Limbah Agro-industri dan Perlindungan Lingkungan

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Pendahuluan

- Pertanian merupakan kegiatan yang paling banyak dilakukan di dunia
- Hasil pertanian kini dinikmati secara langsung maupun diolah terlebih dahulu
- Teknologi Pengolahan telah berkembang pesat shg produk pangan makin berkembang
- Transportasi yang makin baik menjadikan produk pangan terdistribusi ke seluruh dunia tanpa ada batas wilayah.
- Modernisasi menjadikan kebutuhan pangan menjadi beragam dan menghasilkan limbah yg cukup banyak

Pendahuluan

- Negara2 Eropa diperkirakan menghasilkan limbah pertanian 700 juta ton/tahun
- Perancis menghasilkan 400 jutan ton/th dan Austria kurang dari satu juta ton/th
- Bagas tebu mencapai 500 juta ton dan kulit dan biji anggur mencapai 12,2 juta ton/th
- Oleh sebab itu limbah pertanian dan agroindustri perlu penanganan yang baik agar tidak mencemari lingkungan

Limbah Pertanian

- Limbah agro-industri umumnya dikelompokkan dalam: limbah pengolahan pangan, limbah tanaman dan limbah industri perkebunan/kehutanan. Jumlah limbah ini mencapai 15 % dari total limbah
- Jika tidak dikelola dengan baik dapat mencemari lingkungan, rusaknya kualitas air dan mengganggu kenyamanan
- Limbah pengolahan pangan sering menjadi masalah serius terhadap polusi

Permasalahan limbah Agroindustri

- **Biological stability and potential growth of pathogens**
- **Water content**
- **Rapid auto-oxidation**
- **Changes due to enzymatic activity**

Penanganan

- Landfill and open-dumping sites
- Incineration
- Composting
- Recycling or recovery

Penanganan yg lebih baik perlu dilakukan terutama untuk limbah yang masih memiliki nilai ekonomi

Produk produk baru dapat dikembangkan dari limbah

Sumber dan karakteristik limbah

- Limbah pemanenan
- Limbah dari penngolahan buah dan sayur
- Limbah pengolahan pati dan gula dan produk ikutannya
- Limbah olahan bijizan
- Limbah industri minuman
- Limbah olahan hasil ternak, ikan, susu
- Limbah tekstil dan hasil perkebunan
- Limbah hasil hutan
- dsb

Sumber dan karakteristik limbah

- Limbah sisa pemanenan misalnya jerami, tongkol jagung, daun, batang, dsb
- limbah buah dan tanaman terutama dari apel, alpukat, anggur, lemon, jeruk, dsb
- Limbah tanaman sayuran mencakup daun, kulit setelah pemanenan dan pengolahan
- dsb

Fruit/vegetables	Nature of waste	Approx. waste (%)
Mango	Peel, stones,	45
Banana	Peel	35
Citrus	Peel, rag, seed	50
Pineapple	Skin, core	33
Grape	Stem, skin, seed	20
Guava	Peel, core, seed	10
Pea	Shell	40
Tomato	Skin, core, seed	20
Potato	Peel	15
Onion	Outer leaves	10
Apple	Peel, pomace, seed	25

Table 3.4 Chemical constituents of whey. (Evans et al. 2010)

Constituents	Concentration
Water (%)	93–94
Dry matter (%)	5.8–6.8
Lactose (%)	4.2–4.7
Albumin (%)	0.8–1.0
Fat (%)	0.2–0.4
Biotin (μg/kg Dry matter)	325–599
Iron (mg/kg Dry matter)	9.16
Zinc (mg/kg Dry matter)	32.5
Copper (mg/kg Dry matter)	0.32
Cobalt (mg/kg Dry matter)	0.052
Molybdenum (mg/kg Dry matter)	0.573
Total protein (%)	0.8–1.0
Whey protein (%)	0.6–0.75
Citric acid (%)	0.1

Pemanfaatan Limbah Agro

Agro waste	Utilization
Rice husk ash and charcoal	Additive in cement mixes
Rice husk	Water glass manufacture
Banana peel and sugarcane fibers	Active carbon
Oil palm, empty fruit bunch (EFB)	Electricity production
Oil palm stems, rubber wood	Paper making pulp
Onion skin, groundnut husk	Mulching, organic fertilizer
Husk, bagasse	Particleboard, softwood furniture
Bagasse, banana fruit reject	Heavy metal removal
Husk, straw, cow dung	Mushroom cultivation
Sunflower stalk, corn stalk	Ethanol production, animal feed
Bagasse fibers	Biogas production, electricity generation
Animal waste (dung)	Compost, fertilizer

Table 3.6 Principal nutrients in commonly used agro-byproducts as animal feed

Nutrient	By-products
Protein	Brewer's grains, Distiller's grains, Cull beans, Feather meal
Protein and energy	Brewer's grains, Distiller's grains, Corn gluten feed, Peanut screenings, Wheat bran
Energy	Bakery meal, Hominy feed, Snack food waste, Soyhulls, Vegetable, fruit processing waste
Roughage sources	Apple pomace, Corn cobs, Cottonseed hulls, Peanut hulls, Rice by-products

Table 3.8 Microbial utilization of agro by-products for production of various products

Products	Wastes
Ethanol	Citrus industry waste, apple pomace, peach waste, cashew apple pomace, pineapple waste, pear cuttings
Animal feed	Apple pomace, olive waste, brewery spent grain
Biogas	Waste from fruit and vegetable industry, fermentation industry
Single cell protein	Apple pomace, peach waste, cashew apple
Pectin, fibers	Citrus waste, apple pomace
Cider, beer and vinegar	Apple pomace, citrus waste
Bakers yeast	Apple pomace, brewery waste
Citric acid	Apple pomace, pine apple waste
Color	Vinery waste and distillery waste
Flavors/xanthan gum	Apple pomace and grape pomace

Table 3.9 Single cell production by agro by-products by using different microorganisms

Agro by-products	Microorganism	Use of single cell protein	References
Brewery waste	*Pleurotus* spp., *Agrocybe* spp., *Lentinus* spp.	As single cell protein, protein rich biomass	Schildbach et al. (1992)
Brewery waste	*Pleurotus ostreatus*	As single cell protein	Wang et al. (2001)
Bagasse	*Cellulomonas flavigena and Xanthomonas* spp.	Single cell protein	Rodriguez-Vazquez and Diazcervantes (1994)
Cassava wastes	*Saccharomyces cerevisiae, Lactobacillus* spp., *Rhizopus* spp., *Aspergillus niger* *Streptomyces, Pleurotus* spp.	Single cell protein animal feed and food	Ubalua (2007) and Oboh and Elusiyan (2007)
Coffee pulp, coffee husk other coffee wastes	*Candida utilis*	Protein rich biomass	Orozco et al. (2008)
Defatted rice polishing	*Cryptococcus curvatus*	Single cell protein, protein enriched biomass	Rajoka et al. (2006)
Beet molasses and corn gluten meal	*Microsphaeropsis* spp; *Streptomyces cyaneus*	Single cell oil	El-Fadaly et al. (2009)
Wheat bran, straw, buck wheat, sugar beet pulp	*Phanerochaete chrysosporium*	Single cell protein, feed and food ingredients	Orozco et al. (2008) and Salmones et al. (2005)

Table 3.10 Production of organic acids by solid state fermentation of agro-byproducts by using different microorganisms

Agro by-products	Micro-organisms used	Organic acid	References
Molasses, beet pulp residues, sugar cane bagasse, orange waste apple and grape pomace	*Aspergillus niger*	Citric acid	Soccol et al. (2004)
Pine apple waste, apple pomace	*Aspergillus niger*	Citric acid	Hang and Woodams (1986)
Pine apple waste	*Aspergillus niger*	Citric acid	De Lima et al. (1995)
Pine apple waste	*Yarrowia lipolytica*	Citric acid	Imandi et al. (2008)
Grape pomace			
Cassava, sugar cane bagasse	*Aspergillus niger and Gluconobacter oxidans*	Gluconic acid	Buzzini et al. (1993)
Citrus peel	*Rhizopus oryzae* *Debaryomyces courderti*	Lactic acid Pyruvic acid	Tay and Yang (2002) Moriguchi (1982)
Apple pomace	Yeast	Oxalic acid	Kennedy (1994)

Table 3.11 Production of enzymes by solid state fermentation of agro-by-products by using different microorganisms

Agro by-products	Micro- organisms used	Organic acid	References
Fishery waste, brewery waste, apple pomace and paper industry sludge	*Phanerochate chrysoporium*	Lignolytic enzymes	Fatma et al. (2010)
Wheat bran	*Aspergillus foetidus*	Xylanase	Chapla et al. (2010)
Sugar beer waste	*Aspergillus heteromorrphus* *Phanerchate chrysosporium*	Laccase, manganese peroxidase	Vassileva et al. (2009)
Lemon pulp waste	*Aspergillus niger and Trichoderma viridae*	Pectinase	De Gregorio et al. (2002)
Grape pomace	*Aspergillus awamari*	Pectinase	Botella et al. (2007)
Corn cob and oat	*Pencillium janthinellum*	Xylanase and pectinase	Oliveira et al. (2006)

Table 3.12 Production of flavor compounds by using different agro-industrial wastes

Agro-by-product	Microorganisms	Flavor compounds	References
Cassava bagasse, apple pomace and soybean	*Ceratocystis fimbriate*	Fruity flavour	Bramorski et al. (1998)
Coiffe husks	*Ceratocystis fimbriate*	Pine apple flavour	Soares et al. (2000)
Tropical agro-by-products	*Rhizopus oryzae*	acetaldehyde and 3-methylbutanol	Bramorski et al. (1998) and Christen et al. (2000)
Cassava bagasse and giant palm bran	*Kluveromyces marxianus*	Fruity aroma	Medeiros et al. (2001)
Soybean by-products	*Bacillus subtilis*	2,5-Dimethyl-pyrazine and etramethylpyrazine	Besson et al. (1997) and Larroche et al. (1999)
Semi solid maize	*Pediococcus pentosaceus* *Lactobacillus acidophilus*	Dairy flavour compounds	Escamilla-Hurtado et al. (2005)
Copra fat by-products	*Aspergillus niger*	Methyl ketones	Allegrone et al. (1991)
Wheat bran	*E.coli* JM109 (pBBI)	Vanillin	Gioia et al. (2007)

Table 3.13 Agro-industrial residues and plant waste materials used for biofuel production

Agro industrial waste	Biofuel	References
Brewer's yeast; autolyzate and	Bioethanol	Ruanglek et al. (2006)
Fish soluble waste	Bioethanol	Liimatainen et al. (2004)
Waste Potato	Bioethanol	Ruanglek et al. (2006)
Corn steep liquor	Biogas	Fountoulakis et al. (2008)
Olive oil waste, Vinery waste	Biogas	Kivaisi and Rubindamayugi (1996)
Cereals waste, sugar bagasse, coffee husk		

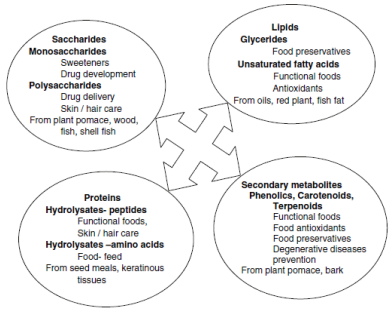

Fig. 3.4 Major bioactive compounds, their sources and applications

Table 3.14 Bioactive compounds from food processing industry by-products

By-products	Bioactive compounds	References
Fruits		
Apple peel	Flavonoids and anthocyanins	Wolfe et al. (2003)
	Pectin and phenolics	Carle et al. (2001)
Citrus peel	Phenolics, dietary fiber	Gorinstein et al. (2001)
Banana peel	Phenolic compounds	Someya et al. (2002)
Banana bract	Anthocyanins	Pazmiño-Durán et al. (2001)
Apple pomace	Flavonoids and anthocyanins	Sheiber et al. (2003)
Grape skin and seed	Phenolics, anthocyanin, dietary fiber	Torres et al. (2002)
Peach pomace	Pectin	
Mango seed	Phenolics and phospholipids	Arogba (2000)
Mango peel	Phneolics and dietary fiber	Ajila et al. (2007a, b, 2008)
Pine apple waste	Antioxidants	Wrolstad and Ling (2001)
Vegetable		
Carrot pomace	Carotenoids	Stoll et al. (2001)
Onion waste	Quercetin	Waldron (2001)
Red beet waste	Betalins	Kujala et al. (2000)
Potato peel	Phenolic acids	Rodriguez et al. (1994)
Tomato peel	Lycopene	Baysal et al. (2002)
Others		
Soybean hull	Peroxidase	Sessa (2003)
Black gram husk	Phenolic acids	Ajila et al. (2009)
Almond hulls	Phenolic compounds	Duh and Yen (1995)
Pea nut hulls	Phenolic compounds	Ge et al. (2002)
Wheat germ	Vitamin E	

Table 3.15 Composition of biofibers in agro-by-products

By-products	Cellulose (%)	Liginin (%)	Hemicellulose (%)	References
Bagasse	50	25	25	Pandey et al. (2000)
Banana	60–65	6–8	5–10	Majumdar and Chanda (2001)
Barely straw	31–45	27–38	14–19	Rowell et al. (1997)
Corn stover	38–40	28	7–21	Reddy and Yang (2004)
Coir	36–43	0.15–0.25	41–45	Majumdar and Chanda (2001)
Pineapple by-products	70–82	18	5–12	Majumdar and Chanda (2001)
Rice straw	28–36	23–28	12–14	Rowell et al. (1997)
Sorgham stalks	27	25	11	Rowell et al. (1997)
Wheat straw	33–38	26–32	17–19	Gressel and Zilberstein (2003)


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