens on fresh produce

- Equipment
- Transport vehicles
- Contaminated wash water and ice
- Contamination during processing
- Improper storage and packing
- Cross contamination
- Improper handling after wholesale or retail purchase

A diagram of how biological hazards can come in contact with fresh produce

Preventing contamination is the goal



Manure = Fecal Matter = Microbes





Eating contaminated produce (fruits, vegetables and juices made from contaminated produce) can lead to foodborne illness, often called "food poisoning."

Type of microorganism contamination in fruit and vegetables

• Bacteria

- E. coliO157:H7
- Listeria monocytogenes
- Aeromonas hydrophilis
- Bacillus cereus
- Campylobacter jejuni
- Clostridium boyulinum
- Salmonella spp.
- Staphylococcus
- Virus: Rotavirus, Hepatitis A and E
- Protozoas/parasites: Angiostrongylus cantonensis, Ascaris Cryptosporidium, Giardia, Entamoeba histolytica, Fassiolopsis buski,

Bacteria in foods

E. coli O157:H7 verocytotoxin-producing E.coli

- Transmission is via the fecal-oral route, and most illness has been through distribution of contaminated raw leaf green vegetables and undercooked meat.
- Symptoms
 - severe, acute hemorrhagic diarrhea (although nonhemorrhagic diarrhea is also possible) and
 - abdominal cramps
 - usually little or no fever , and
 - the illness resolves in five to 10 days
 - It can also be asymptomatic.

E. coli O157:H7

- Treatment
 - Fluid replacement and blood pressure support.....necessary to prevent death from dehydration, most victims recover without treatment in five to 10 days.

 Antidiarrheal agents should also be avoided as they may prolong the duration of the infection.

L. monocytogenes

- *L. monocytogenes* is found in soil and water.
- Vegetables can become contaminated from the soil or from manure used as fertilizer.
- Animals can carry the bacteria and can contaminate meats and dairy products.
- Processed foods, such as soft cheeses and cold cuts, can be contaminated after processing.

L. monocytogenes

- The symptoms of listeriosis include fever, muscle aches, and sometimes nausea or diarrhea.
- If infection spreads to the nervous system, symptoms such as
 - headache, stiff neck, confusion, loss of balance, or convulsions.
 - Treatment of *listeriosis*
 - the overall mortality 70%,
 - from septicemia 50%, and
 - from perinatal/neonatal infections greater than 80%.
 - Reports of successful treatment with parenteral penicillin or ampicilln.

Protozoa and parasites

- Giardia lamblia
- Angiostrongylus cantonensis
- Ascaris
- Fasiolopsis buski

 – enter the food chain via water or soil and can contaminate fresh produce

Giardia lamblia







<mark>Giardia lamblia</mark>



Symptoms

- stomachache
- persistent diarrhea
- frothy stools with mucus
- steatorrhea

Coloured scanning electron micrograph (SEM)

Angiostrongylus cantonensis





Intermediate host: Snail






Ascaris lumbricoides



Ascariasis is classified by severity of manifestations

Type A is often asymptomatic,

Type B causes permanent growth retardation in children,

Type C is clinically overt and is characterized by intermittent abdominal pain, nausea, anorexia, diarrhea,

Type D includes acute complications that often require hospitalization (intestinal obstructions, biliary ascariasis, appendicitis, etc.),

Ttype E is most severe frequently fatal disease.

Fasiolopsis buski



Intermediate host



Metacercaria

- Symptoms
 - -nausea/ vomiting
 - stomach cramp
 - -diarrhea
 - -allergic symptom

up to 3mm thick

Carriers: Watery vegetable



Thai morning glory

Rotavirus

- Rotaviruses are the principal cause of dehydration caused by diarrhea, especially in children younger than 2 years of age.
- It takes about 1 to 3 days for a child who is exposed to the virus to start having symptoms.
- Vomiting is often the first symptom. Usually, a fever and diarrhea follow.
 - very watery diarrhea, severe diarrhea lasts 3 to 8 days.
 - Diarrhea, especially when it occurs along with vomiting, can quickly lead to dehydration.

Panel 1. Potential mechanisms by which rotavirus might induce diarrhoea¹⁴

Reduced absorptive surface

Denudation of microvilli; shortening, flattening, and atrophy of villi; invasion of villi by rotavirus causing ischaemia and shortening^{3,18,19}

Functionally impaired absorption

Depressed disaccharidase concentrations; impaired co-transport of glucose and sodium; decreased sodium-potassium ATPase activity impairing electrochemical gradient^{3,18,19,23-25}

Cellular damage impairing absorption

Mitochondrial swelling; distension of endoplasmic reticulum; mononuclear cell infiltration^{3,13,18,19}

Enterotoxigenic effects of rotavirus protein NSP4

Induces increased intracellular calcium concentrations; in murine models, acts like a toxin to induce diarrhoea^{21,22}

Stimulation of enteric nervous system

Stimulation of intestinal secretion of fluid and electrolytes; stimulation of intestinal motility resulting in decreased intestinal transit time^{14,20}

Altered epithelial permeability

Increased paracellular permeability by weakening tight junctions between cells²⁶⁻²⁸







SOURCES: Dr. Aimin Chen; Casarett & Doull's Toxicology, (Curtis D. Klaassen); Environmental Health Perspectives, Dec. 2009 AP



Source: Cadmium contamination

- Cd is rare in the natural in environment.
- It generally comes from environmental pollution from industrial and agricultural waste.
- Cd is used in batteries and electroplating.
- It is a component of paint for plastic products and chalk pastels, acrylic colors, and watercolor pigments.
- Recently, in laboratory experiments, Cd with helium....a common component of blue-ultraviolet light in fluorescence microscopes.
- In agriculture, some fertilizers contain Cd

Lead poisoning



Source: Lead contamination

- Lead-containing pigments still are used for outdoor paint products because of their bright colors and weather resistant properties.
- Tetraethyl and tetramethyl lead are still used as additives in gasoline in several countries.



- Methemoglobinemia is a blood disorder caused when nitrite interacts with the hemoglobin in red blood cells.
- Unlike hemoglobin, the methemoglobin formed in this interaction cannot carry sufficient oxygen to the body's cells and tissues.

Methemoglobinemia

- Symptoms of acquired methemoglobinemia include:
 - Bluish coloring of the skin
 - Headache
 - Fatigue
 - Shortness of breath
 - Lack of energy





Pesticides

- Organophosphate
- Carbamate
- Organochlorine
- Pyretriods





Organophosphates are anti-esterase insecticides



Enzyme inhibition



Example	PESTICIDES in I Do you know which foods are best to buy organic?	RODUCE You 'll consume fewer	
Consume average 14 pesticides a day		2 pesticide a day	
	Peaches Apples Sweet Bell Peppers Celery Nectarines Strawberries Cherries Pears Grapes (Imported) Spinach Lettuce Potatoes	Onions Avocado Sweet Corn (Frozen) Pineapples Mango Asparagus Sweet Peas (Frozen) Kiwi Fruit Bananas Cabbage Broccoli Papaya	

Thailand situation: risk vegetables

• Popular vegetable: consume at least 3 pesticides a day



Collard greens

Long bean

Chilli

Celery

Thailand situation: safe vegetables



Cabbage

Chinese cabbage

Chinese watercress



Natural toxicants in plants

- Alkaloids
- Glycosides
- Antienzymes
- Phytate
- Oxalate
- Toxic mushroom





• Source: Potatos

Type of glycoalkaloids in potato

Alfa- solanine

Alfa- chaconine

Chemistry property of glycoalkaloids

Rather heatstable (stable at 230-280 °C) Nonpolar lipophilic





Potatoes: Glycoalkaloids occur in all parts of potato plants including tubers, roots, sprouts,



Table 1. Levels of glycoalkaloids (GA) in various parts of the potato plant			
	Plant part	GA concentration (mg/kg fresh weight)	Refs
	Flowers	2150-5000	6, 7
į	Leaves	230-1000	8, 9
1	Stems	23-33	7
1	Roots	180-400	7
	Bitter-tasting tuber	250-800	10
	Whole tuber Skin (2–3% of tuber) Peel (10–12% of tuber) Flesh Cortex Pith	10-150 300-640 150-1068 12-100 125 Not detectable	6 7 6, 7 7 11 11
	Sprouts	2000-7300	6, 7



Product or preparation	GA concentration (mg/kg product)	Refs
Boiled peeled potato ^a	27-42	15
Baked jacket potato ^a	99113	16
Chips (US French fries)	0.4-8	13
Fried skins	5671450	16
Frozen mashed potato	2.3	16
Frozen baked potato	80-123	16
Frozen chips	2-29	16
Frozen skins	65-121	17
Frozen fried potato	4-31	16, 18
Canned peeled potato	1–2	16
Canned whole new potato	24-34	19
Crisps (US potato chips)	23-180	13, 16, 20
Crisps (with skin)	95-720	14
Dehydrated potato flour	65-75	16
Dehydrated potato flakes	15-23	16

Mechanism of action (toxic action)

- 1. Inhibition of blood and brain cholinesterase
 - Dyspnea Drowsiness
 - Itchinesis in the neck
 - Hyperesthesia

2. Gastrointestinal tract effect (injury of membrane)

- vomiting and diarrhea

Neurological effects

- severe stomach cramps
- symptom of solanine poisoning may begin about 8 hours after ingestion





Toxicity

1. Acute effect : The lethal dose in human 0.5 - 3.5mg/kg BW

- Inhibit mitochondrial respiration
- bind and destroy cytochrome oxidase
- no oxygen transfer to cellcell, death

Symptom

- Cyanosis
- Peripheral numbness
- Mental confusion and stupor
- Convulsion lacksquare

- Coma
- Death

2. Chronic effect : regular intake of nonlethal doses of HCN

2.1 Chronic cyanide intoxication " ataxia neuropathy"



- Headache
 Palpitation
- Sensation of tightness in neck
- Weakness of muscle

2.2 Malnutrition



Reduction cyanide content

- Crushing and grinding
- Food processing

 Heating evaporate HCN from food
- Sun drying
 - remove about 85% free cyanide
 1% bound cyanide
- Fermentation
 - reduce cyanide 95 100 %

Antienzyme : Trypsin inhibitor

Source





Soybean



Lima bean





Toxicity

Block trypsin activity

Pancreatic enlargement

• Loss S - containing amino acid

Mechanism of pancreatic enlargement from TI Cholecystokinin (Intestinal mucosa) Trypsinogen (Pancrease) **Dietary protein** Trypsin (Intestine) Trypsin inhibitor (TI) **Proteolysis** Trypsin - TI complex Amino acid





Factors

• Time

• Particle size

• Temperature



Interfere absorption and utilization of mineral



Source : legumes and cereal seeds

Property: Semi heat stable/ heat stable; strong chelating agent

Machanism of action

- Reduce bioavailability of minerals : Calcium (Ca), Magnesium (Mg), Iron (Fe), Zinc (Zn)
- Reduce bioavailability of protein: Protein-phytate complex

Table 1

Food types	Phytate (mg/g)
Cereals	
Rice (polished, cooked)	1.2-3.7
Rice (unpolished, cooked)	12.7-21.6
Maize bread	4.3-8.2
Unleavened maize bread	12.2-19.3
Wheat bread	3.2-7.3
Unleavened wheat bread	3.2-10.6
Rye bread	1.9-4.3
Sourdough rye bread	0.1-0.3
French bread	0.2-0.4
Flour bread (70% wheat, 30% rye)	0.4-1.1
Flour bread (30% wheat, 70% rye)	0-0.4
Cornflakes	0.4-1.5
Oat flakes	8.4-12.1
Pasta	0.7-9.1
Sorghum	5.9-11.8
Oat porridge	6.9-10.2
Legume-based food	
Green peas (cooked)	1.8-11.5
Soybeans	9.2-16.7
Tofu	8.9-17.8
Lentils (cooked)	2.1-10.1
Peanuts	9.2-19.7
Chickpea (cooked)	2.9-11.7
Cowpea (cooked)	3.9-13.2
Black beans (cooked)	8.5-17.3
White beans (cooked)	9.6-13.9
Kidney beans (cooked	8,3-13,4
Miscellaneous	
Sesame seeds (toasted)	39.3-57.2
Soy protein isolate	2.4-13.1
Soy protein concentrate	11.2-23.4
Buckwheat	9.2-16.2
Amaranth grain	10.6-15.1

Phytate content (mg/g on dry matter basis) in plant-derived human food (Greiner & Konietzny, 2006).




Blood clotting



Hypocalcemic tetany





Iron and function

- 1. Promote growth in infant and adolescent
- 2. Promote growth performance
- 3. Promote behavior and intellectual performance (Fe cofactor for neurotransmitter enzyme synthesis
- Ex. Dopamine epinephrine norepinephrine serotonin: important for normal early cognitive development)
- 4. Regulate body temperature (relate to decrease ecretion of thyroid stimulating hormone & thyroid hormone)
- 5. Immunity and infection resistance



Phytate : magnesium absorption

In animal : growth retardation

Important of Mg

- Biosynthesis, Glycolysis, Phosphorylation and transmission of the genetic code
- More than 300 enzymes (use ATP) involvement
- Serious case : Death



Because zinc is a important factors in growth and development of children

Reduction of phytate

Food processing: steaming, boiling, frying, roasting





Fig. 4 comparison of Phytate levels in various beans and seed after cooking processes



Phytate reduction



Prevention



- 1. essential mineral intake
 - Ca : daily product, Vit. D adequate
 - Fe : meat, visceral organ Vit. C
 - Mg : Green vegetable seafood, fish
 - Zn : meat, seafood, liver, egg
 - 2. Decrease phytate rich food





Oxalate

Two types

Structure

- 1. Soluble form
 - Oxalic acid
 - Soluble salt Potassium oxalate



- 2. Insoluble form
 - Calcium salt









spinach, beets, swisschard collard, almonds, cashew nut chocolate, cocoa

Oxalate

Nutritional effect

Toxicity

Decrease Ca absorption
Increase Ca excretion in urine

- Acute toxicity
 - Burning of mouth and thorax membrane
 - High dose : gastroenteritis, shock convulsion, low plasma calcium, renal damage

Source: Oxalate





Long term toxicity : cause renal calculi





Toxic mushroom





1. Cytotoxin

- 2. Neurotoxic muhroom (ANS)
- 3. Hallucinogenic mushroom (CNS)
- 4. Gastrointestinal toxic mushroom

Cytotoxic mushroom

Amatoxins

Source

Amanita phalloides

Amanita verna

Amanita virosa

Galerina autumnalis



Galerina autumnalis





Miss understand with Amanita princaps: Edible mushroom





Amanita princaps (Eaten mushroom) VS Amanita virosa (Death cap mushroom)



Amanita princaps Edible mushroom

Amanita virosa Non-edible mushroom





Clinical symptom

1.Latent phase : no symptom between 6- 24 hr after ingestion

2. Gastrointestinal phase : after the delay periods

Symptom

Severe abdominal pain Violent bloody Vomiting Diarrhea

3. Hepatorenal phase

Liver and kidney injury



Death



Prevention

- Eat only known mushroom
- Select every part of mushroom

Some part of mushroom can use to identify type of mushroom

- Select only mature mushroom
- Do not eat raw mushroom
- Do not keep mushroom for a long time
- Do not select mushroom which growth nearby industrial company

How to eat fresh produce with safety?



Tips for consumer

- Purchase & transport
 - Buy right: purchase produce that is not damage
 - Select refrigerated pre-cut produce, surrounded by ice
- Storage properly: affect both quality and safety, store product at proper temperature, use the produce as soon as possible
- Refrigerate all produce that is purchased pre-cut or peeled to maintain both quality and safety.
- Prepare safely
 - Proper hand washing
 - Cut away damage
 - Wash all produce before cut/ eat
 - Separate equipment









Hand washing step



Rub palms together.



Rub the back of both hands.



Interlace fingers and rub hands together.





Interlock fingers and rub the back of fingers of both hands

h Rub thumb in a rotating manner followed by the area between index finger and thumb for both hands.



Rub fingertips on palm for both hands.



Rub both wrists in a rotating manner. Rinse and dry thoroughly.

Proper hand washing Reduces infection 35 to 50% Reduces GI-illness up to 80%



- Washed orange
- Clean hand
- Clean equipment
- Clean area



How to wash fruit and vegetables

- To wash your vegetables clean you will need:
 - Plastic bowl which is large in size.
 - Vegetable brush
 - Plastic dish pan
 - Baking soda or apple cider vinegar





Soaking in water





Chemical used for fruit and vegetable washing







What do think about the following ?

- Eat seasoning fruits & vegetables
- Eat indigenous fruit & vegetables
- Eat organic fruit & vegetables



