
Co-production of clean solid biomass fuel and biogas from food industry residues by means of hydrothermal processing (TORWASH®)

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How much biomass is there available?

Examples of Biomass availability in NL

Biomass feedstock	kton/a (wet)
Fruit-Vegetable-Garden waste	1,300
Cow, calve and pig manure	57,000
Sewage Sludge	1,300



Examples of Biomass availability Worldwide

Biomass feedstock	kton/a (wet)
Chicken manure (India)	12,100
Empty Fruit Bunches (Indonesia)	22,000
Sugar cane tops (Colombia)	21,300
Peanut shells (Argentina)	40,000
Rice husk (Asia)	770,000



Limitations for wet and high-ash biomass

- Problem: Difficulties in combustion and gasification

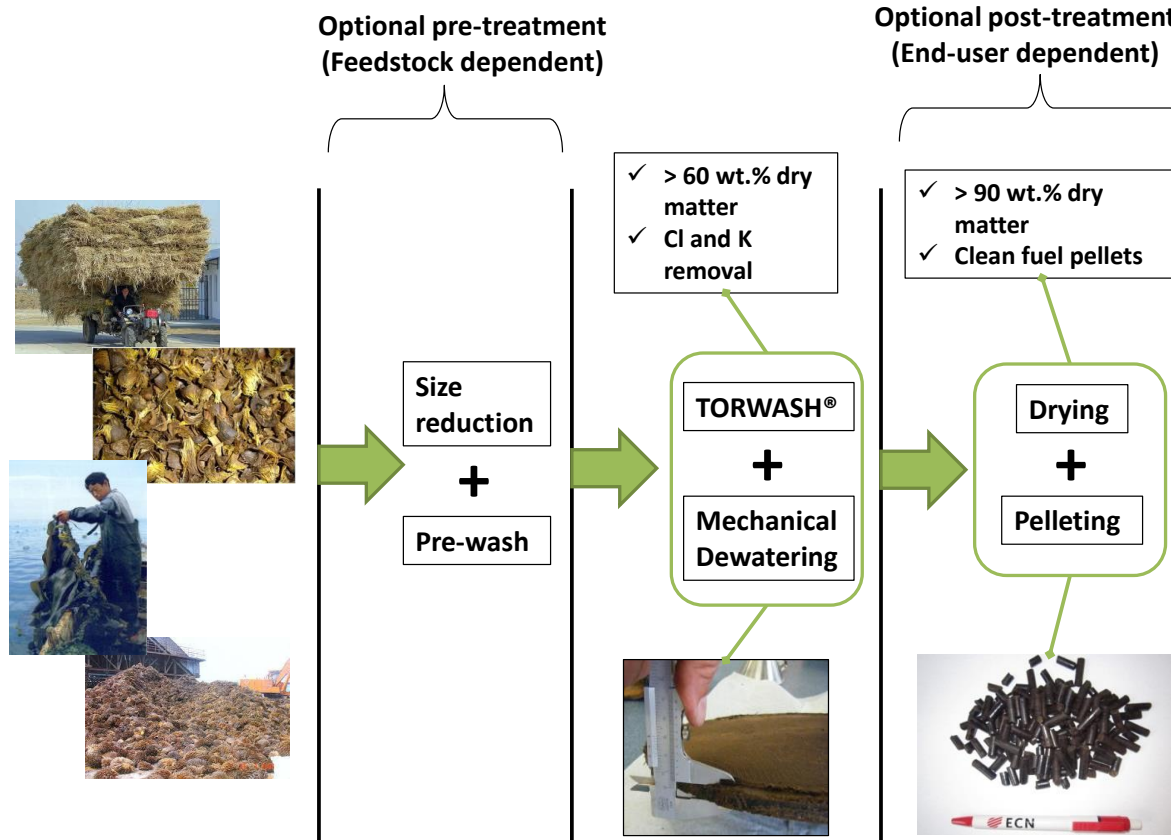
- Low combustion efficiency
- chlorine : corrosion
- potassium : slagging, fouling and agglomeration



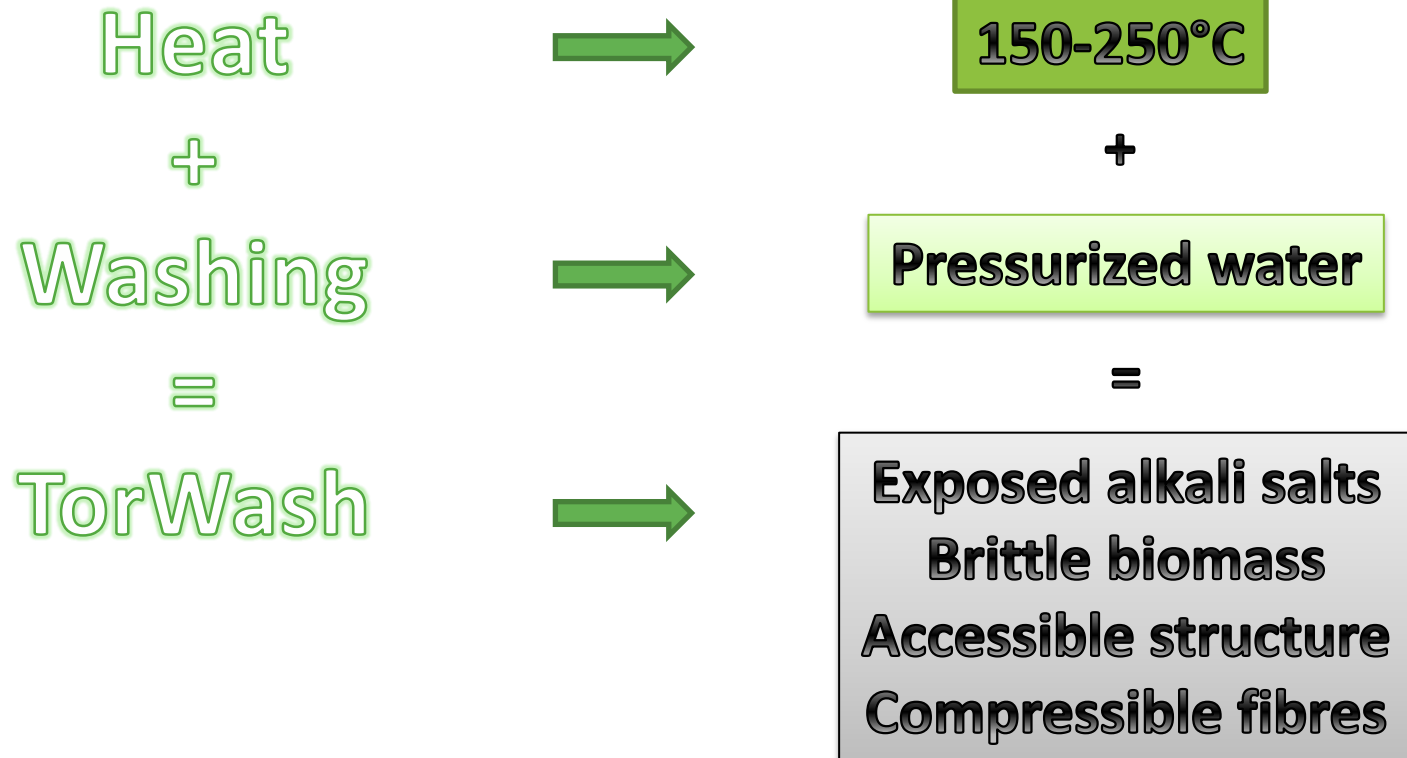
- Solution: Wash chlorine and potassium from the fuel

- > not all is removed – bound in cells, poor access
- > resulting ‘fuel’ is soaking wet – drying very energy-intensive

TorWash[®]: From residues to fuel



What is TorWash[®]?



Experimental approach



Orange Peels



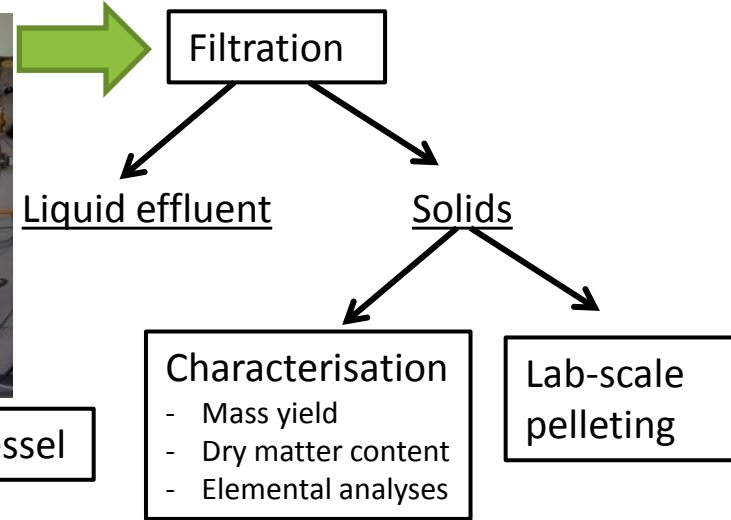
Empty Fruit Bunches



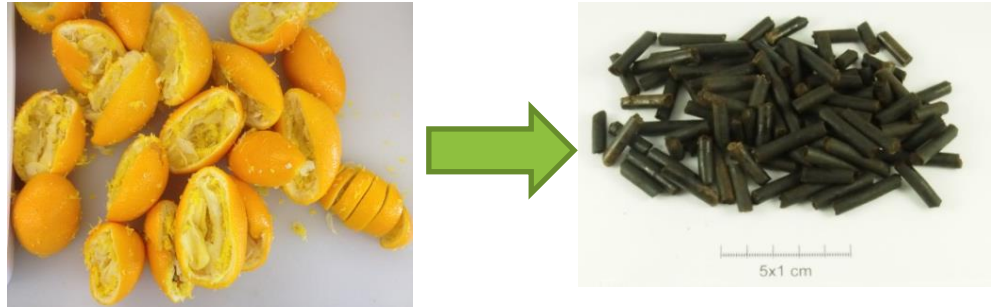
Pre-washing



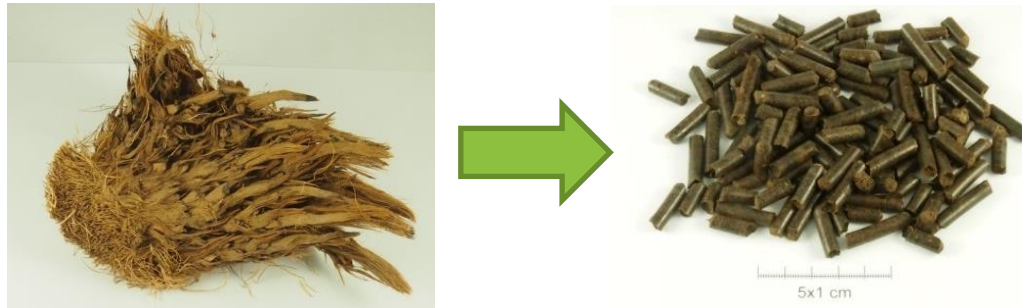
20-L autoclave vessel



Feedstocks & Products



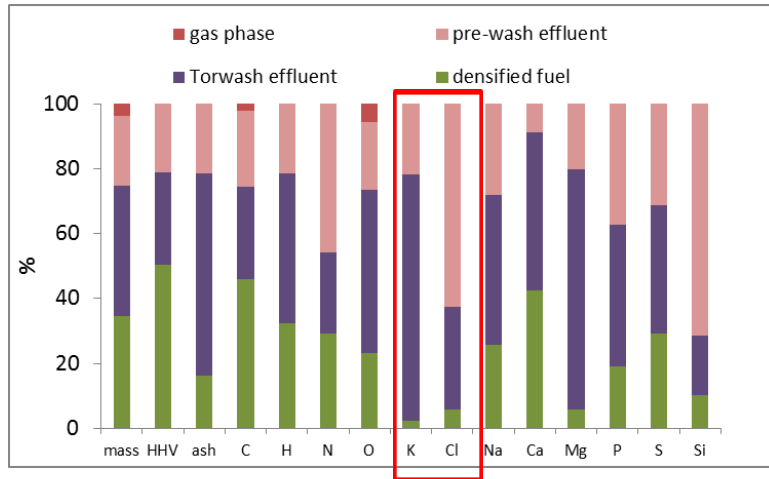
Orange peels, before and after Torwash® + pelletization



Empty Fruit Bunches (EFB) and after Torwash® + pelletization

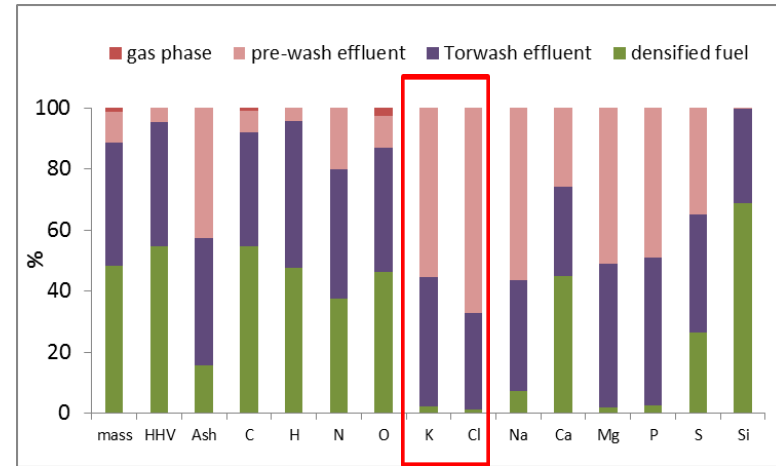
Up to 98-99% reduction of K and Cl

Orange Peels



- TORWASH® treatment converts 35 wt% of the dry orange peels into solid fuel pellets
- Reduction: K by 97% and Cl by 94%

Empty Fruit Bunches



- TORWASH® treatment converts 50 wt% of the dry EFB into solid fuel pellets
- Reduction: K by 98% and Cl by 99%

TorWash® is able to upgrade residues to energy pellets

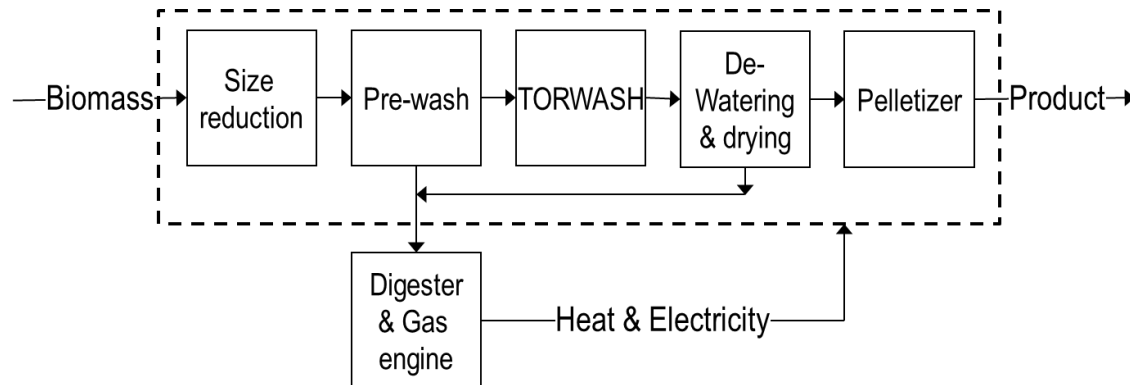
Compliance to pellet fuel standards

Parameter	Unit	EN Plus A1	IWPB-I2	Wood pellets	Wood pellets torrefied	Orange Peel raw	Orange Peel Pellets Torwashed	EFB raw	EFB Pellets Torwashed
Additives	wt%	0	≤ 3	none	none	none	none	none	none
Water	wt%	≤ 10	≤ 10	8.3	8	70-90	ND	variable	3
Bulk density	kg/m ³	≥ 600	≥ 600	636	701	-	ND	-	610
LHV	GJ/ton DM	≥ 18.6*	≥ 18.6*	18.6	20.2	15.6	23.4	17.5	19.8
Ash	wt% DM	≤ 0.7	≤ 1.5	0.3	0.4	3.4	1.6	4.4	2.9
Cl	wt% DM	≤ 0.02	≤ 0.05	0.012	0.002	0.02	0.003	0.34	0.005
K	mg/kg DM	-	-	380	505	8 200	600	16 200	660

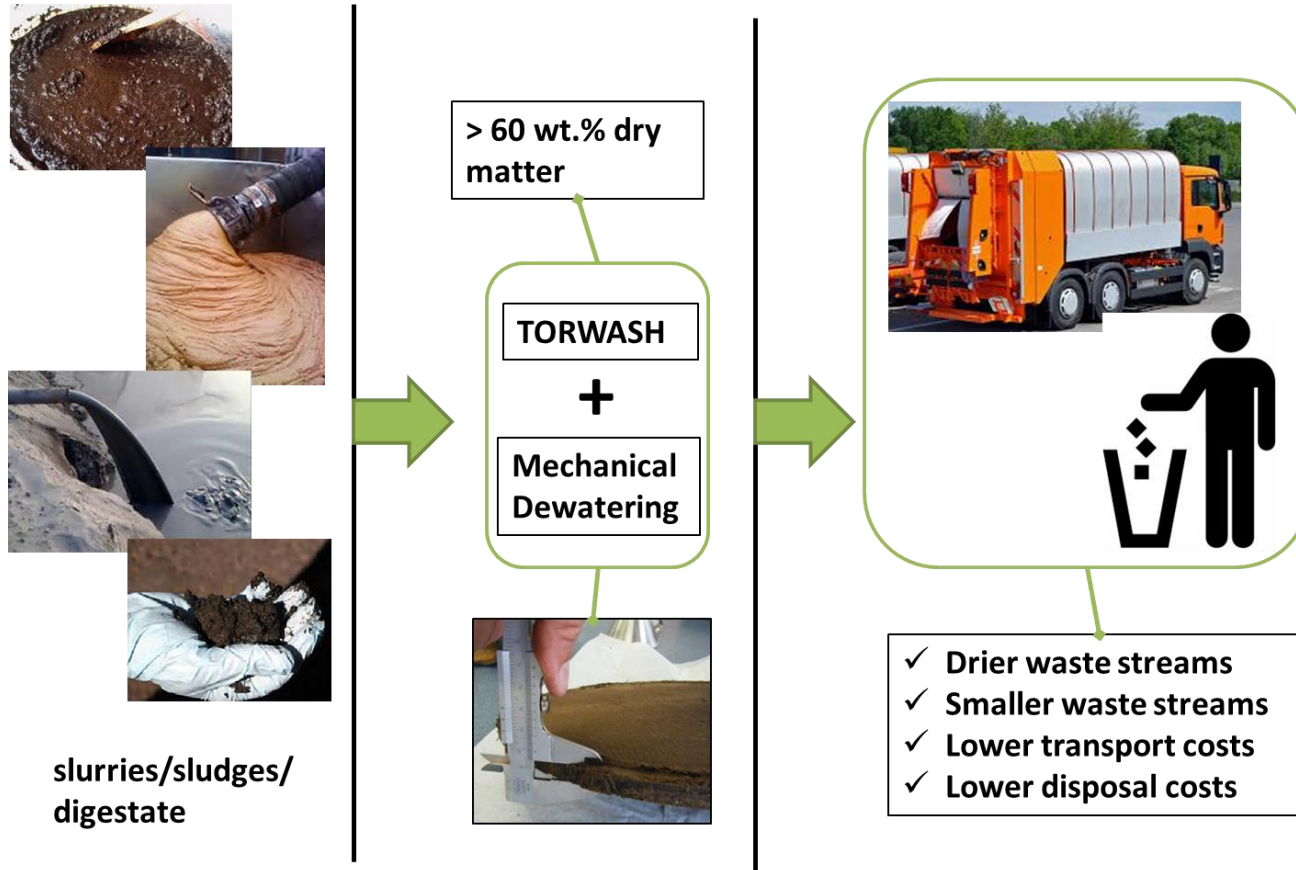
* For the wood pellet standards the calorific value is adjusted in this tabel to dry basis for the sake of comparison, calculated for an NCV (Net Calorific Value) of 16.5 GJ/ton and water content of 10 wt%.

TorWash[®] features and process scheme

- Mild TorWash[®] conditions allow excellent pelletization
- The effluent is suitable for biogas production (covers process power & heat requirements)
- The (digested) liquid effluent contains most of the nutrients
 - 99% of K, 50 % of N and 10-90% of P
- Efficient solid-liquid contacting to maximize washing efficiency and minimize fresh water requirement



TorWash[®]: A means to lower disposal costs



TorWash[®] current projects

- Empty Fruit Bunches (EFB)

- Partners with Felda Global Ventures (FGV)
- TorWash[®] pilot plant (1 ton/h)



- Sewage sludge & digestate

- Consortium formed together with Dutch Water Authorities
- TorWash[®] + biogas production pilot (40 kg/h)



Thank you for your attention!!!

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