National Technical University of Athens
Unit of Environmental Science and Technology

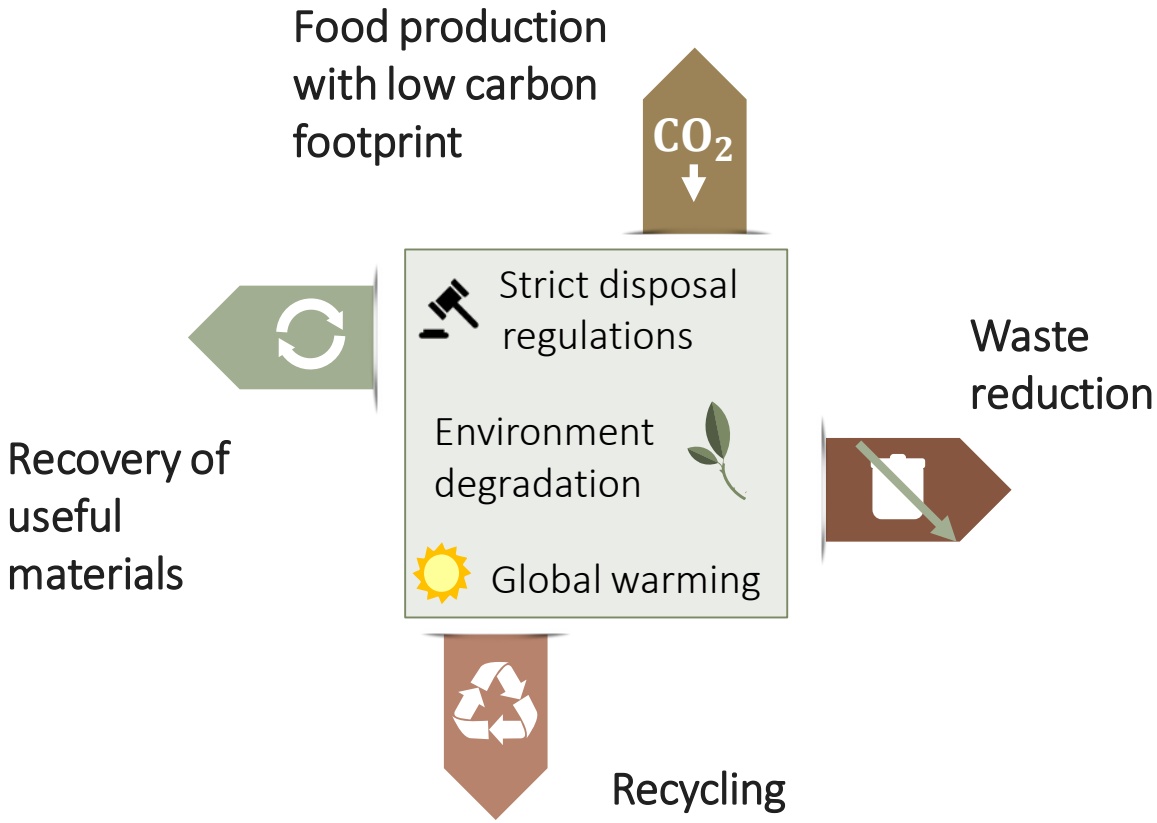
CORFU2022
15-18 JUNE
9th International Conference on Sustainable Solid Waste Management

Improving sustainability of potato processing industries

V. Felekis, C. Stavraki, D. Malamis, S. Mai, E.M. Barampouti

CIRCforBIO

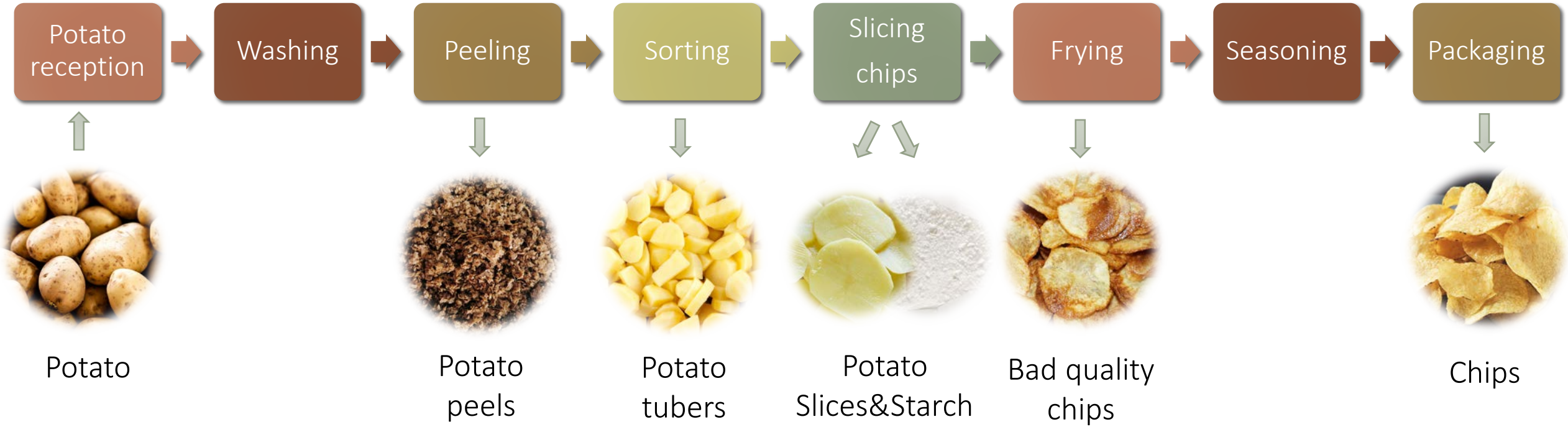
Ever-increasing population → Rapid industrialization → Vast volumes of industrial waste



Potato

- ✓ 4th main crop consumed worldwide
- ✓ 18% increase of global potato production since 2001 to 2020
- ✓ 0.16 tons of solid waste are generated per ton of potato processed

Chips Production

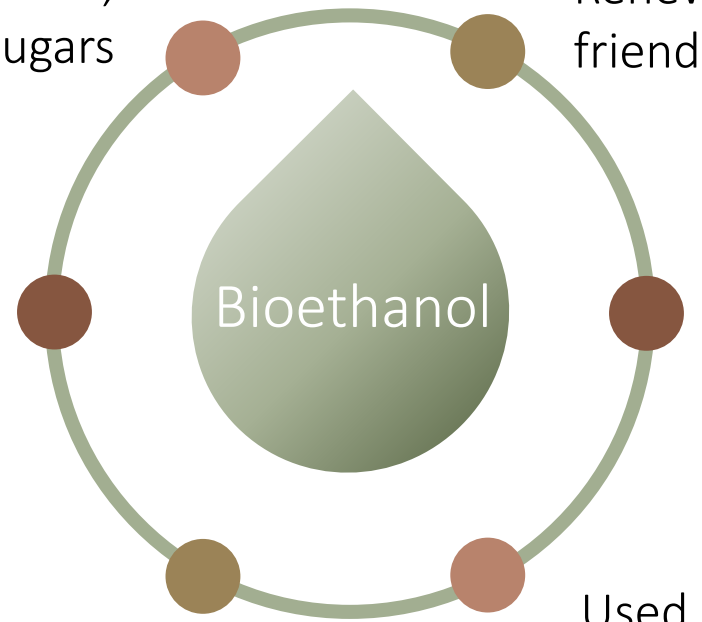


Aim of the research

The valorization and degradation of the potato processing waste with production of value added bioproducts.

- ✓ What is the composition of this waste?
- ✓ What could be produced by these components?
- ✓ What are the ways we could produce it?
- ✓ What yields can we achieve?
- ✓ What solid degradation can we reach?

Bioproduct



Made from carbohydrates, lignocellulosic substances and sugars

Renewable, environmental friendly biofuel

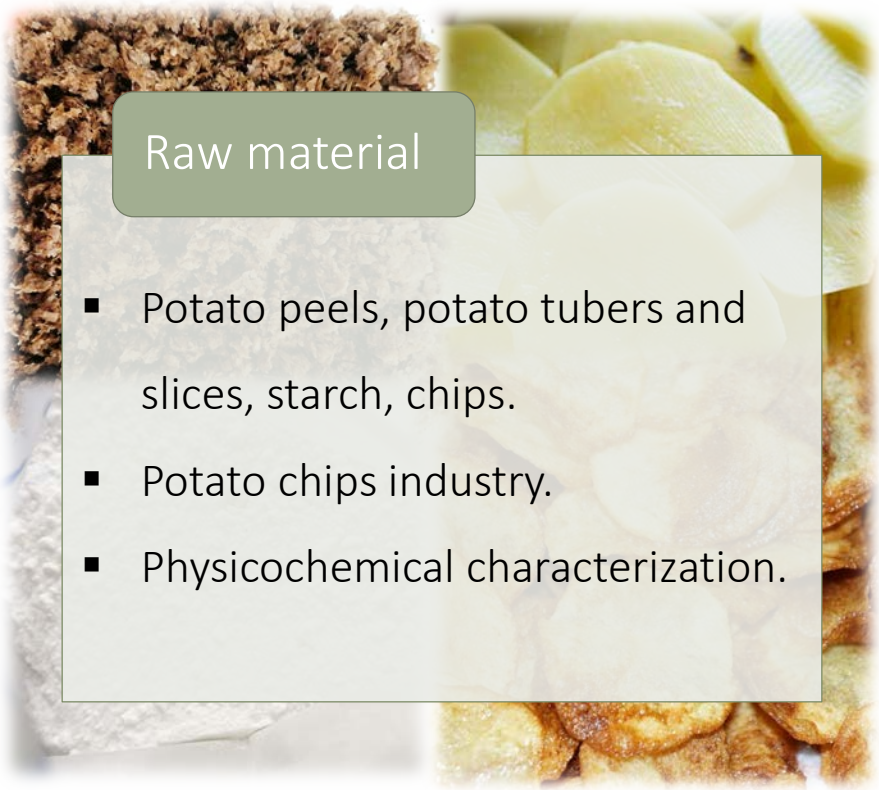
Safer storage and transportation

Reduction of GHG emissions

Similar properties to gasoline

Used as blend along with conventional fossil fuels

Materials & Methods (I)



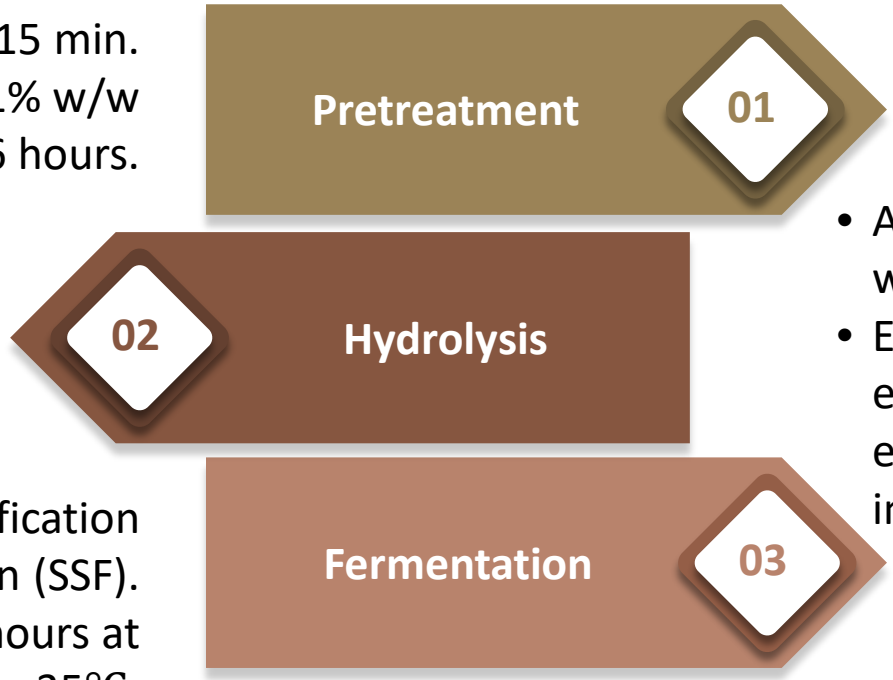
Raw material

- Potato peels, potato tubers and slices, starch, chips.
- Potato chips industry.
- Physicochemical characterization.

Parameter (% d.b)	Potato peels	Potato tubers & slices	Starch	Chips
Moisture	85.90	75.94	1.24	2.83
Total solids	14.10	24.06	98.26	97.17
Oils	-	-	-	36.19
Starch	17.31	62.79	83.43	39.92
Cellulose	18.94	18.28	-	7.37
Hemicellulose	13.12	8.99	-	2.56
Insoluble Acid Residues	20.39	1.73	8.60	0.77

Materials & Methods (II)

- Autoclave, 121℃ for 15 min.
- Alkali pretreatment with 1% w/w NaOH at 50℃ for 6 hours.



- Acid hydrolysis with 1% v/v of 78% w/w dissolved sulfuric acid.
- Enzymatic hydrolysis by amylolytic enzyme SpirizymeXL and cellulolytic enzyme NS22177 from Novozymes in various concentrations.

- Simultaneous Saccharification Fermentation (SSF).
- 2% w/w *S. cerevisiae* for 48 hours at 35℃.

All experiments were conducted in lab scale, without drying of substrates.

Results and discussion

Alkali pretreatment

Conditions

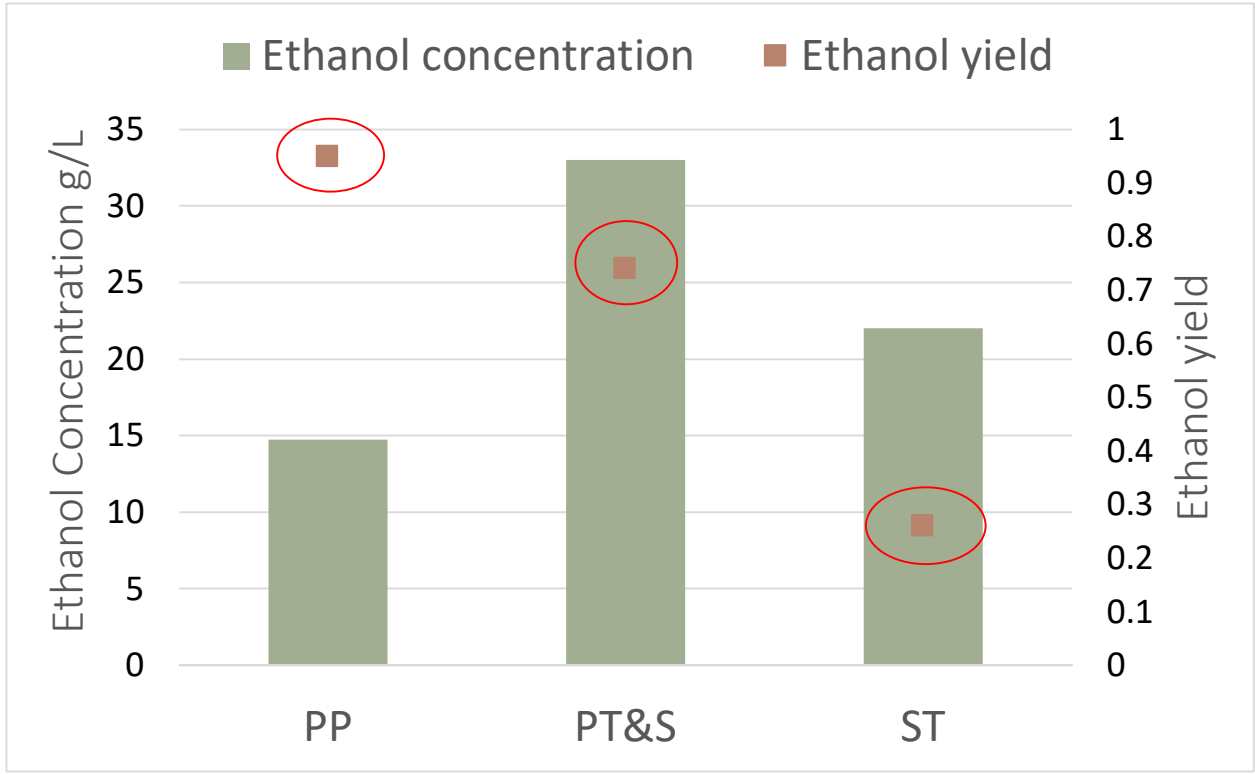
Pretreatment

- ✓1% w/w NaOH
- ✓50 °C
- ✓6 hours

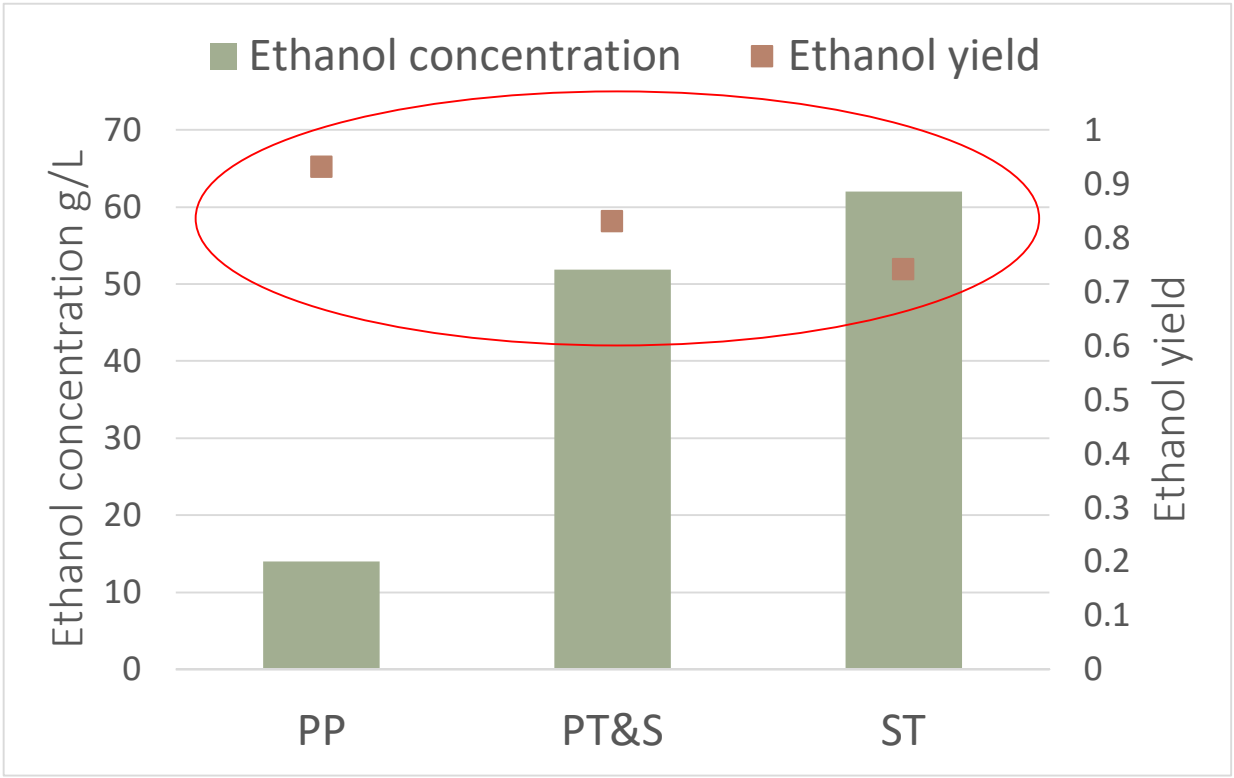
SSF

- ✓2 % w/w *S. cerevisiae*
- ✓35°C
- ✓48 hours

Parameter	Potato peel (PP)	Potato tubers & slices (PT&S)	Starch (ST)
Solid loading (% w/w)	5	15	15
Cellulolytic enzyme (µL/g cellulose)	175	-	-
Amylolytic enzyme (µL/g starch)	40	40	40



Hydrothermal pretreatment



Conditions

Autoclave

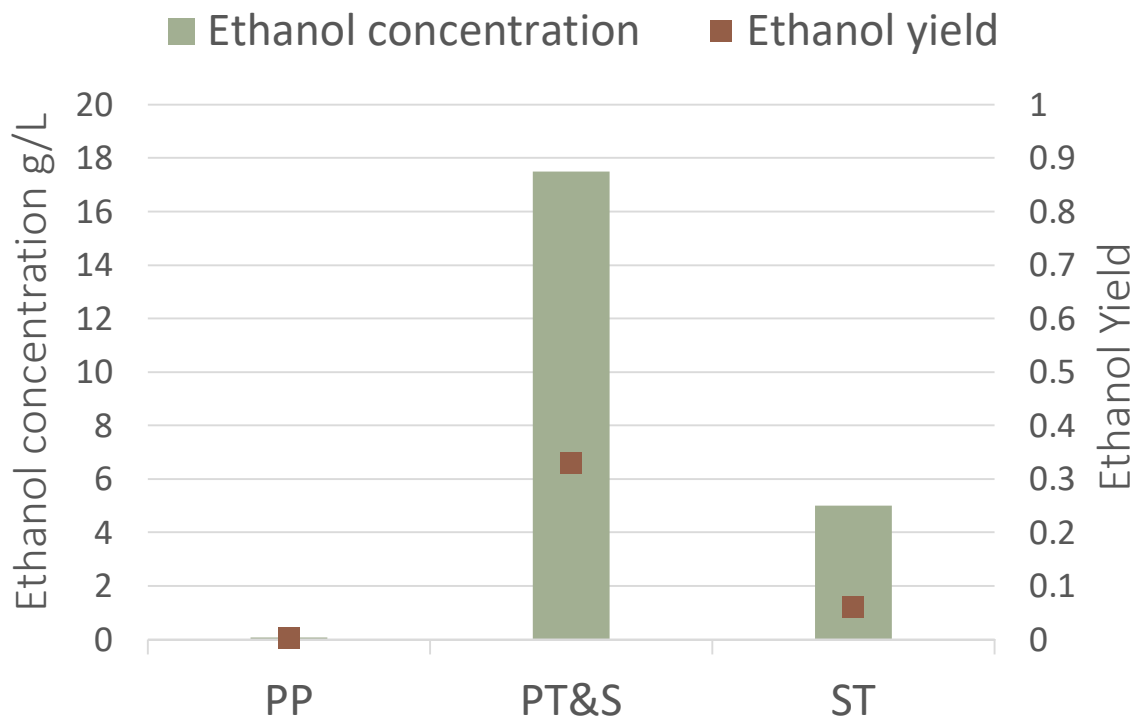
- ✓121 °C
- ✓15 minutes

SSF

- ✓2 % w/w *S. cerevisiae*
- ✓35°C
- ✓48 hours

Parameter	Potato peel (PP)	Potato tubers & slices (PT&S)	Starch (ST)
Solid loading (% w/w)	5	15	15
Cellulolytic enzyme (µL/g cellulose)	550	-	-
Amylolytic enzyme (µL/g starch)	45	40	40

Acid Hydrolysis



Conditions

Hydrolysis

✓1% v/v of 78% w/w dissolved sulfuric acid
✓3 hours
✓60 °C

Fermentation

✓2 % w/w *S. cerevisiae*
✓35°C
✓48 hours

Parameter	Potato peel (PP)	Potato tubers & slices (PT&S)	Starch (ST)
Solid loading (% w/w)	11	15	15

Chips

Parameter	Low Level (-)	High Level (+)	Center
Solid loading (% w/w)	10	20	15
Amylolytic enzyme (µL/g starch)	20	60	40

Treatment

- ✓Milling with blender
- ✓Oils extraction with hexane

SSF

- ✓2 % w/w *S. cerevisiae*
- ✓35°C
- ✓48 hours

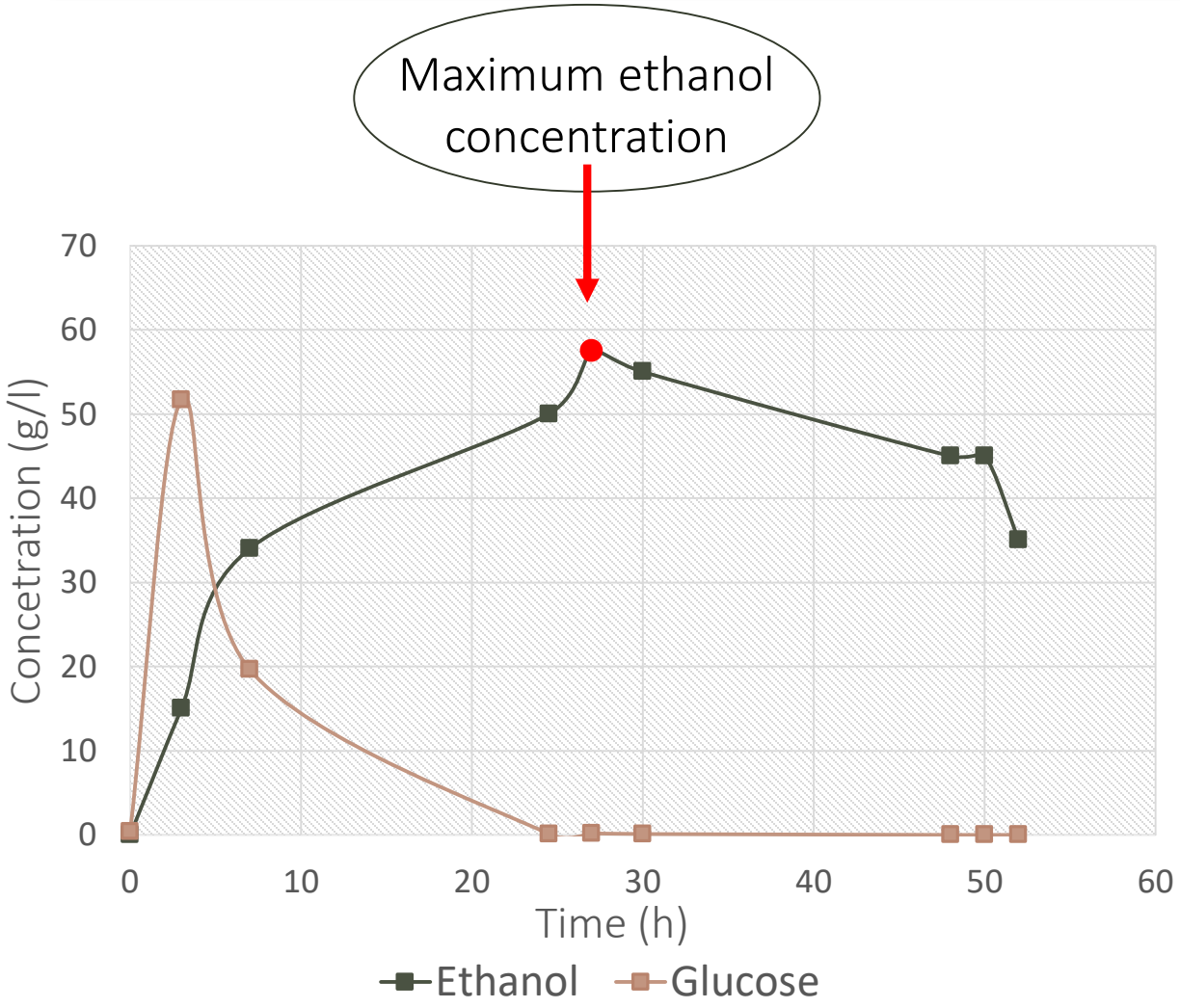
Solid loading (%)	Amylolytic enzyme (µL g^{-1} starch)	Ethanol concentration (g L^{-1})	Ethanol yield (%)	Degradation of solid (%)
10	20	28	97	80.67
20	60	43	73	67.85
20	20	50	85	77.40
10	60	28	97	80.85
15	40	37	89	66.08
10	20	38	95	78.12

Chips

Defatted chips

Max ethanol yield

Chips – 4L reactor

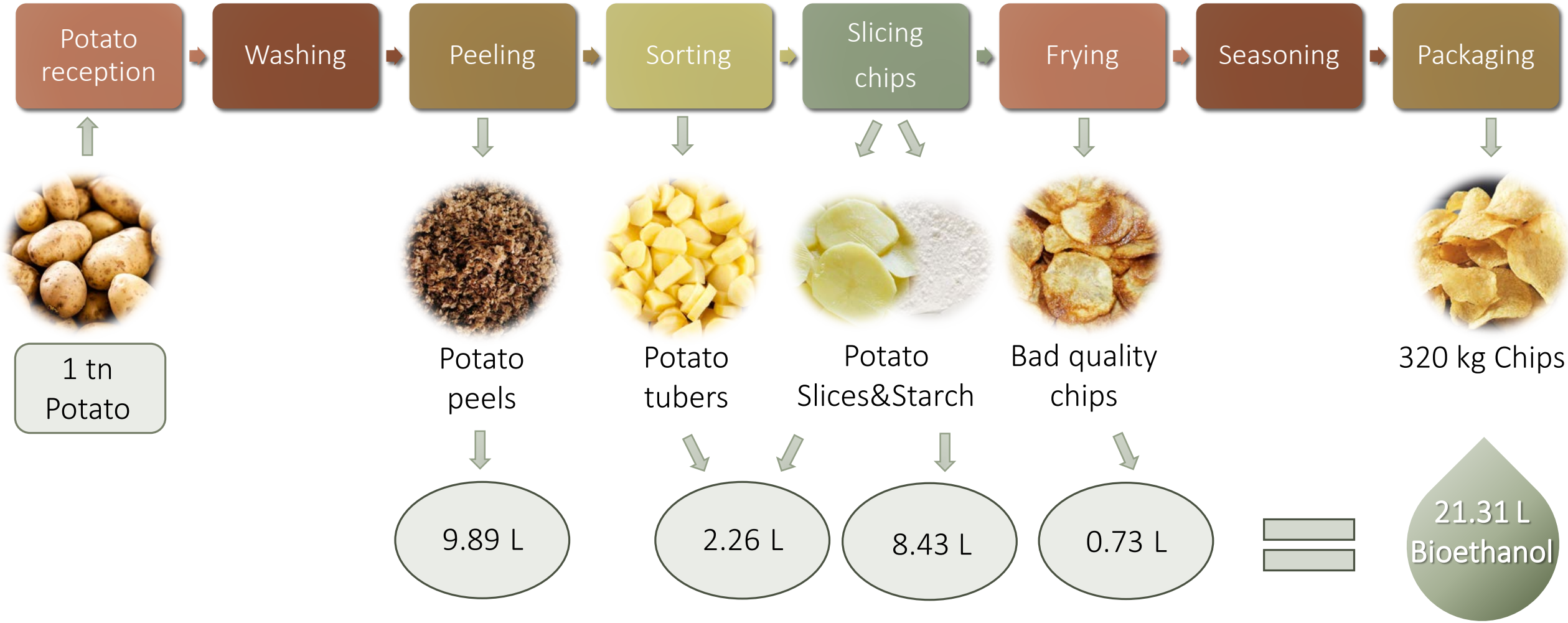


Conditions

- ✓ Blender
- ✓ 4L reactor
- ✓ SSF for 52 hours
- ✓ 35℃
- ✓ 2 % w/w *S. cerevisiae*

Parameter	Value
Solid loading (% w/w)	20
Amylolytic enzyme (μL/g starch)	20
Max ethanol concentration (g/L)	57.5

Bioethanol production



Conclusions & Suggestions

Potato peels	Potato tubers & slices	Starch	Chips
Alkali pretreatment	**Autoclave**	**Autoclave**	**No pretreatment**
SSF	**SSF**	**SSF**	**SSF**
Degradation of solid : 30%	Degradation of solid: 85 %	Degradation of solid: 52 %	Degradation of solid: 95.5 %
Ethanol yield: 100%	Ethanol yield: 83 %	Ethanol yield: 74 %	Ethanol yield: 100 %




- ✓ Valorization of waste from 1 ton of potato results 21.31 L of bioethanol.
- ✓ Solid degradation is achieved.
- ✓ Process optimization is in progress.

- ✓ Recovery and utilization of oil from waste chips for biodiesel production.
- ✓ Utilization of residues for anaerobic digestion.

National Technical University of Athens
Unit of Environmental Science and Technology

Thank you!

chrysanthi.stavraki@gmail.com

$$Y_{EtOH} = \frac{Produced\ EtOH}{Theoretical\ EtOH\ from\ total\ conversion\ of\ carbohydrates}$$