Improving enzymatic saccharification of hybrid poplar by e-beam irradiation pretreatment

Soo-Jeong Shin[1] and Yong Joo Sung[2]

1: Chungbuk National University, South Korea

2: Chungnam National University, South Korea

Energy from biomass

- Depletion of fossil fuels
  - Renewable energy
- Global warming
  - Carbon dioxide neutrals

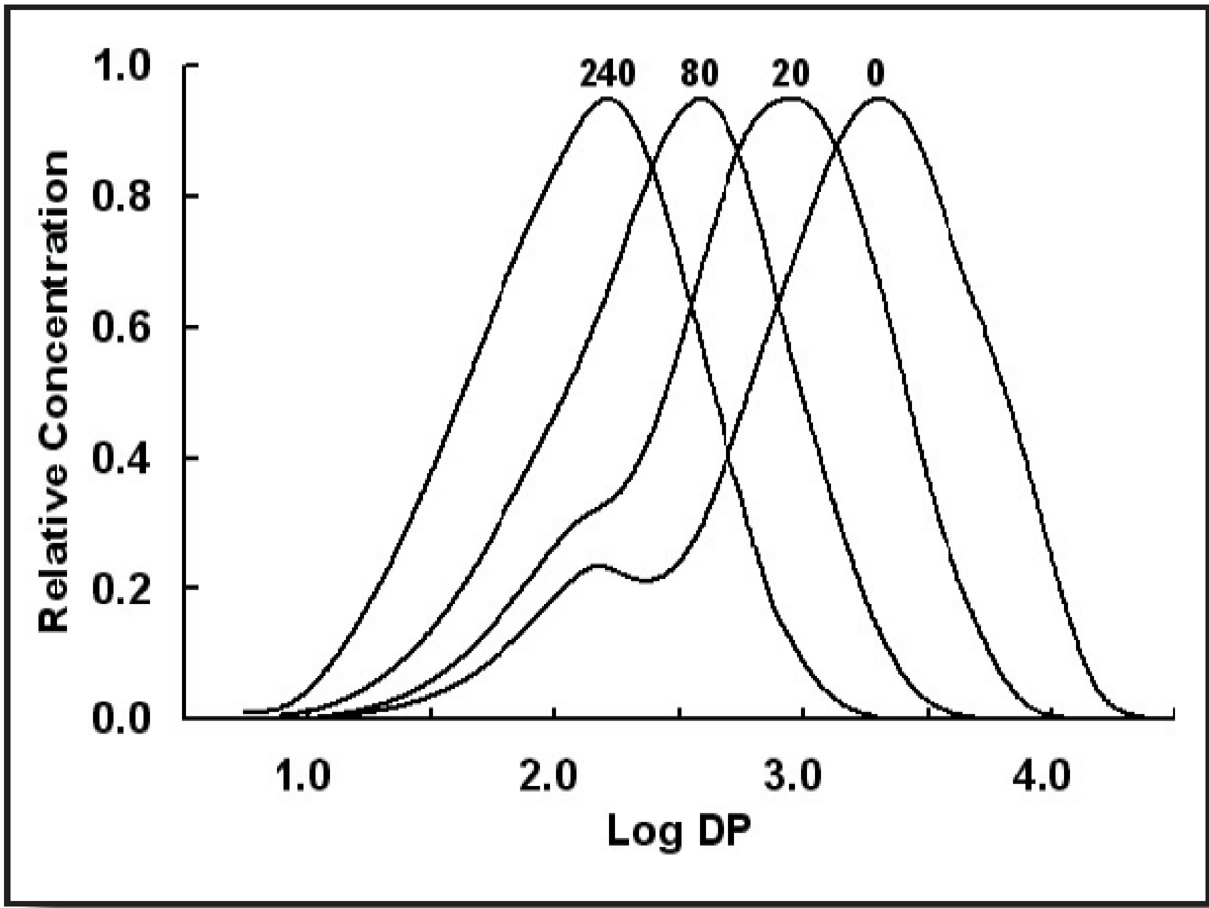
Pretreatments of biomass

- Enhance the enzymatic hydrolysis of cellulose and hemicelluloses in biomass
- By physical, chemical, biological and combination of process
- Minimum generation of fermentation inhibitors

Application of E-beam irradiation

- Crosslinking and chain scission
- Sterilization
- Curing of composite material
- Electron beam lithography

Impact of Electron beam irradiation on cotton cellulose (Bouchard et al. 2006, cellulose)



Experimental-1

Raw Material: hybrid poplar (Populus alba xP. Glandulosa)

Electron Beam Irradiation: 0, 150kGy, 300kGy, 450 kGy levels

5m/min, 13.9mA, 2.5 MeV expose→ 30kGy

Experimental-2

- Enzymatic Saccharification
  - Biomass 2.5g +170 ml (sodium acetate buffer, pH= 4.7), 50oC, shaking incubator
  - Celluclast 1.5L, Novozym 342
- Sugar analysis
  - RI detector, Aminex HPX-87 column for enzymatic saccharified sugar
  - NMR for carbohydrate compositional analysis

Table 1. The effects of electron beam irradiation on the alkaline extraction of hybrid poplar woodmeal

Irradiation Dose	Alkaline extraction (%)	Polyscchariides (%)	Lignin (%)
0 kGy	23	61.6	15.4
150 kGy	26.4	58.4	15.2
300 kGy	30.5	55.1	14.4
450 kGy	33.8	53.8	12.4

Fig. 1. ^{1}H-NMR spectra of electron beam irradiated hybrid poplar after 0.5%-sodium hydroxide aqueous solution extraction.

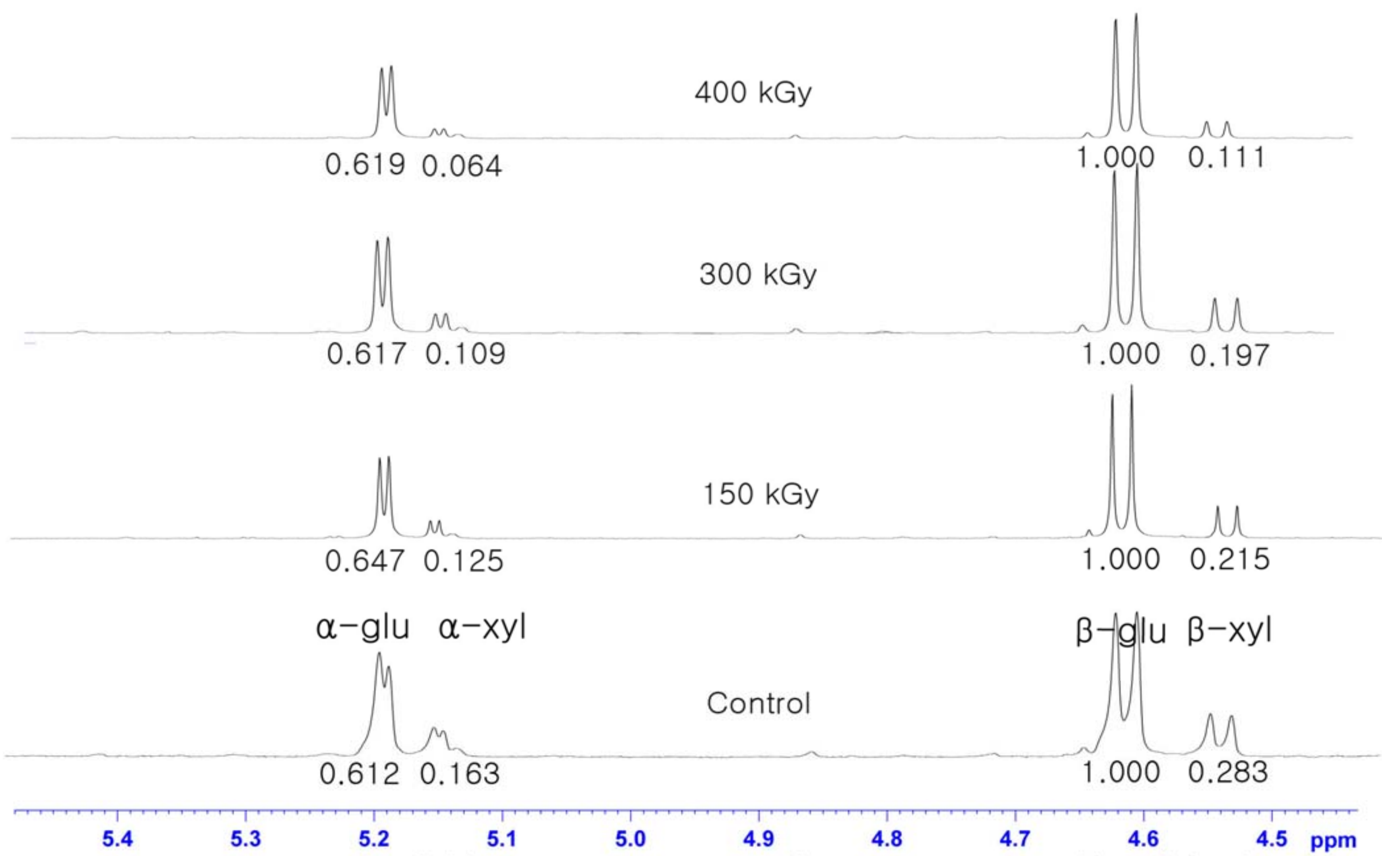


Table 2. The compositional changes in polysaccharides by electron beam irradiation after 0.5%-sodium hydroxide aqueous solution extraction.

Irradiation dose (kGy)	NMR peak areas		Polysaccharide composition (%)		
	glucose	xylose	Holocellulose	cellulose	xylan
0	1.612	0.446	61.6	39.5	22.1
150	1.647	0.340	58.4	41.3	17.1
300	1.613	0.302	55.1	39.9	15.2
450	1.619	0.175	53.8	44.2	9.6

Fig 2. Crystallinity by x-diffraction

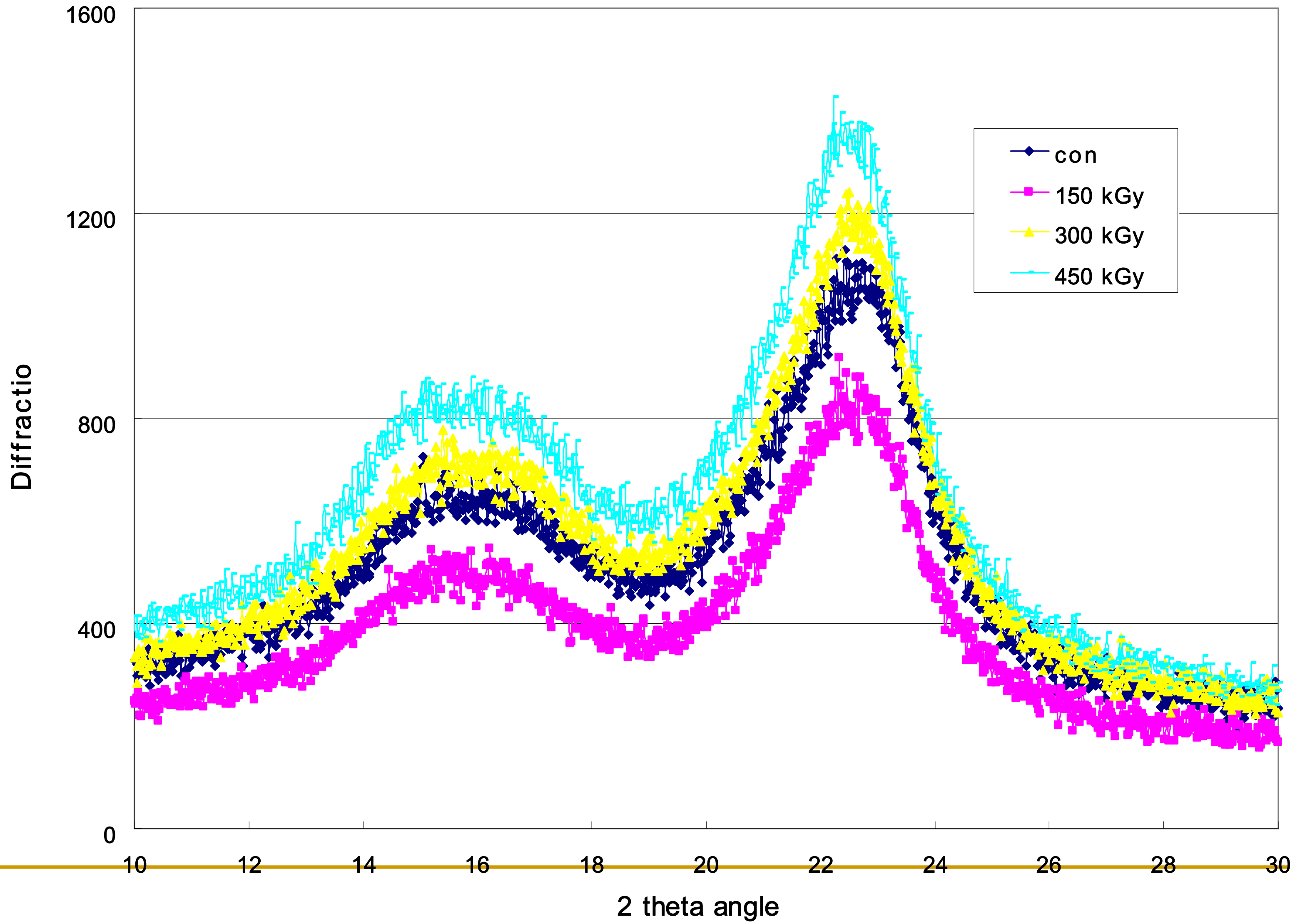


Fig. 3. The effects of irradiation dose on glucose conversion as a function of enzymatic hydrolysis time.

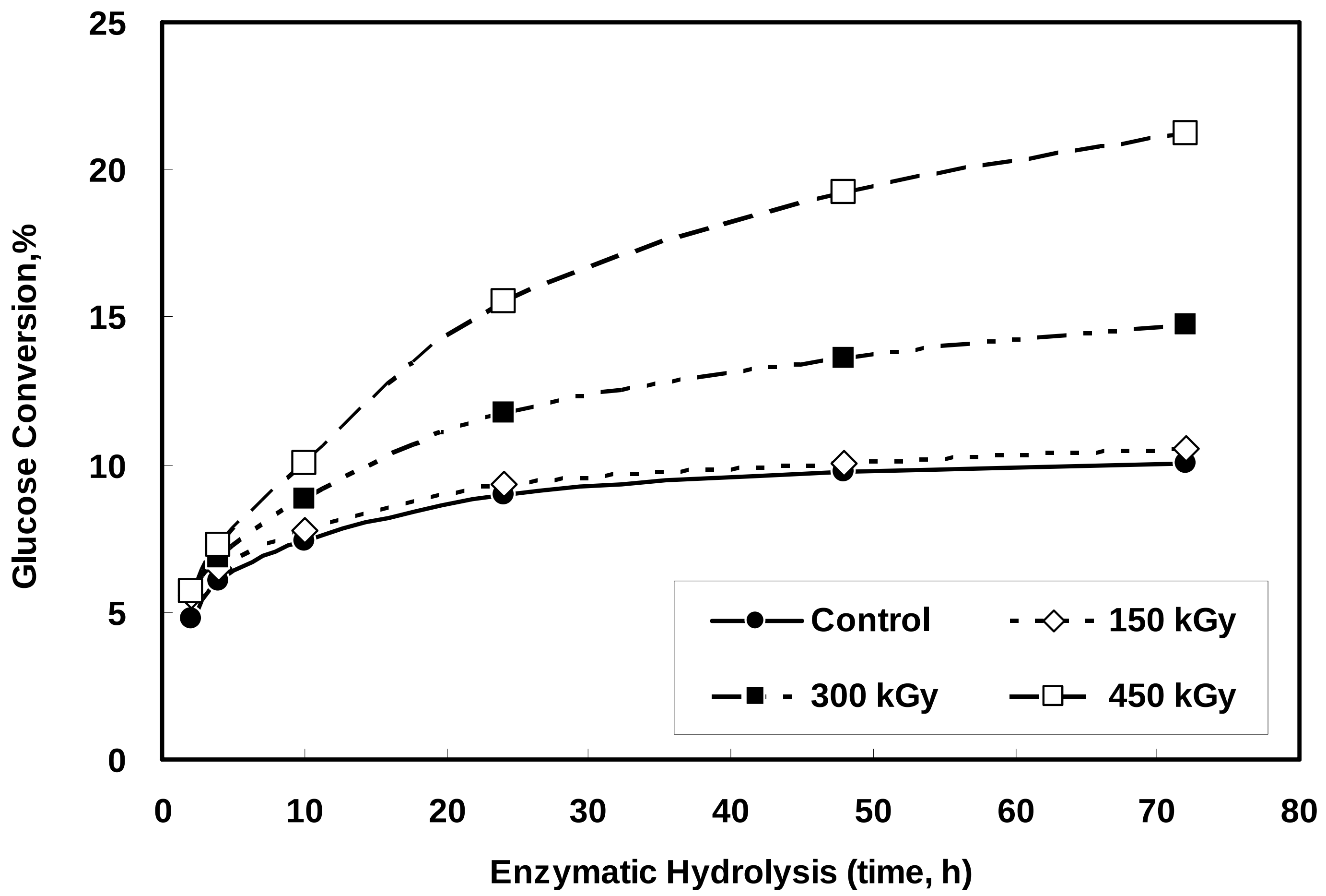
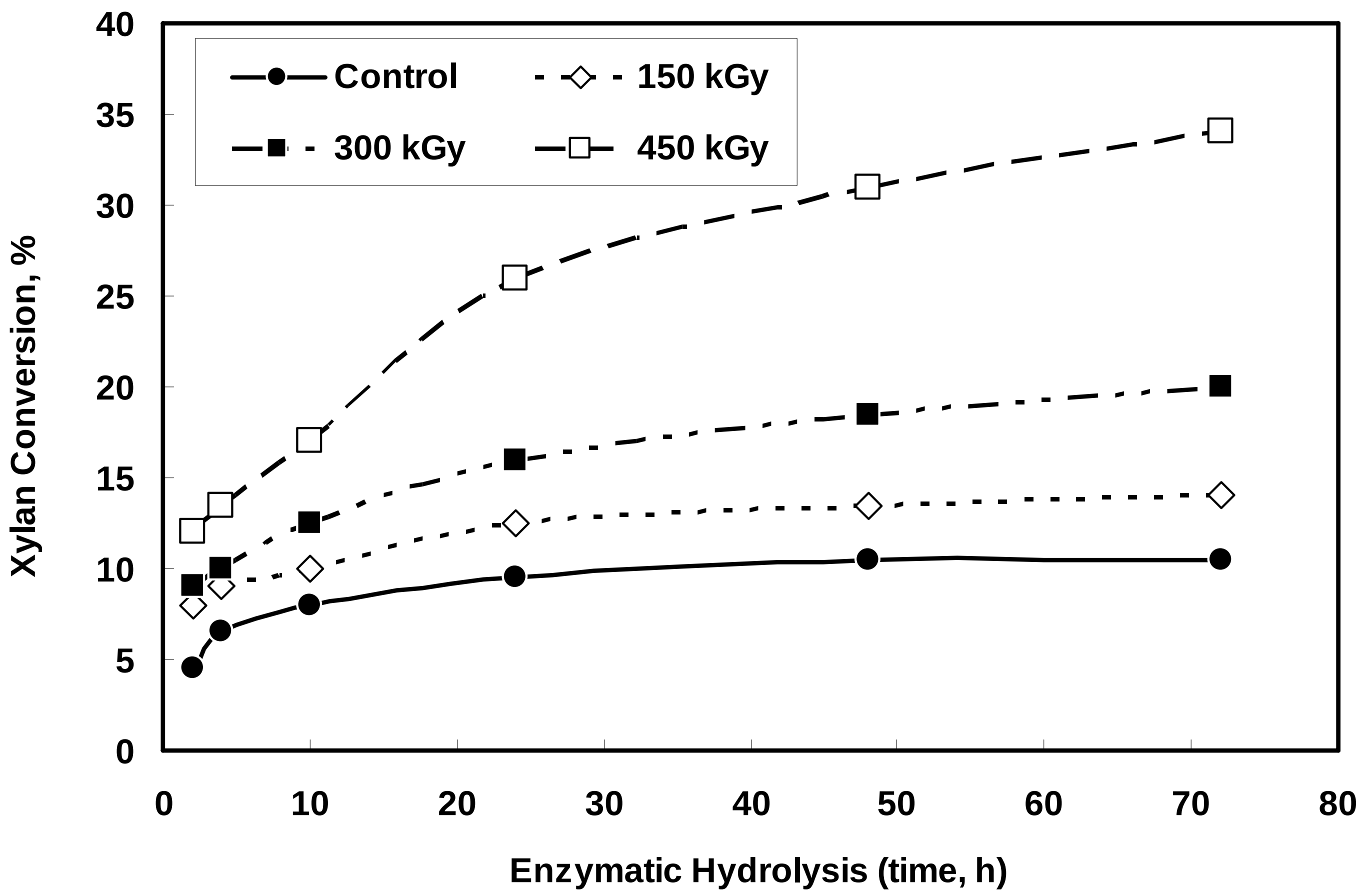


Fig. 4. The effects of irradiation dose on xylose conversion as a function of enzymatic hydrolysis time.



Conclusions

- More sensitive in xylan than cellulose
- Scissoring in carbohydrate and lignin
- Random cleavage between crystalline and paracrystalline in cellulose
- E-beam irradiation → led to more saccahrification in xylan and cellulose


http://jaekodog.tistory.com