

## **Cassava stillage and its anaerobic fermentation liquid as external carbon sources in biological nutrient removal**

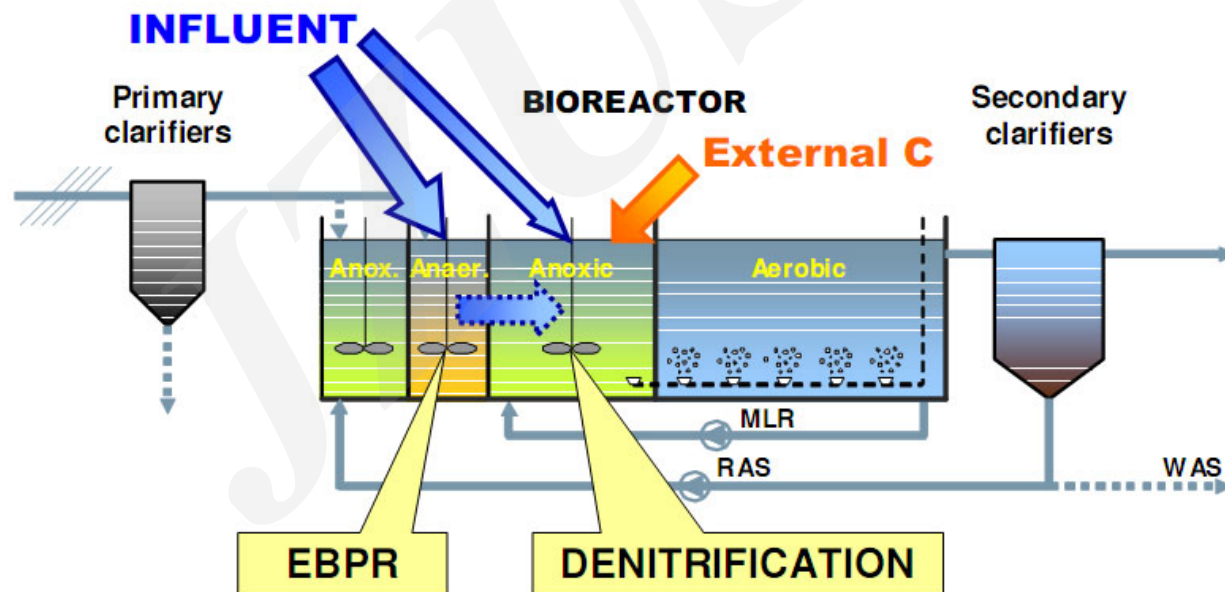
**Key words:**

**Biological nutrient removal (BNR), Denitrification, External carbon source, Enhanced biological phosphorus removal (EBPR)**

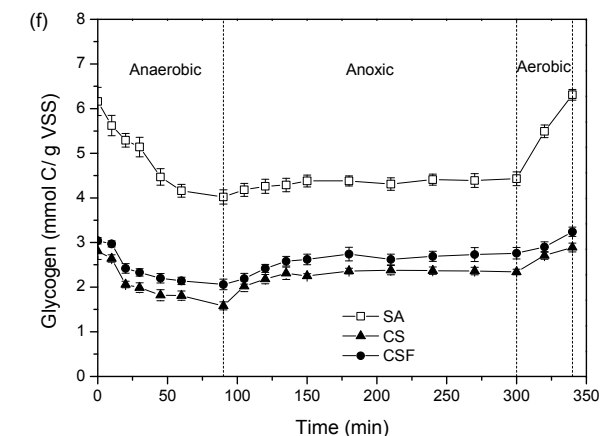
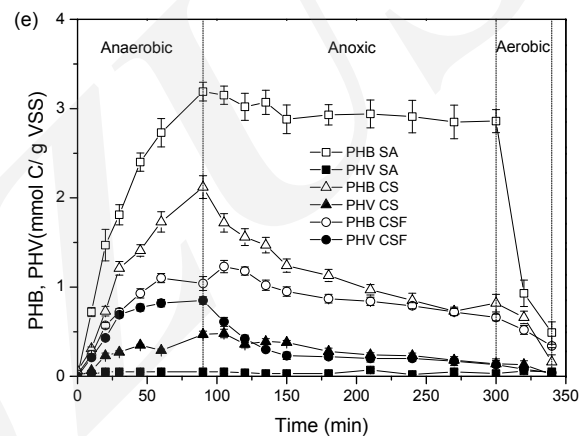
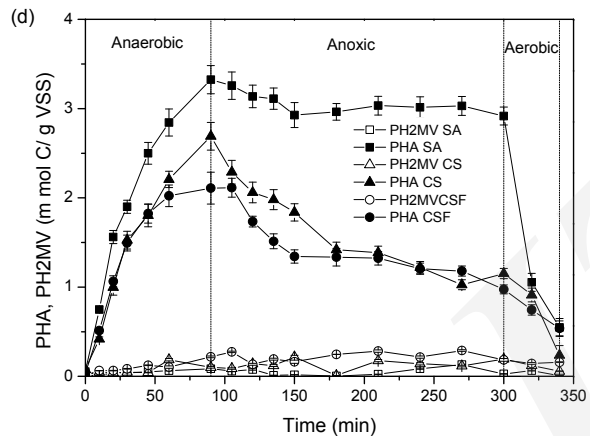
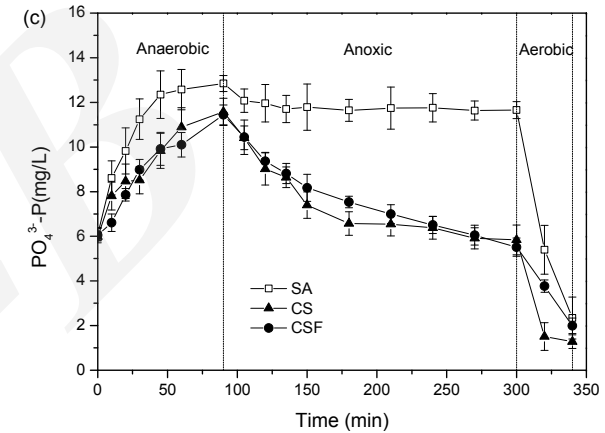
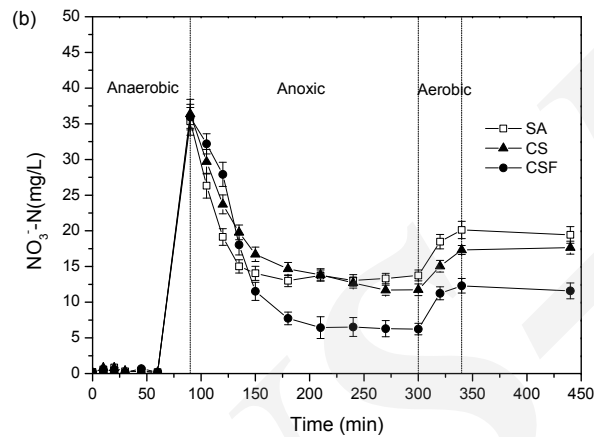
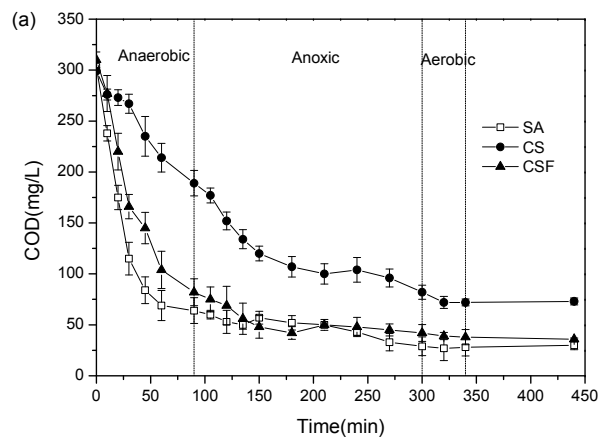
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# External C demand in BNR system

- Supply of organic substrates in municipal wastewater, required for both denitrification and EBPR, is normally limited
- Alternative carbon sources (industrial wastewater, by-products and waste materials) – in many cases, the problem of high costs of commercial “conventional” external carbon sources can be overcome if “by chance one does have access to industrial wastewater, for example, brewery wastewater” (Henze et al., 1995)
- Food industry effluents appear to be good candidates for the external carbon source due to:
  - High C/N ratios,
  - High content of readily biodegradable organic fraction.



# Cyclic study



The cassava stillage and its anaerobic fermentation liquid affected the transformation of COD, nitrogen, phosphorus, PHA and glycogen of the BNR process.

# NUR batch experiments

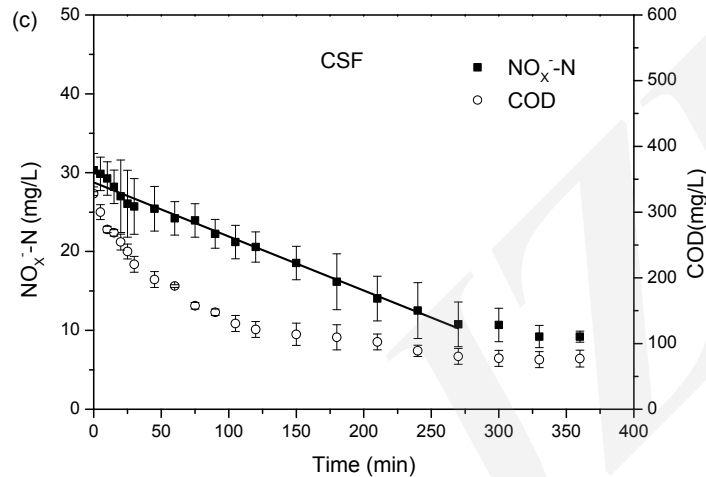
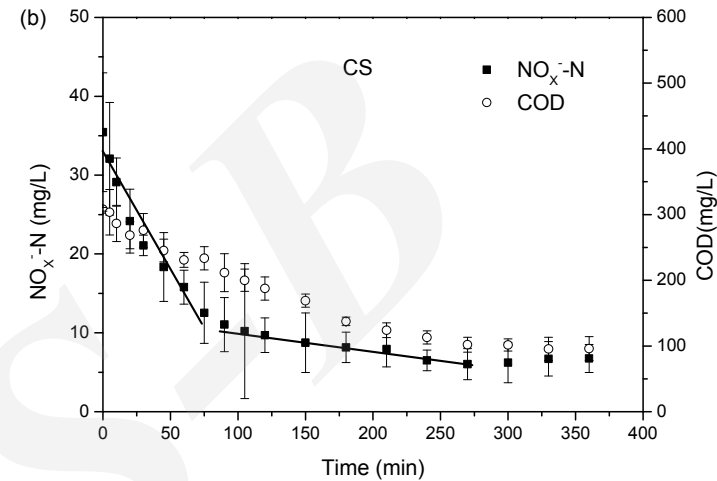
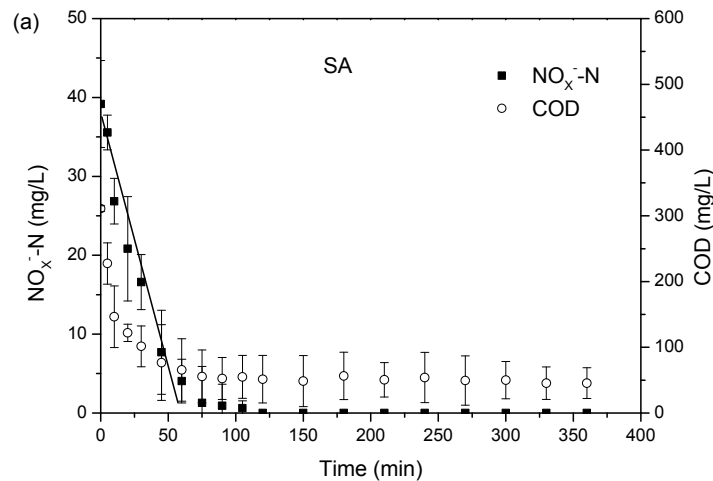
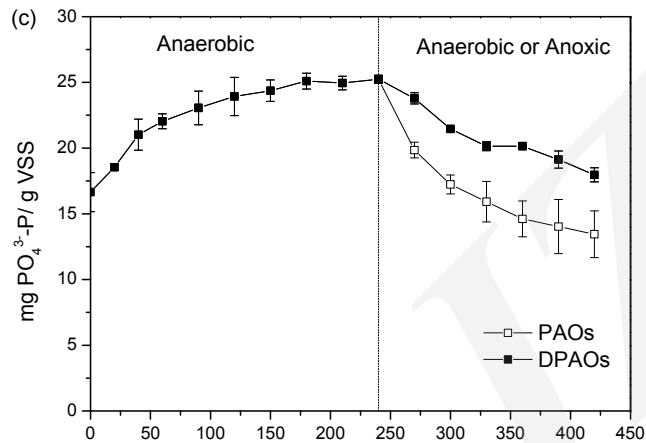
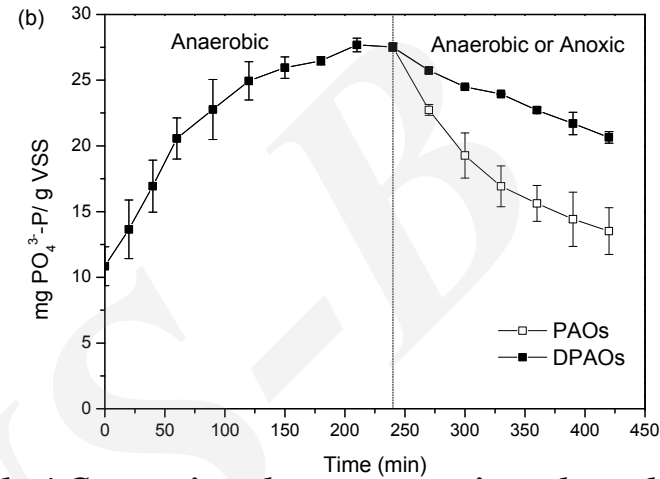
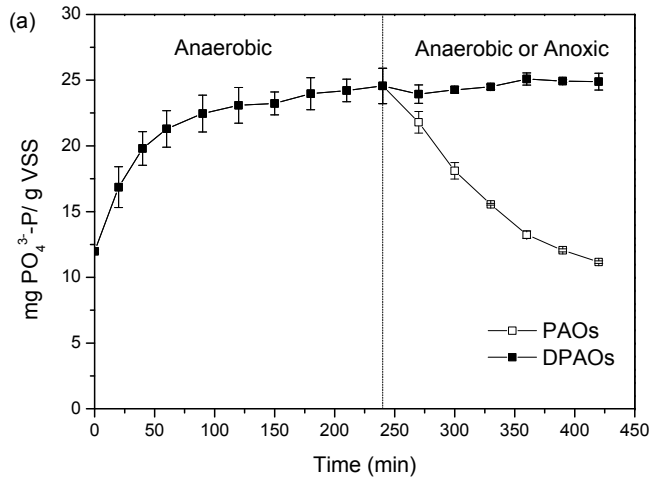


Table 3 Comparison of NURs when using different carbon sources

C source	Temperature ( $^{\circ}\text{C}$ )	NUR[gN/(kgMLVSS·h)]
SA	18.9-23.1	16.69-13.62
CS	19.6-21.9	5.49-5.99 (NUR 1) 0.80-1.06 (NUR 2)
CSF	12.8-13.1	6.63-6.81

The NURs of the cassava stillage and its anaerobic fermentation liquid were similar to or higher than those of other industry wastewaters as external carbon sources.

# Anaerobic-anoxic/aerobic tests



**Table 4 Comparison between anoxic and aerobic phosphorus uptake using different C sources**

Parameter	Units	SA		CS		CSF	
		Day	Day	Day	Day	Day	Day
		86	100	86	100	65	79
$P_{rea}$ rate	mg	2.93	3.36	3.61	4.73	2.15	2.51
Anoxic $P_{upt}$ rate	$PO_4^{3-}/(MLVSS \cdot h)$	0.00	0.00	2.26	2.32	2.43	2.29
Aerobic $P_{upt}$ rate	$h^{-1}$	4.13	4.81	3.61	4.72	3.93	4.26
% DPAOs	-	0.0	0.0	62.6	49.1	61.8	53.8

**EBPR occurred !!!**

**Cassava stillage and its anaerobic fermentation liquid could be used as potential external carbon sources for BNR processes.**