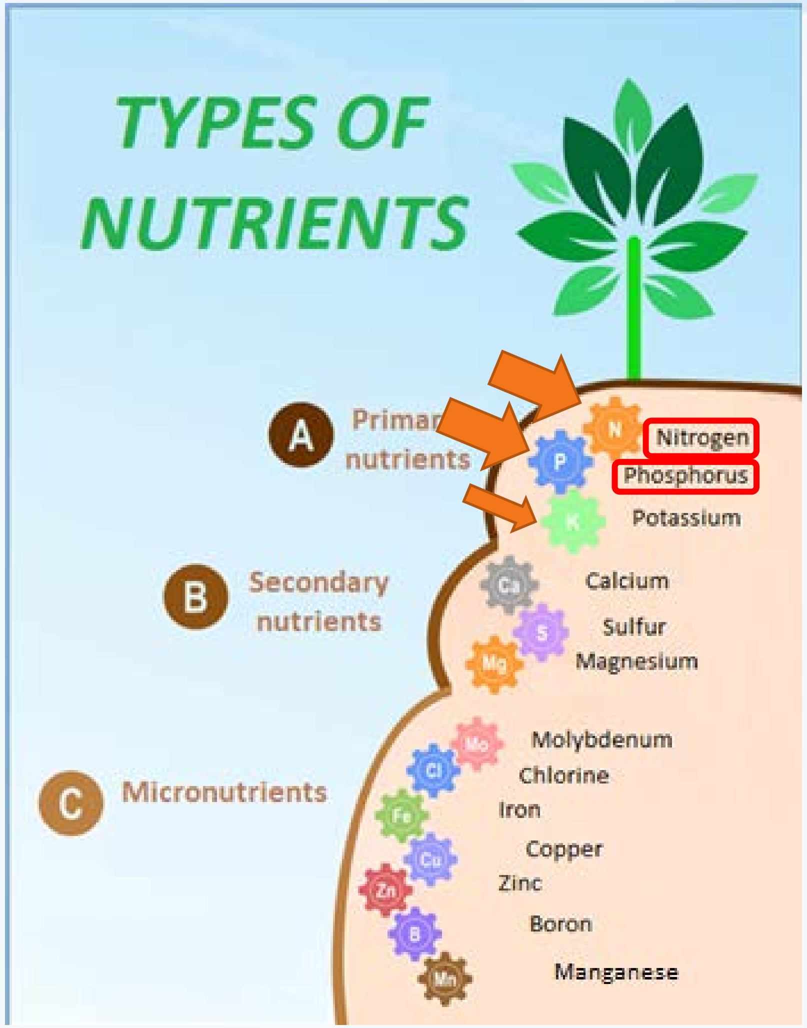
Nutrient recovery by Hydrothermal Treatment of Food Waste

Andres Sarrion, Elena Diaz, Silvia Rodriguez, Angeles de la Rubia , Angel F. Mohedano

Universidad Autónoma de Madrid


TYPES OF NUTRIENTS
A Primary nutrients
N Nitrogen
P Phosphorus
K Potassium
B Secondary nutrients
Ca Calcium
S Sulfur
Mg Magnesium
C Micronutrients
Mo Molybdenum
Cl Chlorine
Fe Iron
Cu Copper
Zn Zinc
B Boron
Mn Manganese


N N
N N
You shall not pass!!


50 years later…
Nice! There is not much Phosphorus!

Types of organic waste

Biomass rich in nutrients

Sewage sludge

Animal manure

Food waste

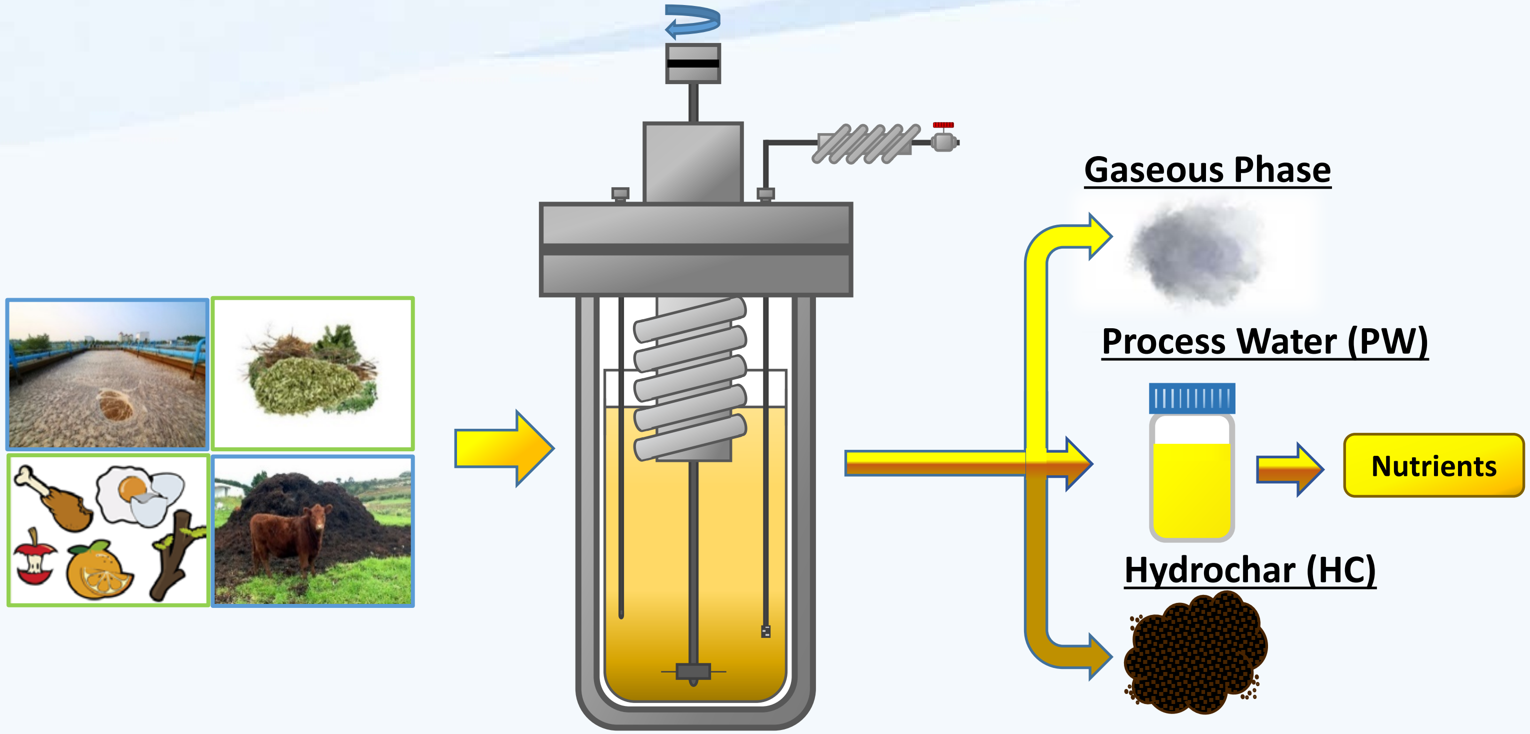
Non suitable biomass for nutrient recovery

Pruning waste

	TP g/kg	TN g/kg	TK g/kg
Sewage sludge	20-30	60-70	5-15
Animal manure	15-20	30-35	10-25
Food waste	3-6	25-35	3-12
Pruning waste	< 1	8-15	< 1

Waste generation is a current global concern

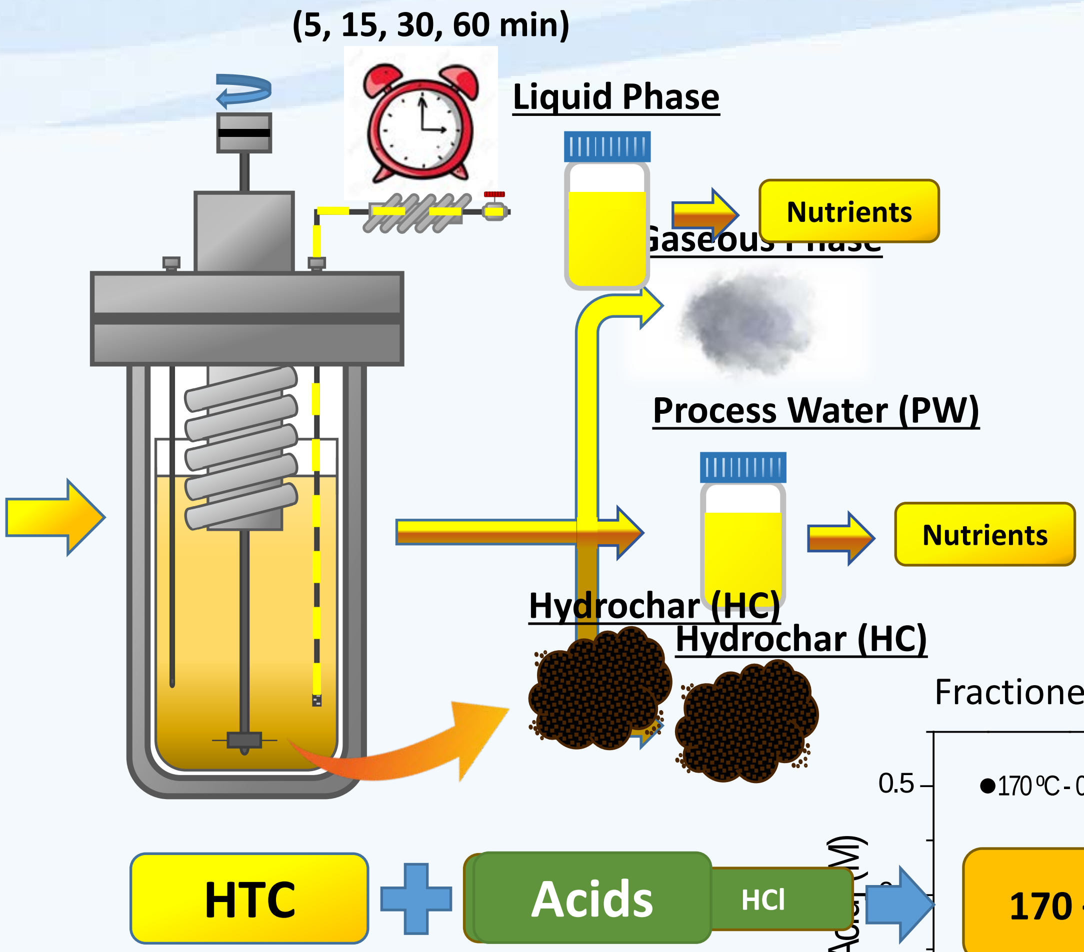
Nowadays, more than 2,000 million tonnes of municipal waste are generated annually worldwide

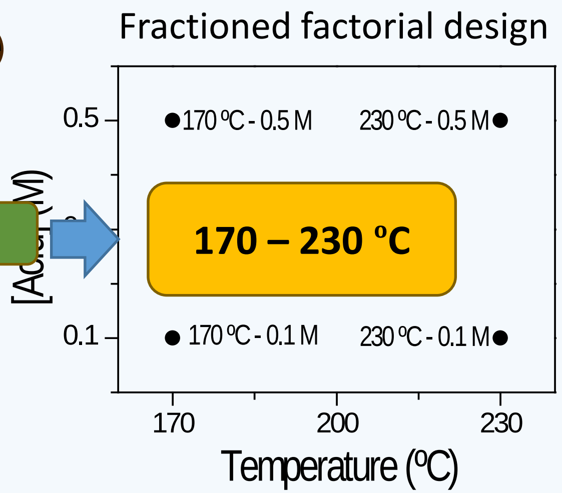


HTC + **Acids**

- Exothermic reaction
- Self-generated pressure

Food Waste	
Total nitrogen (g/kg)	31
Total phosphorus (g/kg)	5
Total potassium (g/kg)	38
Solid content (%)	7

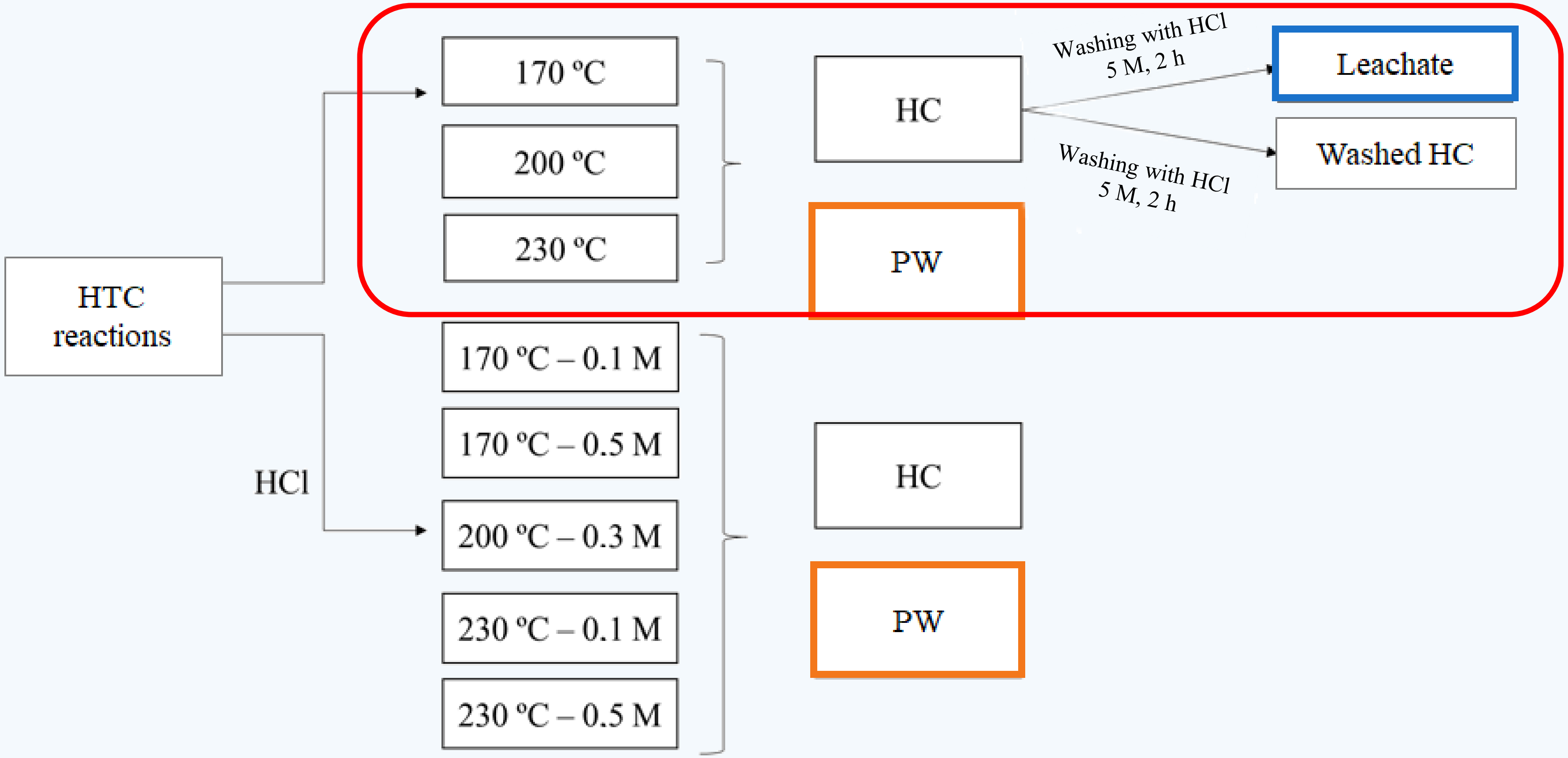




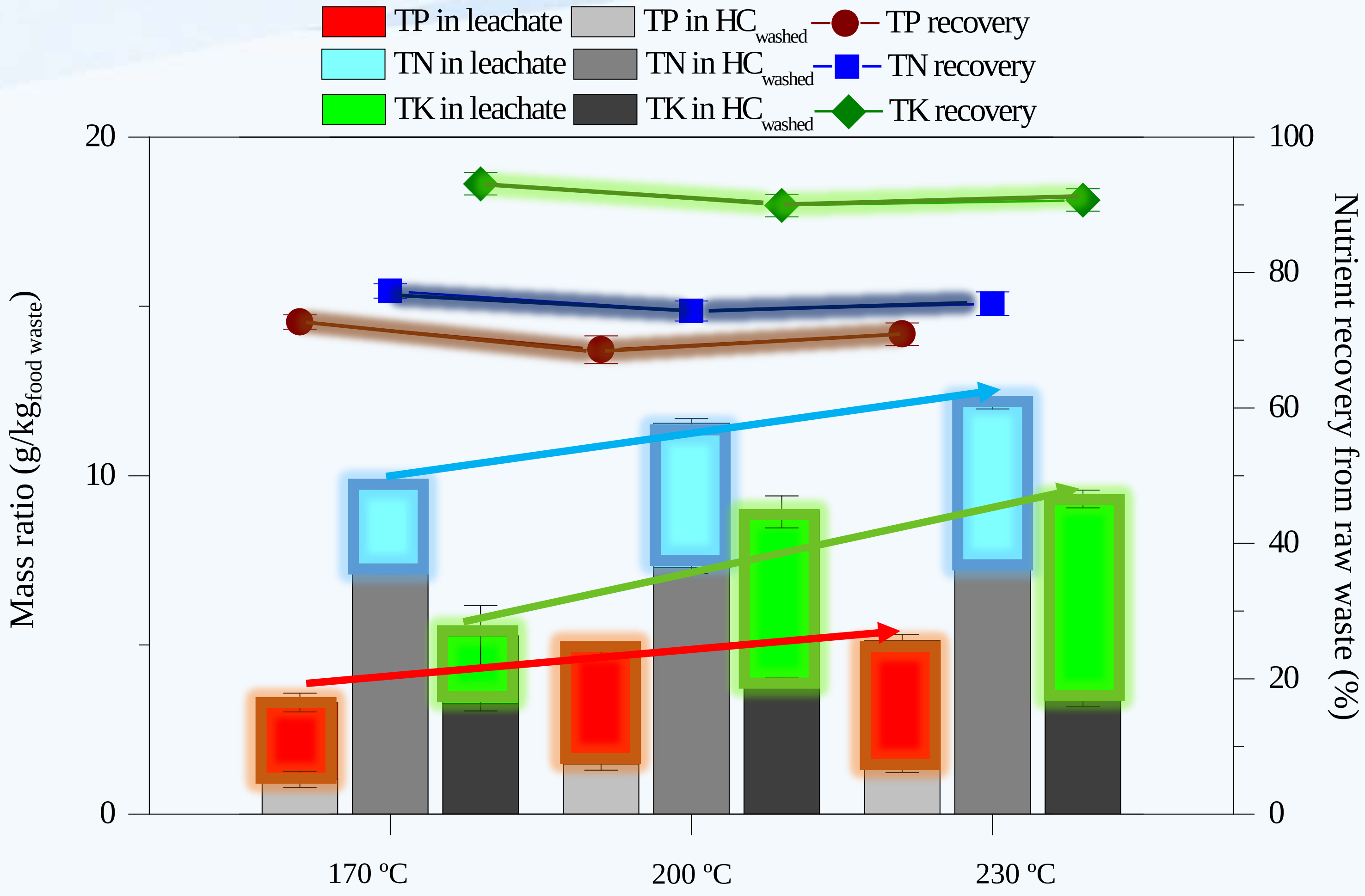
OBJECTIVE

To study the effect of temperature and the addition of acids during hydrothermal carbonization of food waste to recover phosphorus, nitrogen and potassium into the process water

Nutrient recovery from Food Waste

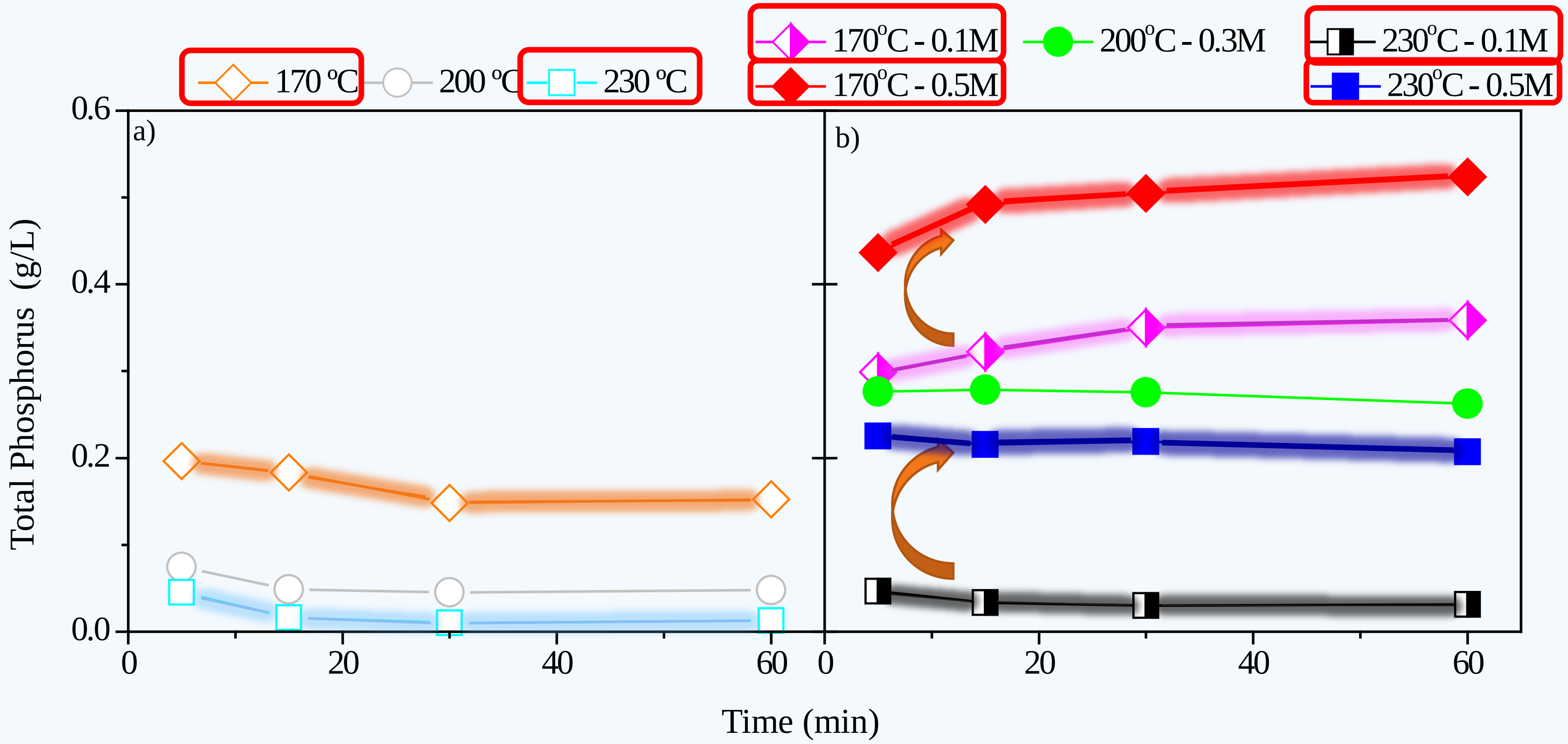


Extraction of nutrient from HC



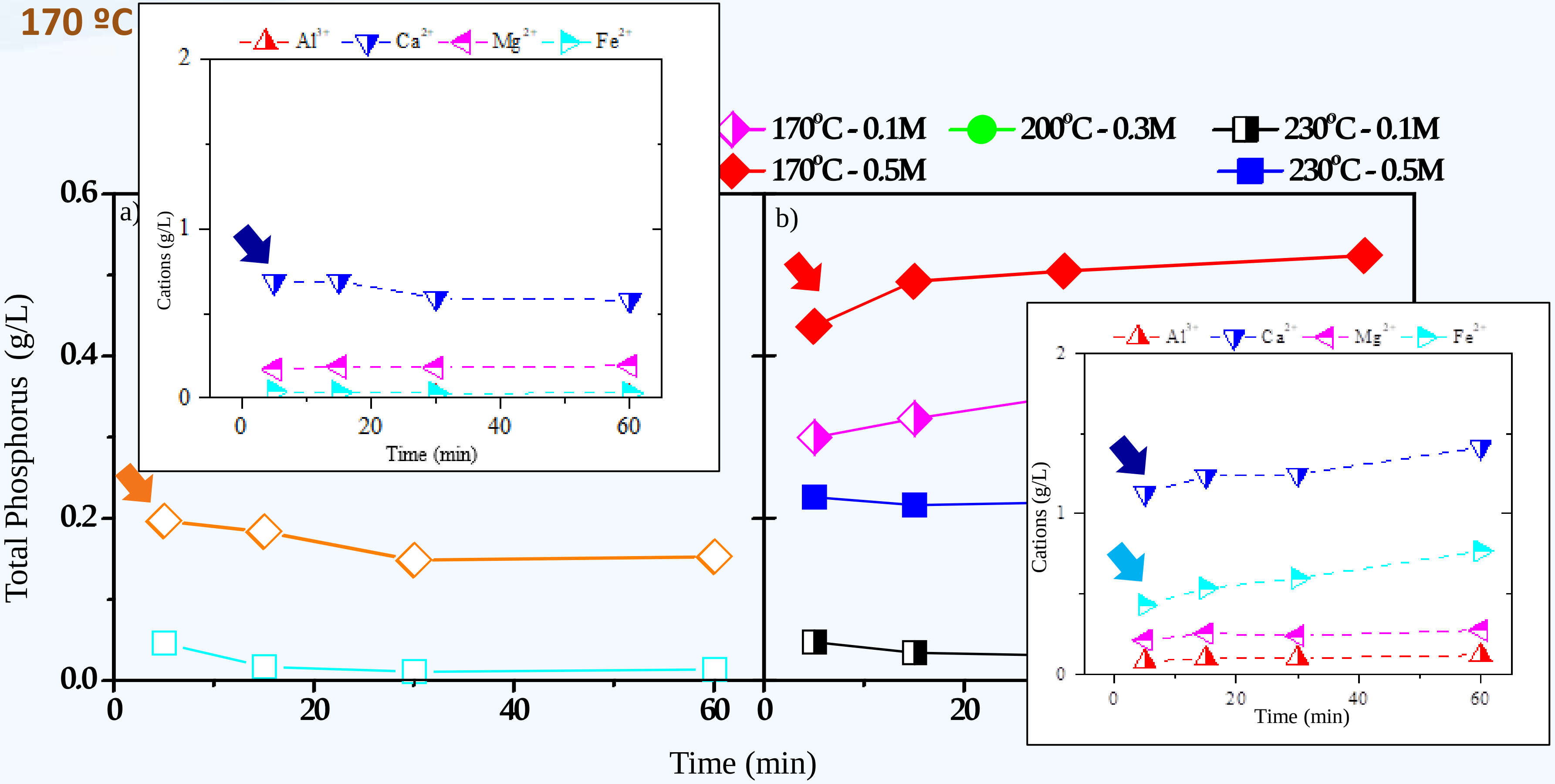
Distribution of nutrients after acid leaching of HC and nutrient recovery in process water plus leachate

Fate of phosphorus in PW during HTC



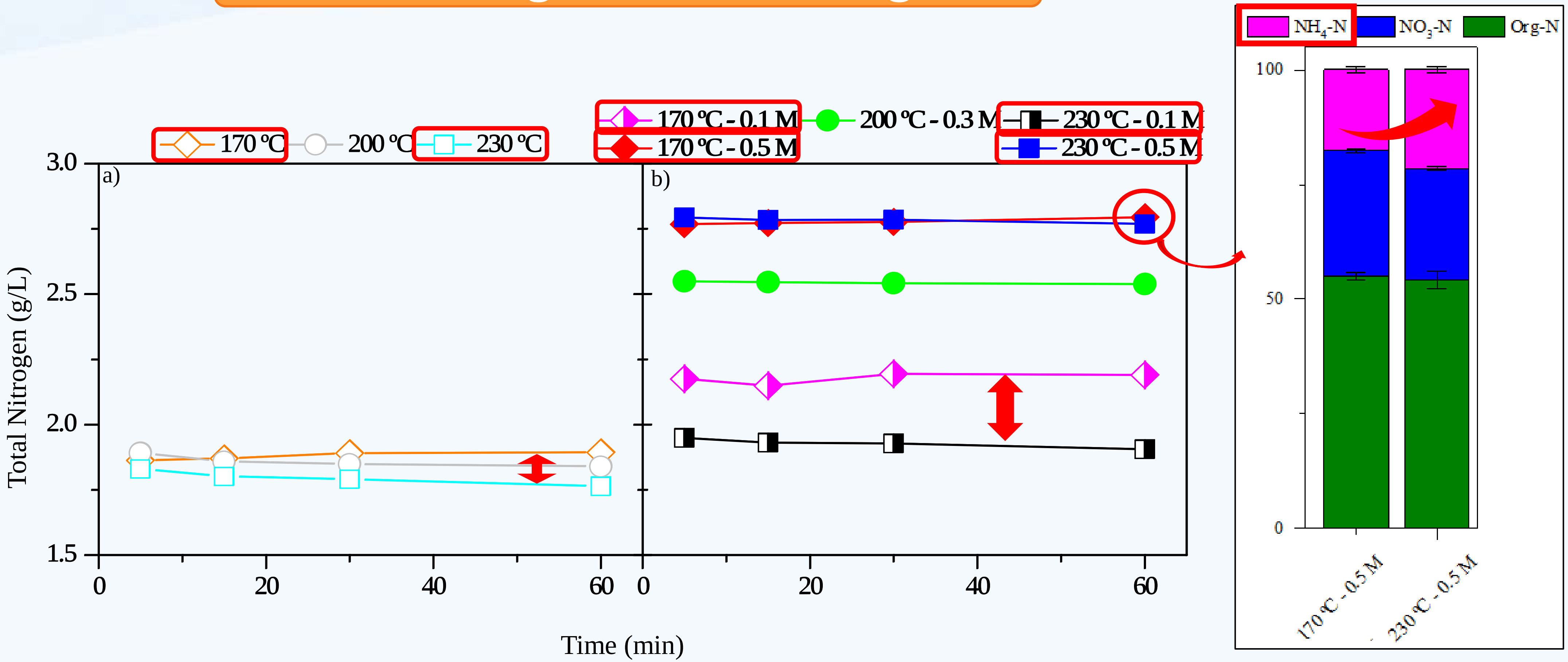
Evolution of total phosphorus in the PW during HTC of food waste (a) without acid, (b) mediated by HCl

Fate of phosphorus in PW during HTC



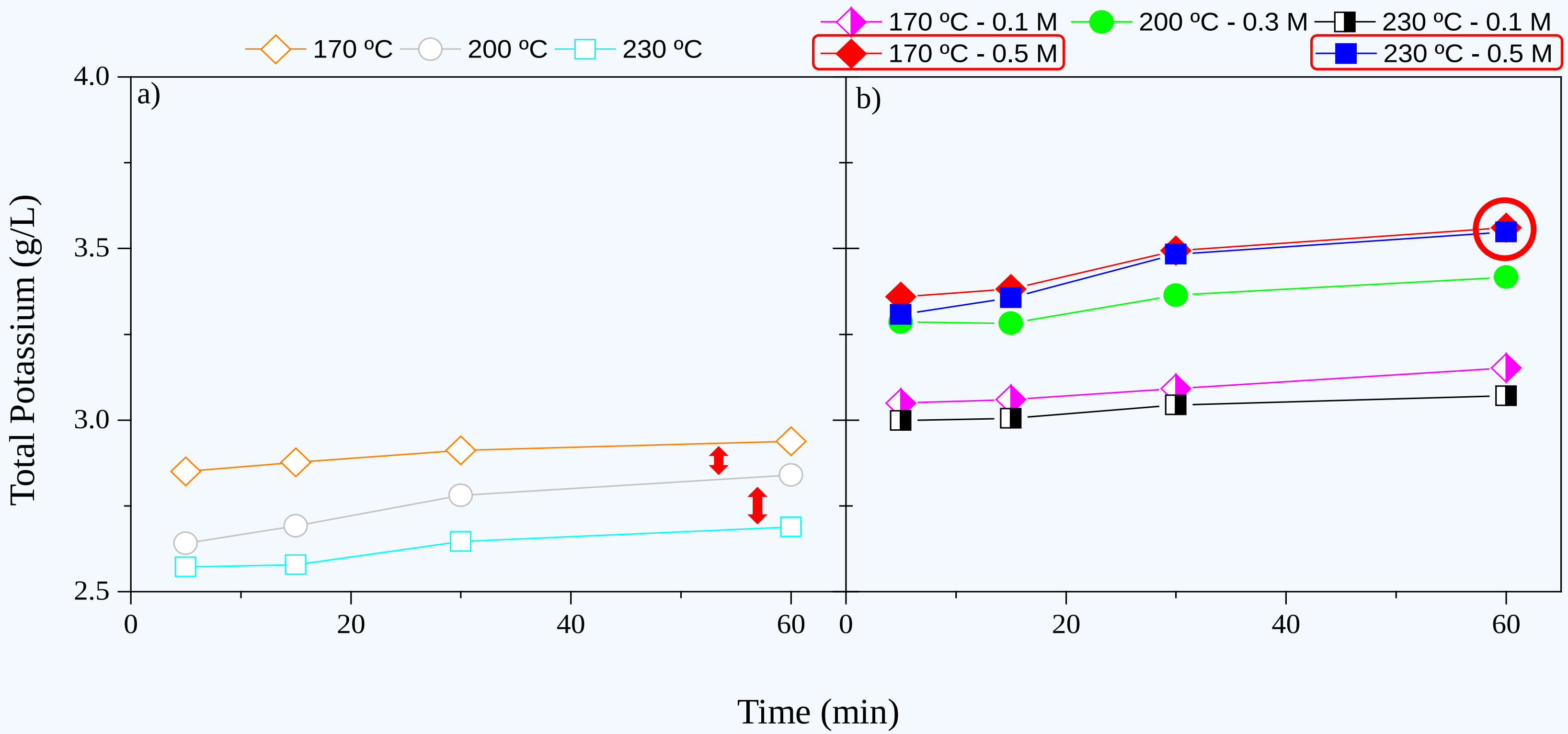
Evolution of total phosphorus in the PW during HTC of food waste (a) without acid, (b) mediated by HCl

Fate of Nitrogen in PW during HTC

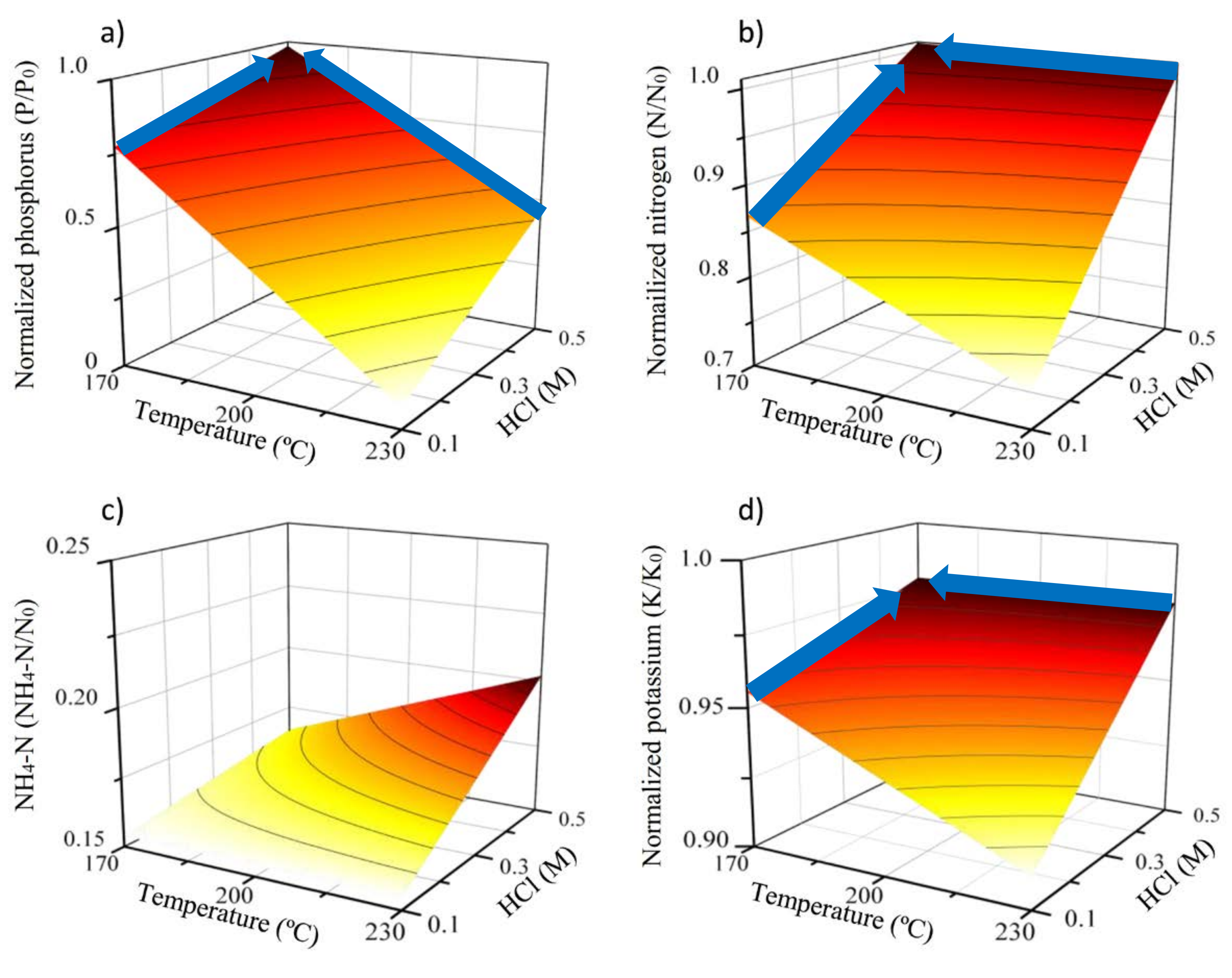


Evolution of total nitrogen in the PW during HTC of food waste (a) without acid, (b) mediated by HCl

Fate of Potassium in PW during HTC



Evolution of total potassium in the PW during HTC of food waste (a) without acid, (b) mediated by HCl



Response surface of (a) phosphorus (in form of ortho-phosphate), (b) nitrogen, (c) NH_4-N, and (d) potassium recovery in the process water at 60 min of HCl-mediated HTC.

Hydrochar as a solid biofuel

ISO 17225-8

"Graded thermally and densified biomass fuels"

HHV (MJ kg^{-1})	VM (%)	N (%)	S (%)
> 18	< 75	< 3	< 0.5

Proximal (wt %) and elemental (wt %) analysis of HC after HTC

T	Sample	Solid yield	VM	FC	Ash	C	H	N	S	O*	HHV (MJ kg^{-1})
170 ºC	**Food Waste**	80.4	60.1 ✓	16.2	12.6 ✓	46.2	5.9	1.7 ✓	0.2 ✓	33.4	19.4 ✓
	A-Food Waste	28.0	53.4 ✓	28.2	6.4 ✓	56.1	6.0	0.3 ✓	0.3 ✓	30.9	23.3 ✓
200 ºC	**Food Waste**	68.6	57.8 ✓	19.0	13.6 ✓	48.6	5.7	2.0 ✓	0.2 ✓	33.4	20.3 ✓
	A-Food Waste	28.2	41.7 ✓	39.5	6.5 ✓	58.2	6.0	0.5 ✓	0.3 ✓	28.5	22.6 ✓
230 ºC	**Food Waste**	62.0	56.2 ✓	21.0	14.3 ✓	54.8	6.1	2.3 ✓	0.2 ✓	22.2	23.7 ✓
	A-Food Waste	27.2	35.3 ✓	48.9	4.7 ✓	62.1	6.2	0.5 ✓	0.3 ✓	26.2	26.2 ✓

Conclusions

P recovery in process water

t = 60 min
T = 170 °C
[HCl] = 0.5 M
98 % P

N recovery in process water

t = 60 min
T = 170 – 230 °C
[HCl] = 0.5 M
100 % N
21 % NH_4-N

K recovery in process water

t = 60 min
T = 170 – 230 °C
[HCl] = 0.5 M
98 % K

P: 32 kt/year

K: 45 kt/year

N: 200 kt/year

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