Bioremediasi Limbah Pangan

Nur Hidayat

Pendahuluan

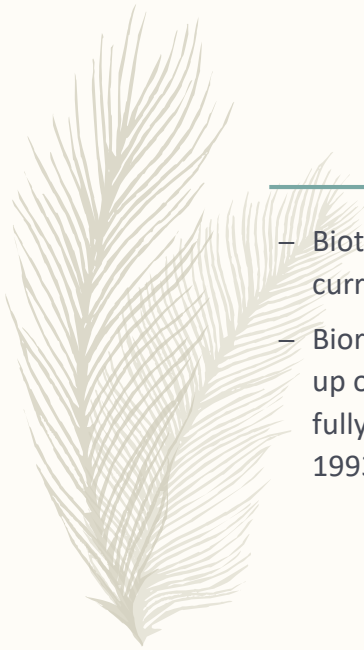
- Pesticides and fertilizers are major sources of pollution followed by industrial processes, waste and wastewater sludge disposal, and accidental release (EEA, 1995)
- Ground water pollution is expected to become increasingly widespread and acute in coming years, particularly because of uncontrolled waste deposits, leakage from petrochemical tanks, and continuing percolation of untreated sewage, pesticides, and other pollutants into aquifers

Solid waste

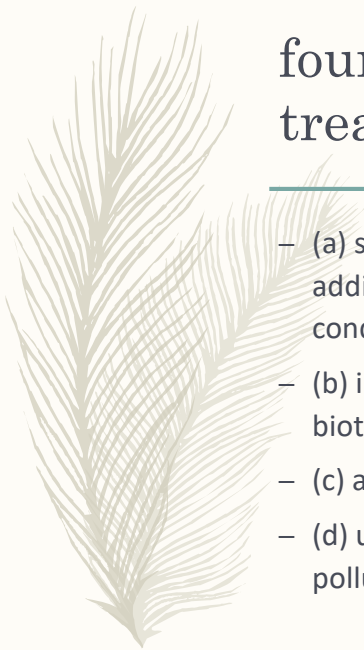
- Solid waste is probably of more importance not so much because of hazard but more because of its volume.
- According to some researchers the amount of solid waste produced by European countries is around 5 billion tonnes per year.
- There are 14,000 industrial sites in the US producing about 265 tonnes of hazardous waste annually (Levin & Gealt, 1993).
- Once an area is polluted, the next step is to suggest possible corrective actions.

Solid waste

- The most common, ineffective and inexpensive way to deal with polluted areas is to ignore deliberately their existence.
- When things get more severe one can either resort to conventional methods, such as prevention and reduction, reuse, employment of degradable materials,
recycling, incineration, pyrolysis and landfill, or to modern innovative methods which include composting, biodegradability and bioremediation.



- Biotreatment is well accepted by industry as it goes along with the current popularity of maintaining nature's harmony.
- Bioremediation has become a widely accepted option for the clean up of contaminated soils and aquifers although it does not have a fully credible reputation within the regulatory community (NRC, 1993).



four main biological techniques for treating soil and groundwater:

- (a) stimulation of the activity of indigenous microorganisms by the addition of nutrients, regulation of redox conditions, optimizing pH conditions, etc;
- (b) inoculation of the site by microorganisms with specific biotransforming abilities;
- (c) application of immobilized enzymes; and
- (d) use of plants (phytoremediation) to remove and/or transform pollutants (Bollag & Bolllag, 1995).

Methods:

- In the specific methods used for bioremediating contaminated soil and water, landfarming, composting, intrinsic bioremediation and slurry bioreactor are included

Landfarming

- Landfarming relies on the principles applied in agriculture and aims at controlling the biocycling of natural compounds.
- The biodegradation conditions by the natural indigenous microbial populations of soil are optimized by the dilution of contaminated soil with clean soil, tilling of the soil to reduce initial toxicity, as well as by controlling physical parameters, such as aeration, pH, soil moisture content, and temperature.

Composting

- Composting is a biological aerobic decomposition of organic materials in which conditions are strictly controlled in order to help the thermophilic microorganisms to transform organic materials into a stable, soillike product (Miller, 1993; Rynk, 1992).
- A composting like process occurs in nature when materials are decomposed by microorganisms present in the soil.
- In order to increase these rates and use composting for industrial purposes, it is necessary to optimize microbial growth.

Table 3. Composting methods[a]

Method	Composting time	Cost	Usage	Disadvantages
Windrow	2–6 months for municipal solid waste	Low	Used mainly in combination with in-vessel technology for curing the compost	Difficult control of conditions, temperature, water concentration odour
Aerated piles	6–12 weeks	Medium	Used for sewage sludges, municipal solid waste, yard wastes and industrial organic wastes	Continued electrical costs
In-vessel	Less than a week to 2 weeks	High due to installation costs	All types of waste	High cost, intense and skillful management

[a] O'Leary *et al.* (1989–1990); Schaub & Leonard (1996).

Intrinsic Bioremediation

Relies on the natural assimilative capacity of the ground to provide site remediation and control contaminant migration.	Relatively inexpensive Low exposure risks. Excavation not required.	years. Low degradation rates. Less control over environmental parameters. Needs good hydrogeological site characterization. Incubation periods are months to years.	Deep contamination. Aerobic or nitrate reducing conditions. Low to medium contamination levels. Oil and gasoline. Chlorinated aromatics. Chlorinated hydrocarbons.

Slurry Bioreactor

- In slurry bioreactor treatment systems, the contaminated soils are excavated and mixed with water to form a slurry that is mechanically aerated in a reactor vessel.
- The reactor contents are agitated to promote breakdown of soil aggregates, enhance desorption of contaminants from soil solids, increase contact between the wastes and microorganisms, and enhance oxygenation of the slurry (Baker, 1994).

Fruit and vegetable processing industry

- These industries may operate seasonally since operation time depends on the production of the fruits and vegetable that they process. That means that the environmental pollution from those industries' waste will also be seasonal.
- According to the processing stage, different types of waste may be produced thus contributing with different percentages to the formation of the final process waste
- he chemical composition of the wastes varies and depends on the processed fruit or vegetable.
- In general, the wastes consist of hydrocarbons and relatively small amounts of proteins
  and fat. The hydrocarbons are mainly sugars and nitrogen and cellulose fibers. The water wastes contain dissolved compounds, pesticides, herbicides and cleaning chemicals.

Fruit and vegetable processing industry

Table 4. Waste characteristics[a]

Fruit or vegetable	BOD mg/l	COD mg/l	SS[b] mg/l	pH
Carrots	1350	2300	4120	8.7
Corn	1550	2500	210	6.9
Tomatoes	1025	1500	950	7.9
Green peas	800	1650	260	6.9
Cherries	2550	2500	400	6.5
Grapefruit	1000	1900	250	7.4
Apples	9600	18700	450	5.9

[a] S.E. Tsiouris (personal communication).
[b] Suspended solids.

Fermentation industry

- the fermentation industry's wastewater contains high concentrations of tannins, phenols and organic acid
- Anaerobic treatment achieved 91% COD reduction at loading rates up to 20 g COD/l day, whereas the aerobic treatment resulted in a 76% reduction at a loading rate of 69 g COD/l day.
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Dairy industry

Table 6. COD of milk, milk products, cleaning and disinfecting chemicals and their ingredients[a]

Product/substance	Concentration (g/l)	COD (g/l)
Cream, 30% fat	–	850–860
Whole milk, 3.5% fat	–	160–210
Skim milk	–	9–100
Whey	–	68–75
Na-dodecyl benzol sulfonate	0.1	0.216
Na-ethoxy alkyl sulfate	0.1	0.178
Dialkyl dimethyl ammonium chloride (C_{18}–C_{20})	0.1	0.235
Sodium hydroxide	10.0	0
Phosphoric acid	10.0	0
Detergent and disinfectant 1 (with QAC)	10.0	2.250
Detergent and disinfectant 2	10.0	0.017
Detergent and disinfectant 3 (with surfactant)	5.0	0.147

[a] Wildbrertt (1988).

Meat and poultry industry

- The meat industry contains slaughterhouses and processing units where meat is prepared, cut in pieces and is either frozen, cooked, cured, smoked or made into sausages.
- Slaughterhouses are more important than the other units in terms of environmental pollution. Slaughterhouse wastewater is typically high in both moisture (90–95%) and nitrogen, has a high BOD and is odourous
- The wastes coming from these units contain various quantities of blood, fats, residues from the intestine, paunch grass and manure