Ethanol Production Using Organic Waste

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Research Background

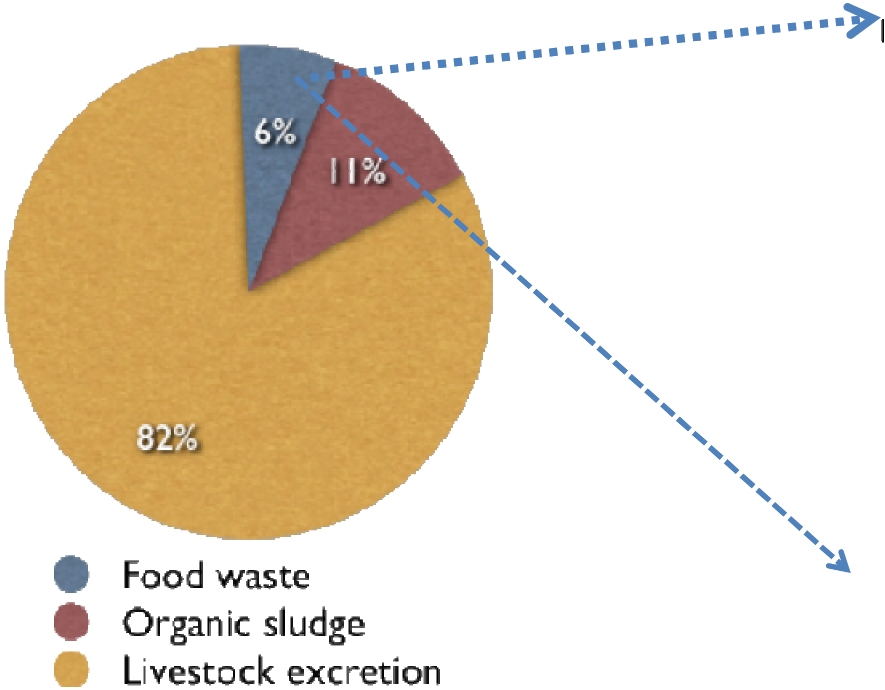
Bioethanol in Korea

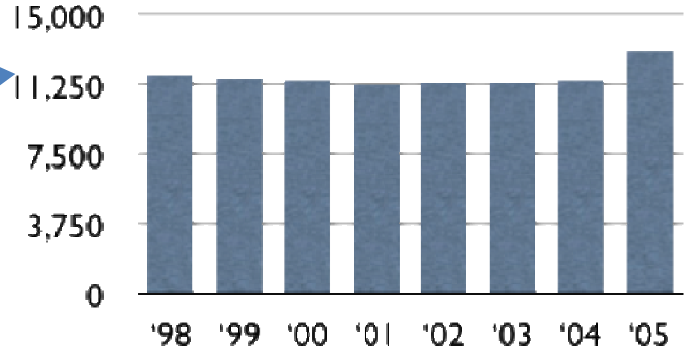
- High oil price
- Reduce global warming gas
- Renewable energy (5% of total energy in 2011)
- Low bioenergy share (5.3% of renewable energy in '08)

→ 3 - 5% ethanol blends with gasoline (E3 and E5)

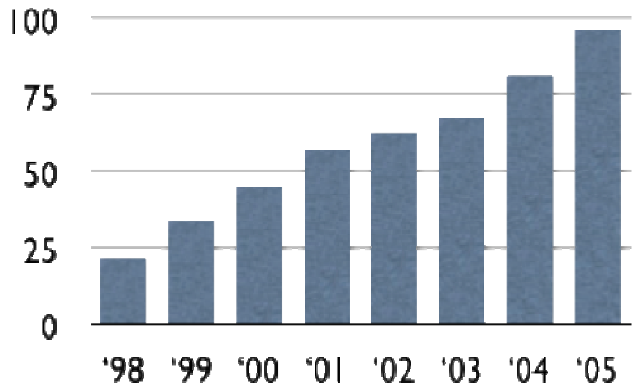
Research Background

Organic waste produced in Korea





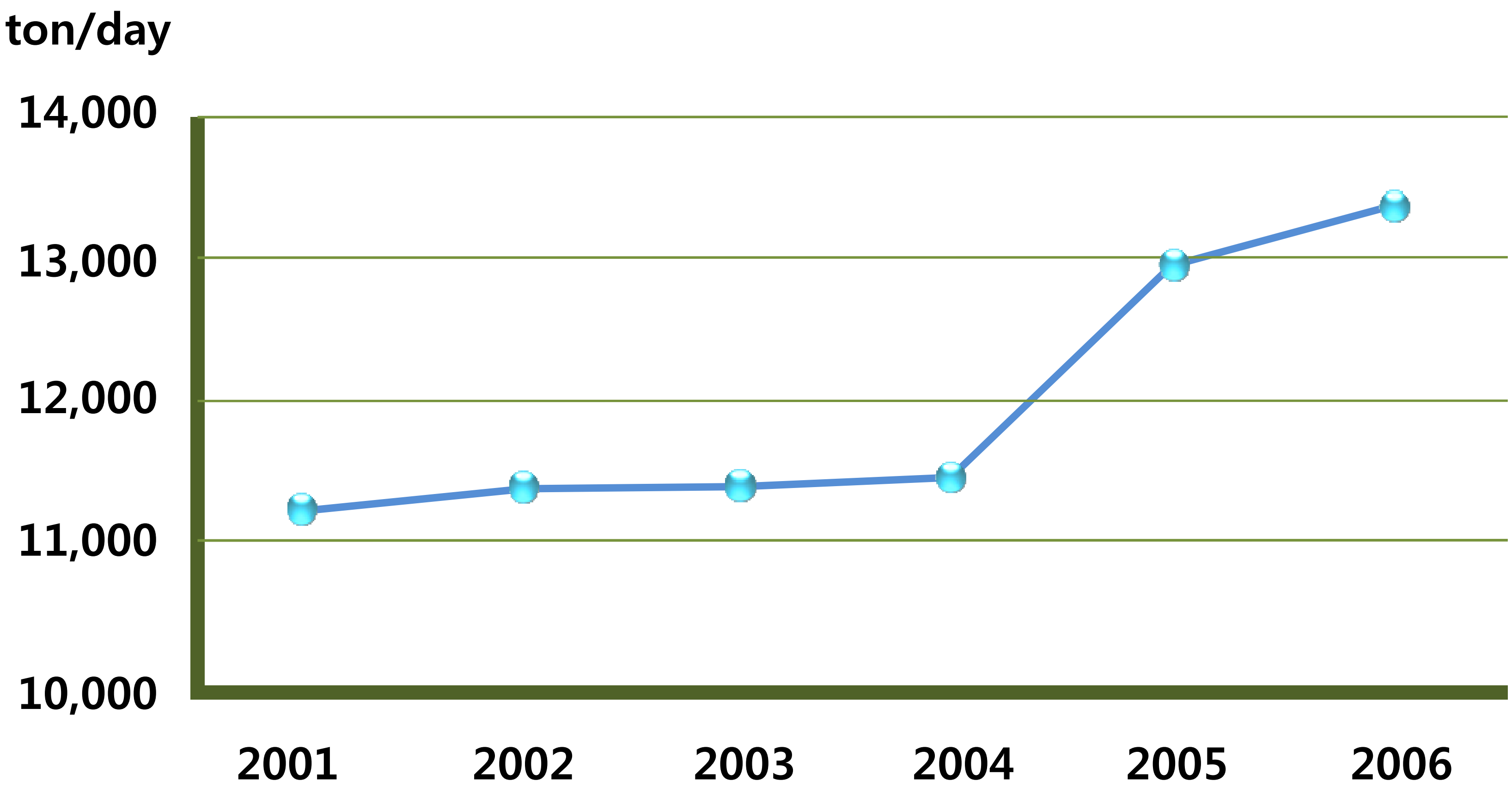
Food waste production (ton/day)



Separate collection (%)

Research Background

Food waste produced in Korea



Research Background

Composition of kitchen refuse

	Composition
C	46.1 ~ 48.1 %
H	6.8 ~ 7.2 %
O	32.4 ~ 36.7 %
N	3.5 ~ 4.1 %
Cl	1.9 ~ 2.2 %
Moisture content	72.99 ~ 84.96 %

pH	4.2~4.5
Ash	5 %
Crude Protein(%)	20~25 %
Crude Fiber(%)	8~20%
Crude Lipid(%)	5~15 %
Total Sugar(%)	47~54 %

weight percentage based on dry food wastes

Research Background

Food waste as alternative substrate for ethanol production

- In abundant supply (about 5 million ton per year)
- Potentially promising bioresource
- High sugar content
- High potential of ethanol production
- High concentration of salt (1.9 – 2.2 %)
- Does not lead to resource conflict (insufficient food supply)

Materials and Methods

Substrate

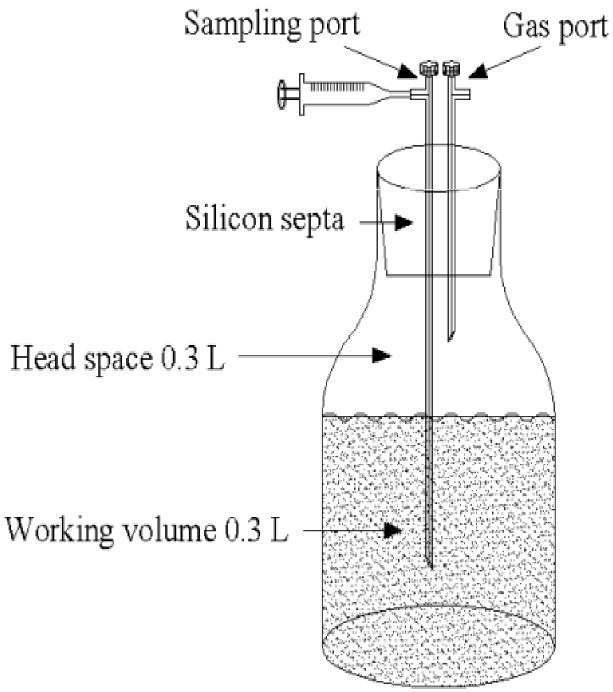
pH	Salinity (%)	Alkalinity (mg/L)	Volatile solid (g/L)	Total solid (g/L)	SCOD (g/L)	TCOD (g/L)
4.5 – 4.8	1.5-1.8	0.1 – 0.3	130 - 138	163 - 190	62 - 98	150 - 180

Enzyme and microorganism

Microorganisms	*Saccharomyces*
Enzyme	Carbohydrase (*Asperrillus aculeatus*, Viscozyme L) Glucoamylase (*Asperrillus niger,* Spirizyme plus FG*)*

Materials and Methods

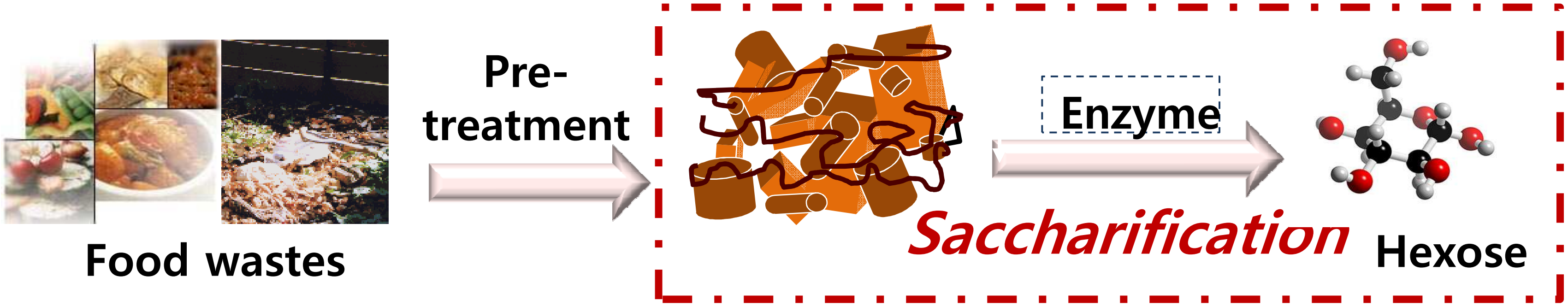
Experimental set-up

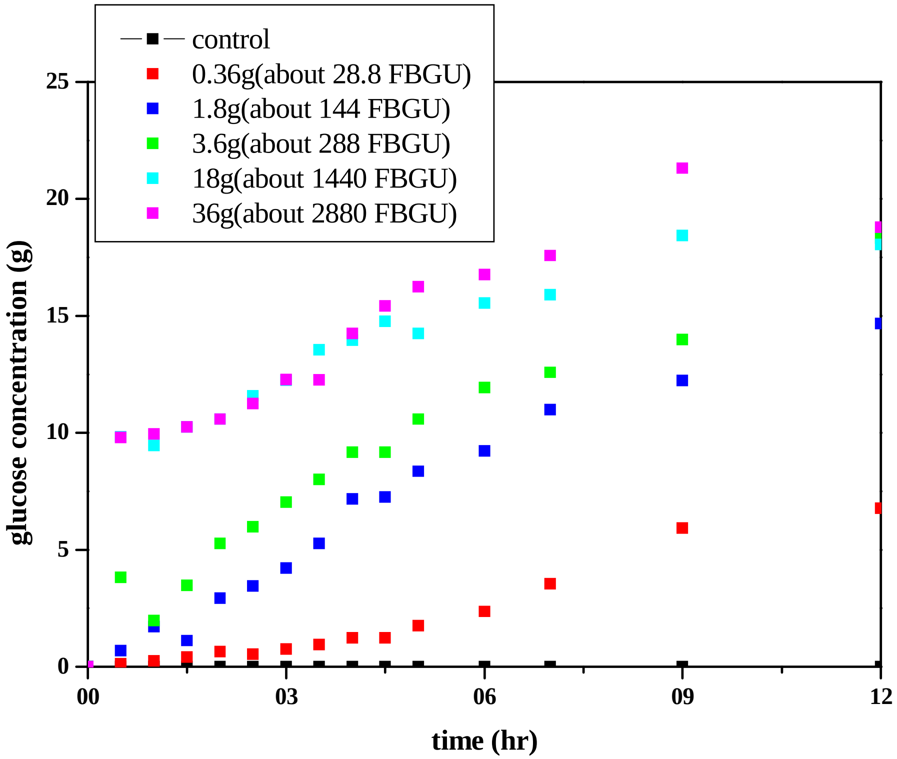


Enzymatic saccharification

Enzymatic saccharification & ethanol fermentation

Enzymatic saccharification of food waste using carbohydrase



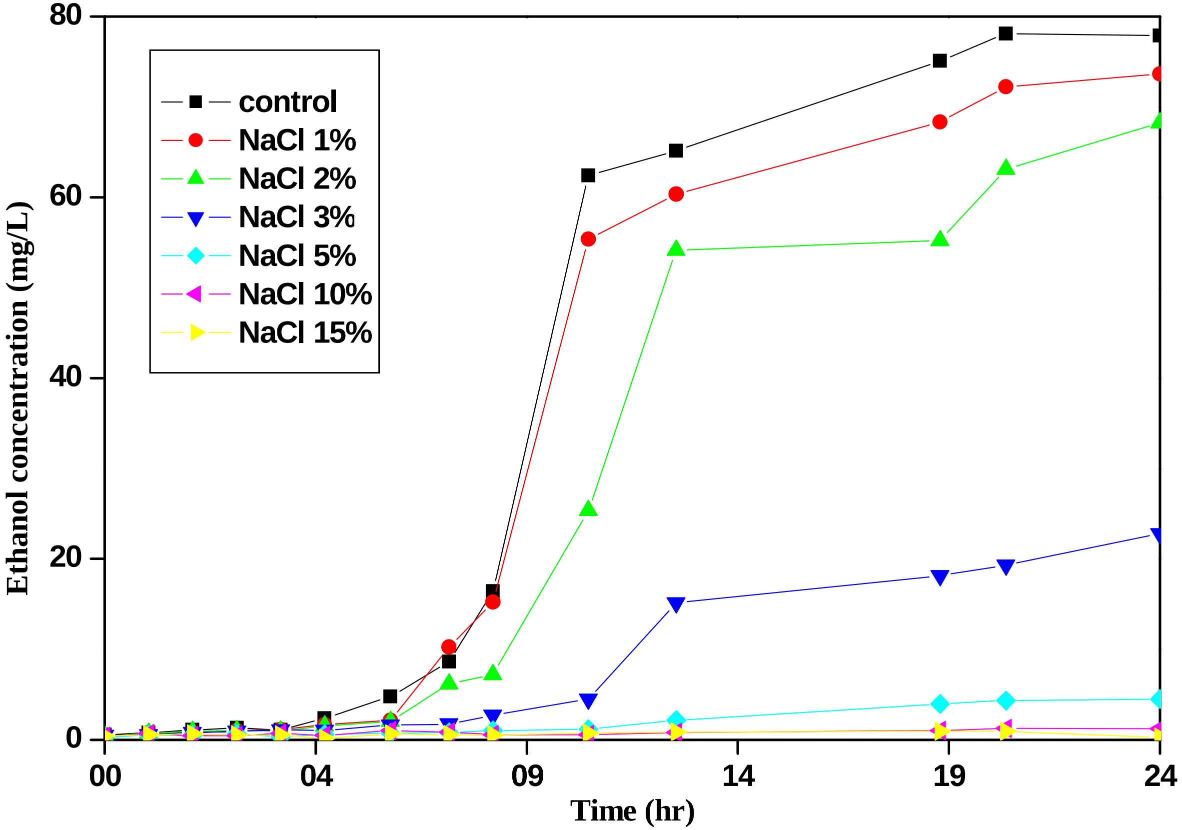


Enzymatic saccharification of food waste using carbohydrase

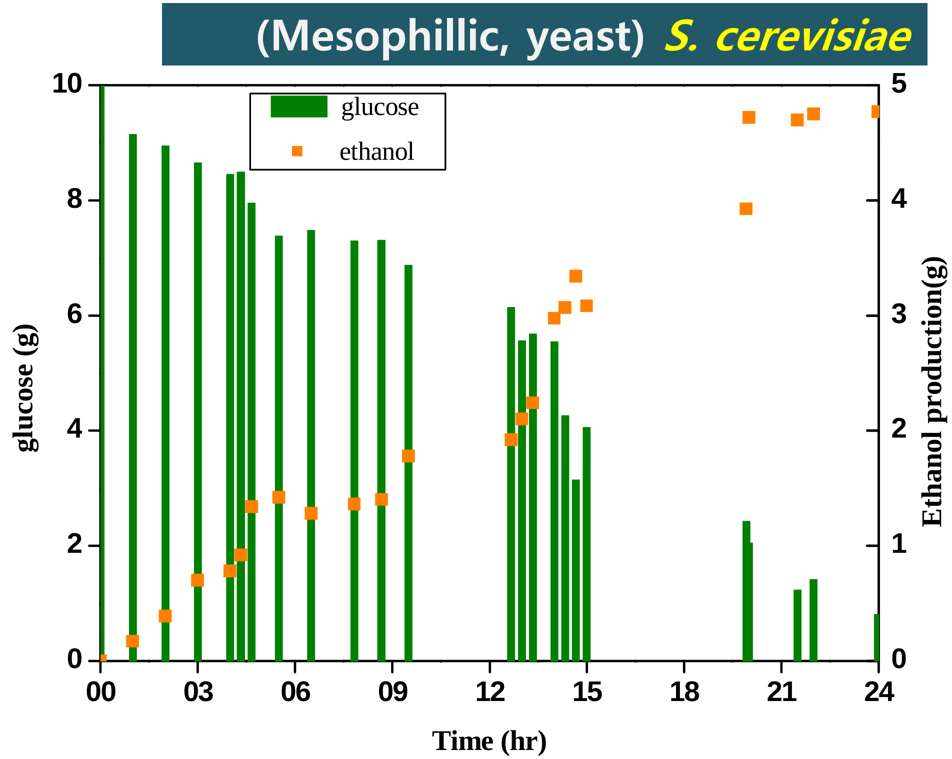
Dosage / Enzyme	Control	0.1%	0.5%	1.0%	5.0%	10.0%
Glucoamylase (Spirizyme)	0.003	0.241	0.314	0.384	0.414	0.436
Carbohydrase (Viscozyme L)	0.003	0.379	0.481	0.495	0.522	0.627

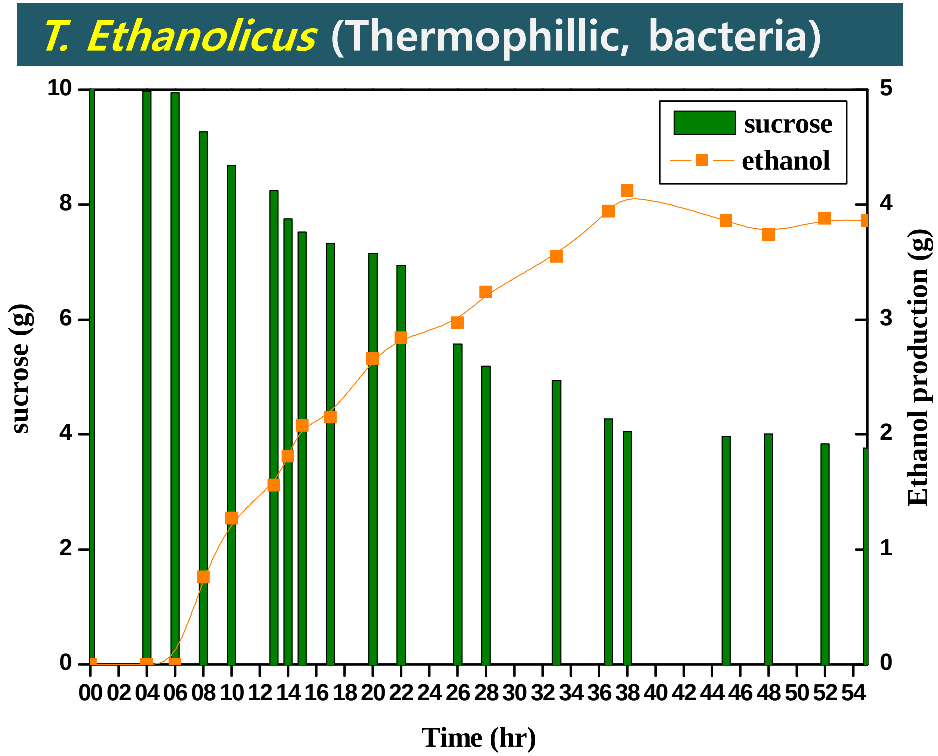
Unit: g glucose/g total solids

Effect of salt concentration on S. cerevisiae for ethanol fermentation



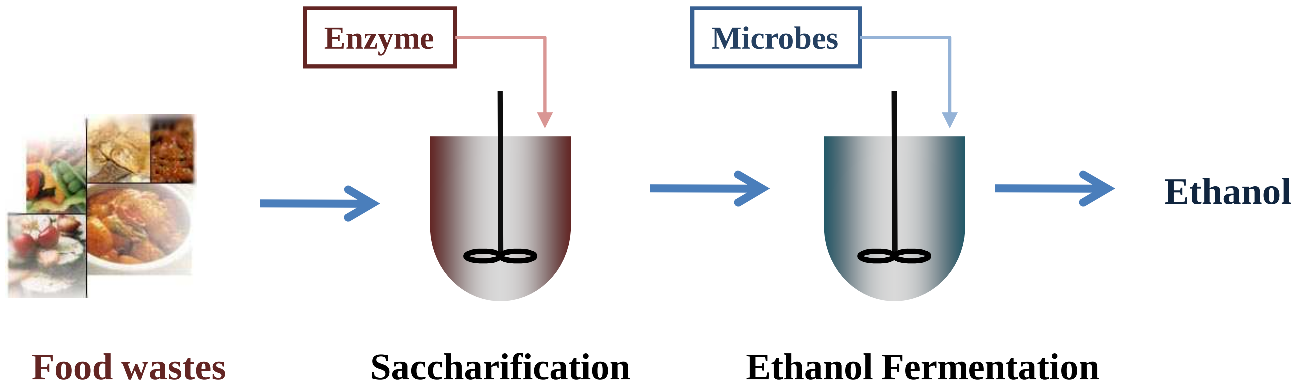
Comparison between *S. cerevisiae* and *T. Ethanolics* for ethanol production

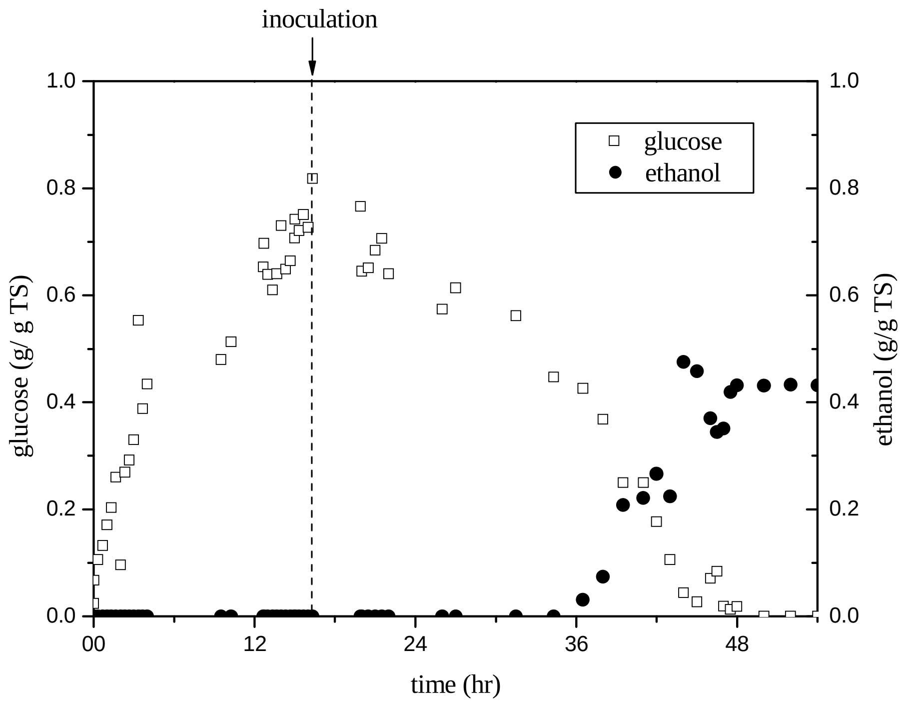




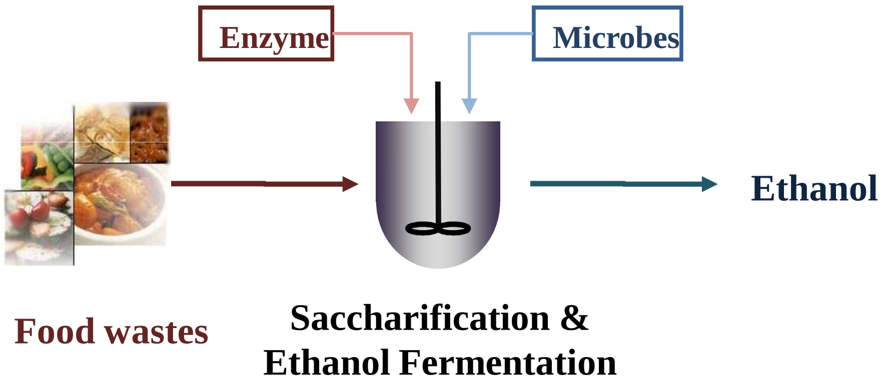
	Ethanol g / g-glucose
S. cerevisiae	0.51
T. ethanolicus	0.37

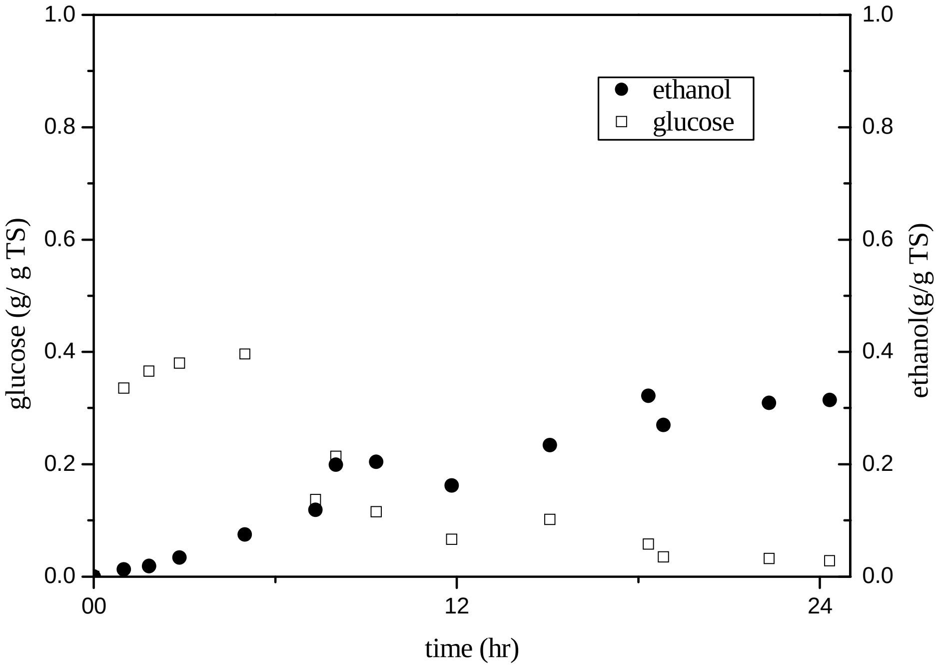
Separate enzymatic saccharification and ethanol fermentation





Simultaneous enzymatic saccharification and ethanol fermentation





Comparison SHF and SSF

	Ethanol production
SHF	0.43 g ethanol /g TS
SSF	0.31 g ethanol /g TS

Conclusions

- Food waste is difficult to be utilized by ethanol producing microorganism. Pretreatment using two different enzymes, carbohydrase (*Aspergillus aculeatus*, Viscozyme L) and glucoamylase (*Aspergillus niger,* Spirizyme Plus FG) were tested for saccharification of food waste. Carbohydrase was able to hydrolyze and produce glucose at 0.63 g glucose/g total solid which was higher than glucoamylase.

- The amount of carbohydrase added to food waste determines the rate of saccharification. As the amount of enzyme addition increased, the rate of saccharification was increased. At higher than 1440 FBG of enzyme activity, the saccharification rate was not increased further.

- In the separate enzymatic hydrolysis and ethanol fermentation, ethanol was produced at 0.43 g ethanol /g TS. For simultaneous saccharification and ethanol fermentation, glucose concentration increased rapidly and reached to a maximum which was less than the level obtained from the separate saccharification and ethanol fermentation. Ethanol was produced at 0.31 g ethanol/g TS which was less than the separate enzymatic hydrolysis and ethanol fermentation.