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Energetic Use of Residues from Coffee Production in Central and South America

Introduction

- **The coffee fruit**
- **Processing of the fruit**
- **Residues of the coffee processing**
- **Options for coffee residues**

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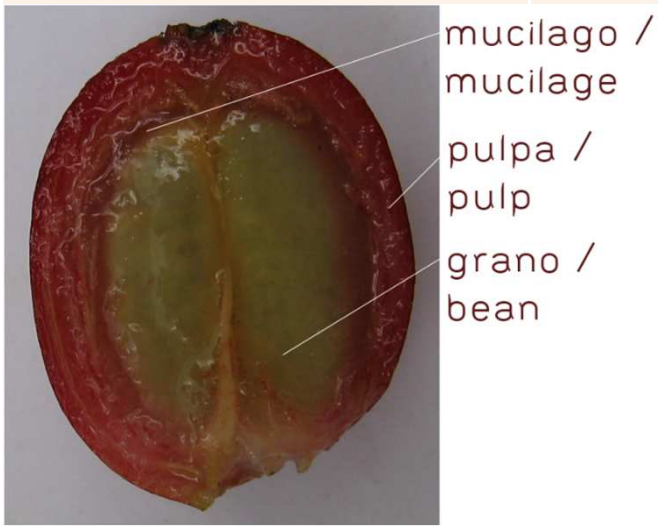
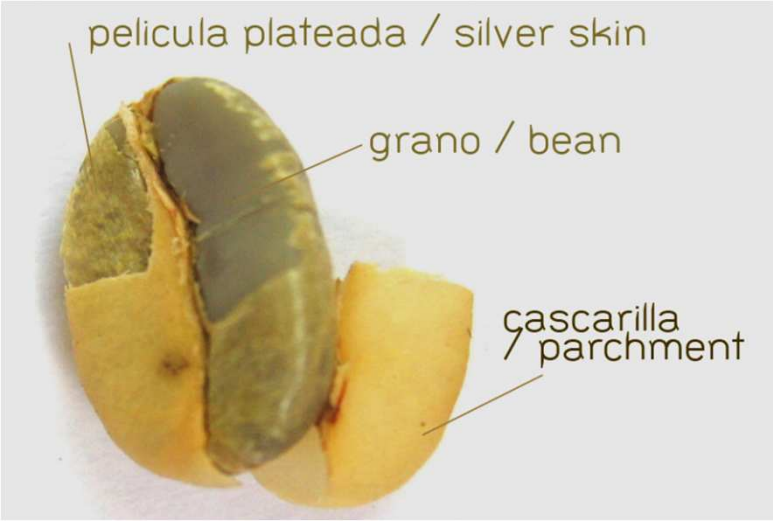
The harvesting of the coffee fruit

- **Coffee plant starts to produce flowers 3-4 years after it is planted.**
- **Coffee cherries (fruit) ripen in 6-8 months (Arabica), 9-11 months (Robusta) after flowering.**
- **One major harvest a year; in Colombia main and secondary crop (two flowerings a year).**

The coffee fruit

Spanish	English	German	aprox. weight %
Pulpa	Pulp	Fruchtfleisch	41
Mucilago	Mucilage, Pectin layer	Schleim- / Pektinschicht	16
Cascarilla, pergamino, cisco	Parchment skin Hull, husk	Pergamenthaut, Schalen	4
Grano (semilla) 12% h.	Bean (seed)	Bohne	19





Dry processing (unwashed/natural coffee)

- Used for ~95% of the Arabica coffee in Brazil, Ethiopia, Haiti, Paraguay.
- India, Ecuador: some Arabicas produced by this method.
- Almost all Robustas processed by this method.
- 1. Harvested cherries sorted and cleaned.
- 2. Cherries dried in the sun on tables or on patios (up to 4 weeks). On larger plantations also by machine-drying after pre-drying in the sun.
- 3. Dried cherries (stored in silos), hulled, sorted, graded and bagged in the mill / processing plant.

Wet processing (wet processed / washed coffee)

- Used in most countries for quality (taste), available space & climate reasons.
- Common in Costa Rica, Colombia, Guatemala, Peru, Bolivia, Ecuador.
- Fruit and pulp remaining (mucilage) is removed before drying.
- Complex process, requires use of specific equipment for each process.
- Higher energy & water consumption.
- Production plant operates during 3-4 months a year.

Wet processing (I)

1. Reception cherries

2. Sorting by Floaters (removal of fruits of bad quality)

3. Pulping (pulp removal)

4. Fermenting & washing or mechanical demucilaging (mucilage removal)

Wet processing (II)

5. Drying (until 10-12% m.c.)

6. Hulling (hull/parchment removal)

9. Bagging / shipping

8. Sorting (removal of defects / separation by grade)

(7.) Polishing (silver skin removal)

Fruto de café / café cereza

Recepción y Selección: Separación por flotación o densidad → Café fruta mala calidad, Café inmaduro

Despulpado → **Pulpa**; **Aguas de despulpado**

Fermentación & Lavado / o Desmucilaginado mecánico → **Aguas de lavado (incl. aguas mieles) o mucilago c. agua**

CAFÉ (52 % humedad)

Secado

Pelado y Clasificación → **Cascarilla**

Café oro / grano verde (9-12% humedad)

Problems of residues from wet processing

Often residues are not treated well:

- **Unpleasant odours & attraction of flies and insects.**
- **Waste water («sugar water») with a high oxygen demand: effect of depleting the water of oxygen and killing off aquatic life.**
- **Pollution of local rivers or lakes.**
- **Greenhouse gas emissions (CH_4 , N_2O of pulp pile and anaerobic lagoon).**

Residue/ subproduct	Utilisation options *(italic: typical practice today); *often not well conducted*	
	Energetic	**Material / treatment**

Pulpa / pulp	• Biogas-production
	• Combustion
	• Pyrolysis / Biochar
	• Gasification
	• Ethanol production
	• Briquetting, pelletizing → Combustion/Gasific.
		• Compost / fertilizer / soil conditioner:
		  • ***Composting**** (mechanical or worm-composting)
		  • Pyrolysis → Biochar
		• Animal feed
		• Caffeine or tanin extraction
		• Mushroom cultivation
		• Alcohol
		• Paper / carton

Cascarilla / parchment	• ***Combustion (for coffee drying)*** • Gasification • Briquetting, pelletizing → Combustion/Gasific.	• Composting • Utilisation of cellulose, production plastic, carton
Mucílago / mucilage	• Biogas-production • Ethanol production	• *Irrigation or (anaerobic) lagoon (Costa Rica)* • Production yeast, suger, wine, alcohol, vinegar, pectin, molasses, acid • Animal feed • Reed bed / wastewater treatment with plants • Aerobic lagoon
Aguas residuales / waste water	• Biogas-production • Distribution on plantation	• *Infiltration (Colombia), Irrigation or (anaerobic) lagoon (Costa Rica)* • Aerobic lagoon • Reed bed • Aerobic waste water treatment plant