

1. RAW MATERIAL

Coconut Husk
(milled powder)



Raw Coconut Husk (per g dry biomass)

- Total carbohydrate content: **450 mg g⁻¹**
- Acid-insoluble lignin: **46.41 %**
- Water extractives: 9.88 %
- Ethanol extractives: 1.32 %
- Ash: 2.84 %

Alkaline delignification

1% (w/v) NaOH,
70 °C, 2 h, 3 cycles

Acid pretreatment

2% (w/v) H₂SO₄,
121 °C, 45 min

Bleaching

2% NaClO₂ + 2% CH₃COOH,
80 °C, 2 h, 2 cycles

Washing to neutral pH
and drying (60 °C)



Pretreated Biomass (per g dry biomass)

- Total carbohydrate content: **300 mg g⁻¹**
- Acid-insoluble lignin: **17.44 %**
- Water extractives: 0.96 %
- Ethanol extractives: 1.93 %
- Ash: 2.33 %

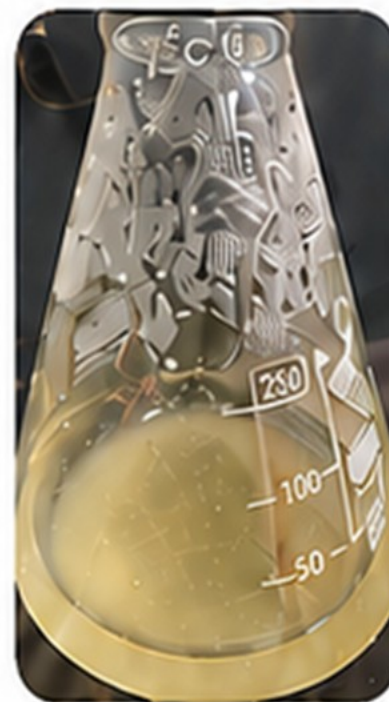
Changes after pretreatment (per g dry biomass)

- Carbohydrate content: **300 mg g⁻¹**
(66.7% of initial)
- Lignin content decreased by **62.4%**

2. PRETREATMENT

3. ENZYMATIC HYDROLYSIS

- Solid loading: 2% (w/v)
- Substrate: 1 g pretreated biomass
- Buffer: 100 mL citrate buffer (pH 4.8)
- Enzyme loading:
5 FPU g⁻¹ Cellulase +
150 U g⁻¹ Hemicellulase
- Temperature: 50 °C
- Agitation: 150 rpm
- Hydrolysis time: 72 h



Hydrolysate (per g original dry biomass)

- Glucose: **230 mg g⁻¹**

4. FERMENTATION

by *Zymomonas mobilis*

- Inoculum: *Zymomonas mobilis*
- pH: 6.0 (controlled)
- Temperature: 30 °C
- Agitation: 200 rpm
- Anaerobic (5% CO₂, N₂ balance)
- Fermentation time: 72 h



Fermentation Broth (per g original dry biomass)

- Ethanol: **97.5 mg g⁻¹**

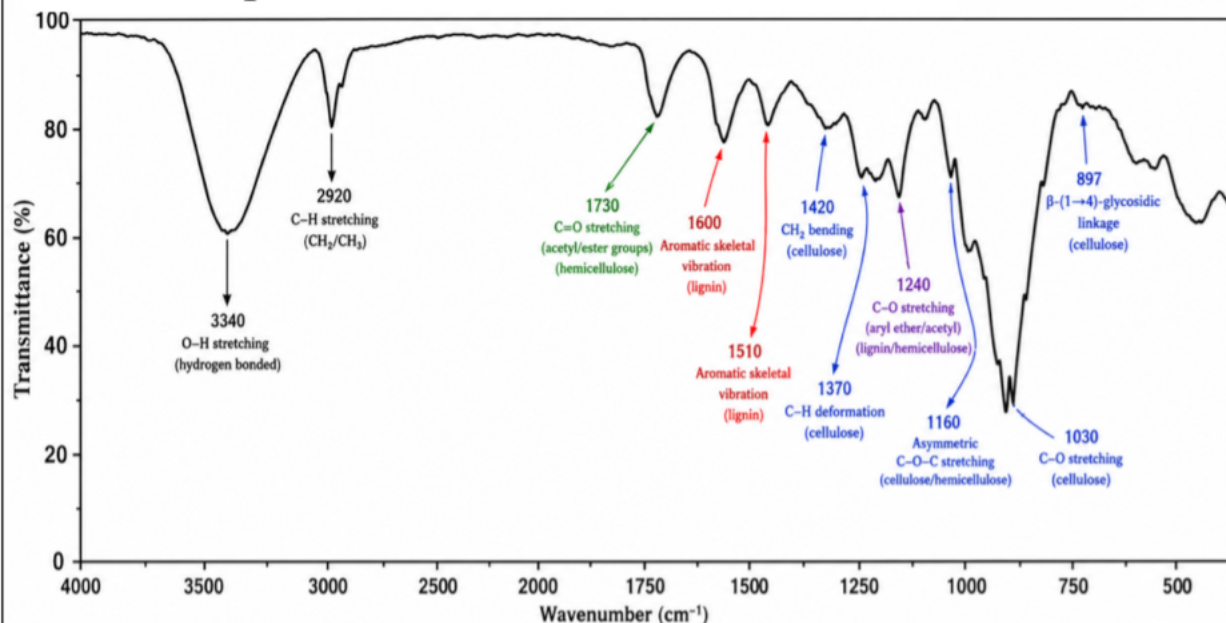
Ethanol conversion (based on glucose)

Ethanol produced: **97.5 mg g⁻¹**
Theoretical ethanol (glucose × 0.511): **117.5 mg g⁻¹**

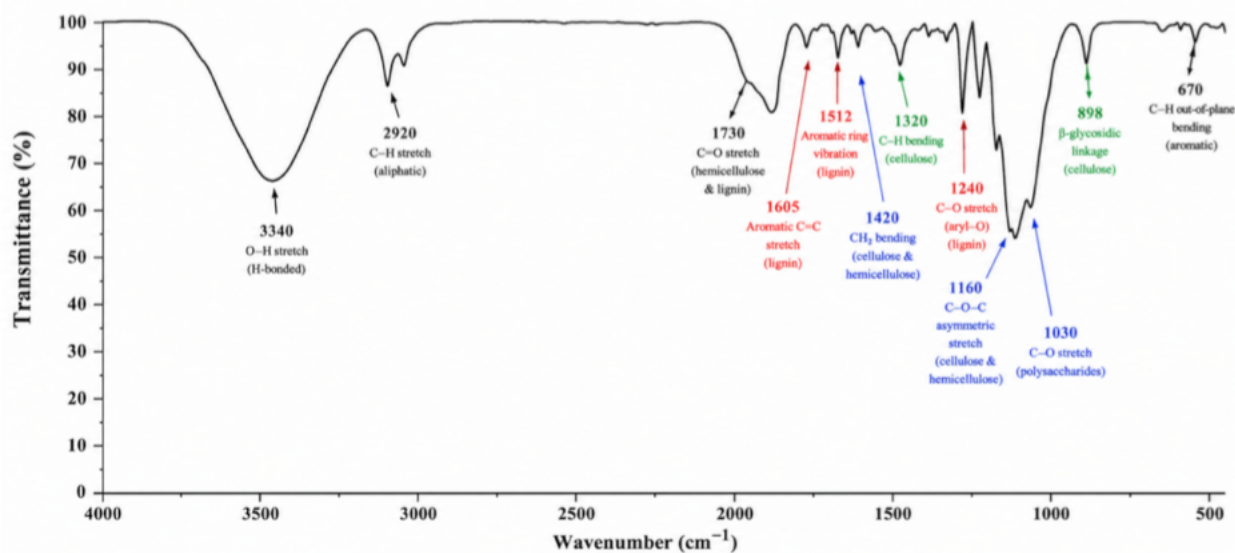
Glucose-to-ethanol conversion efficiency: 83%

Theoretical ethanol was calculated from glucose using the stoichiometric conversion factor of 0.511 g ethanol per g glucose.

A. FTIR Spectrum of untreated Coconut husk



B. FTIR Spectrum of Pretreated Coconut husk



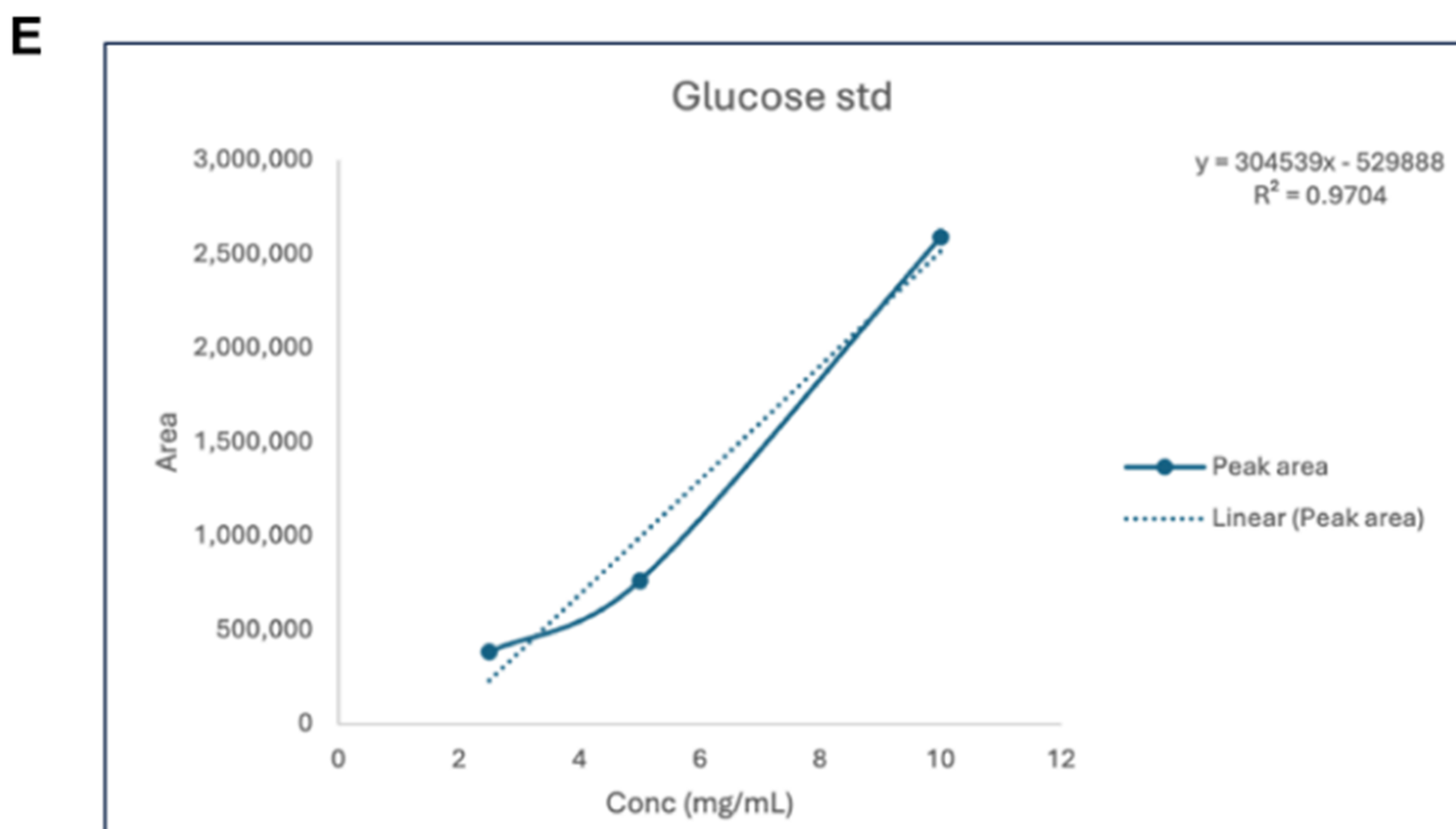
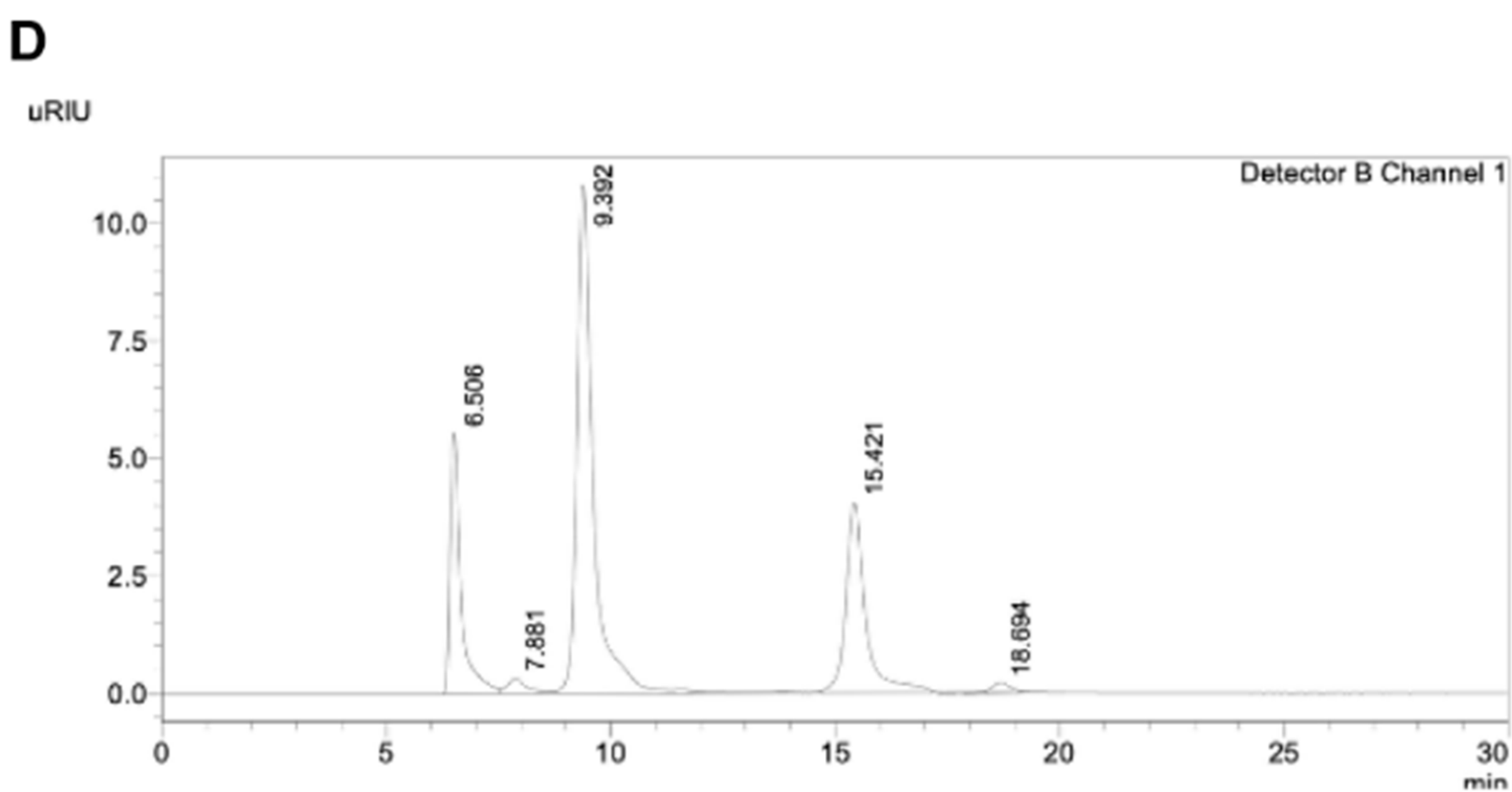
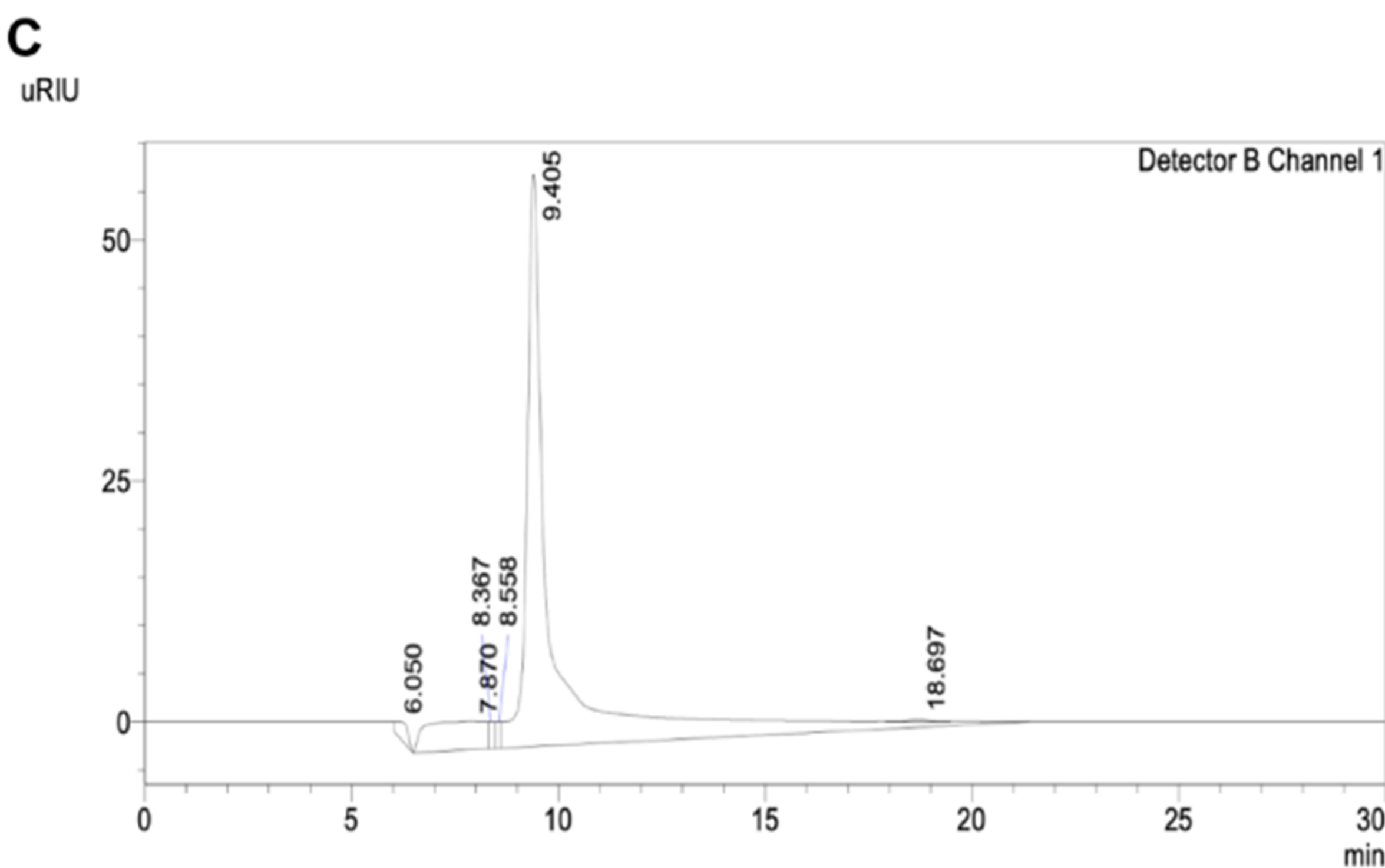
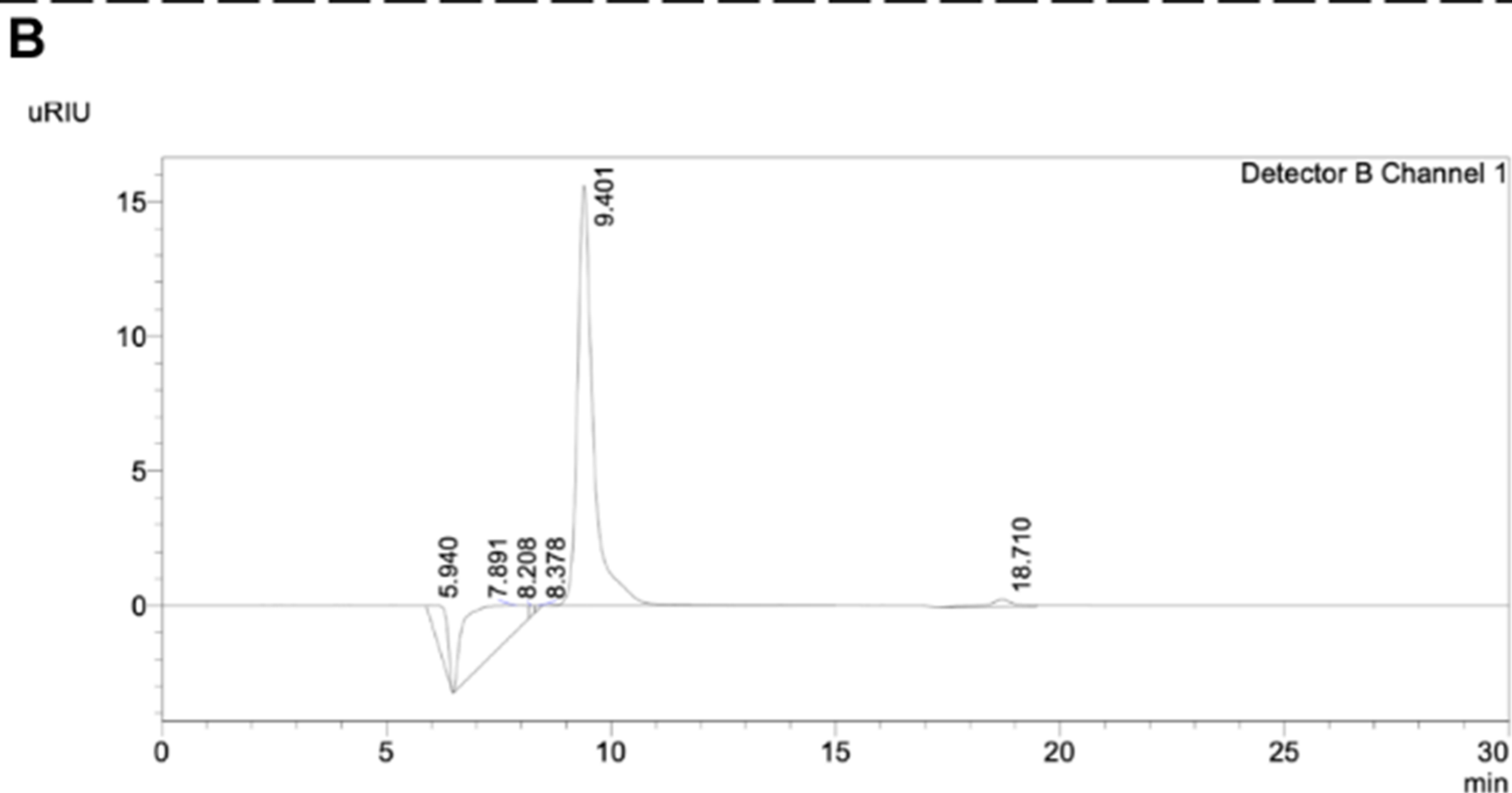
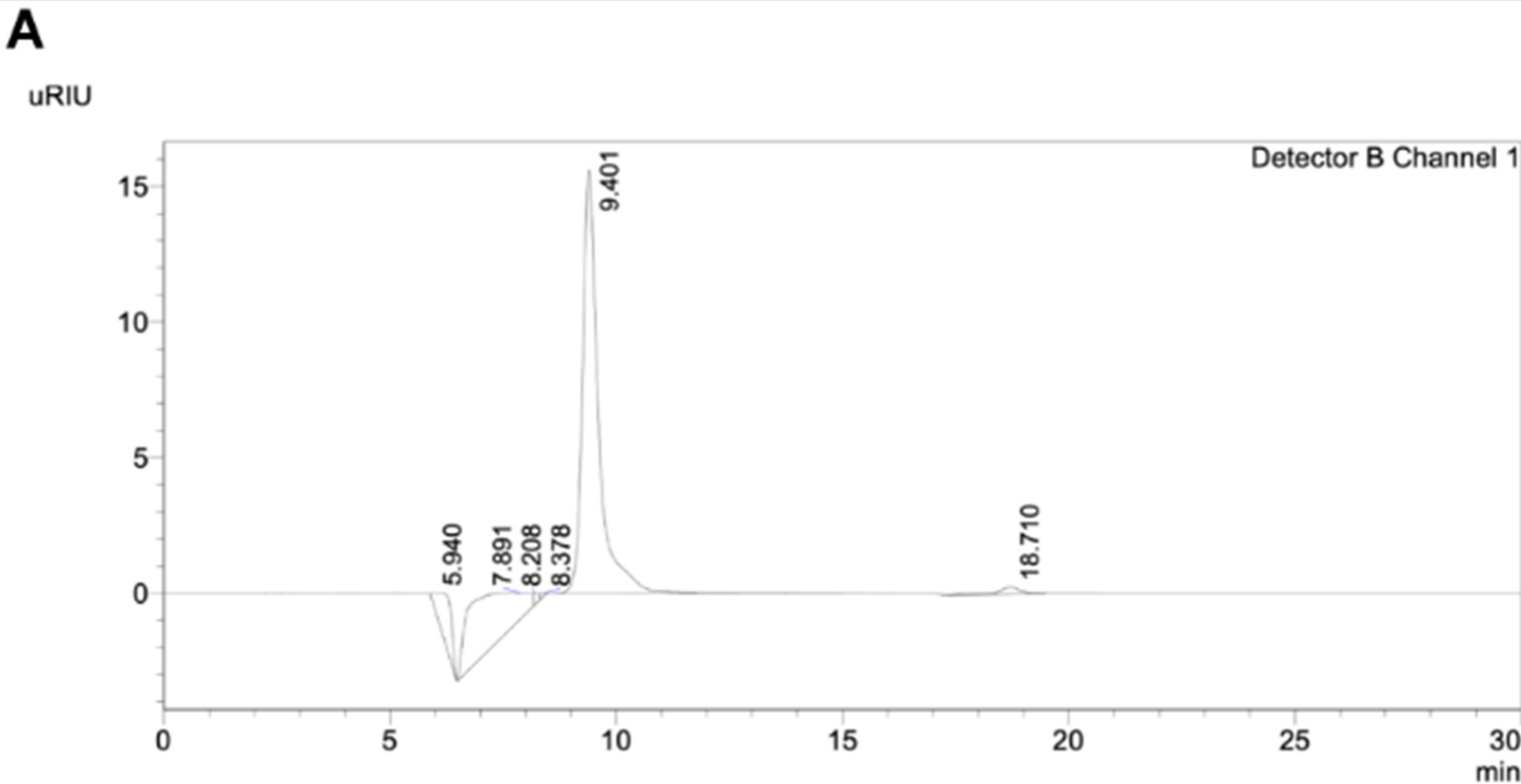
— Common functional groups

— Hemicellulose

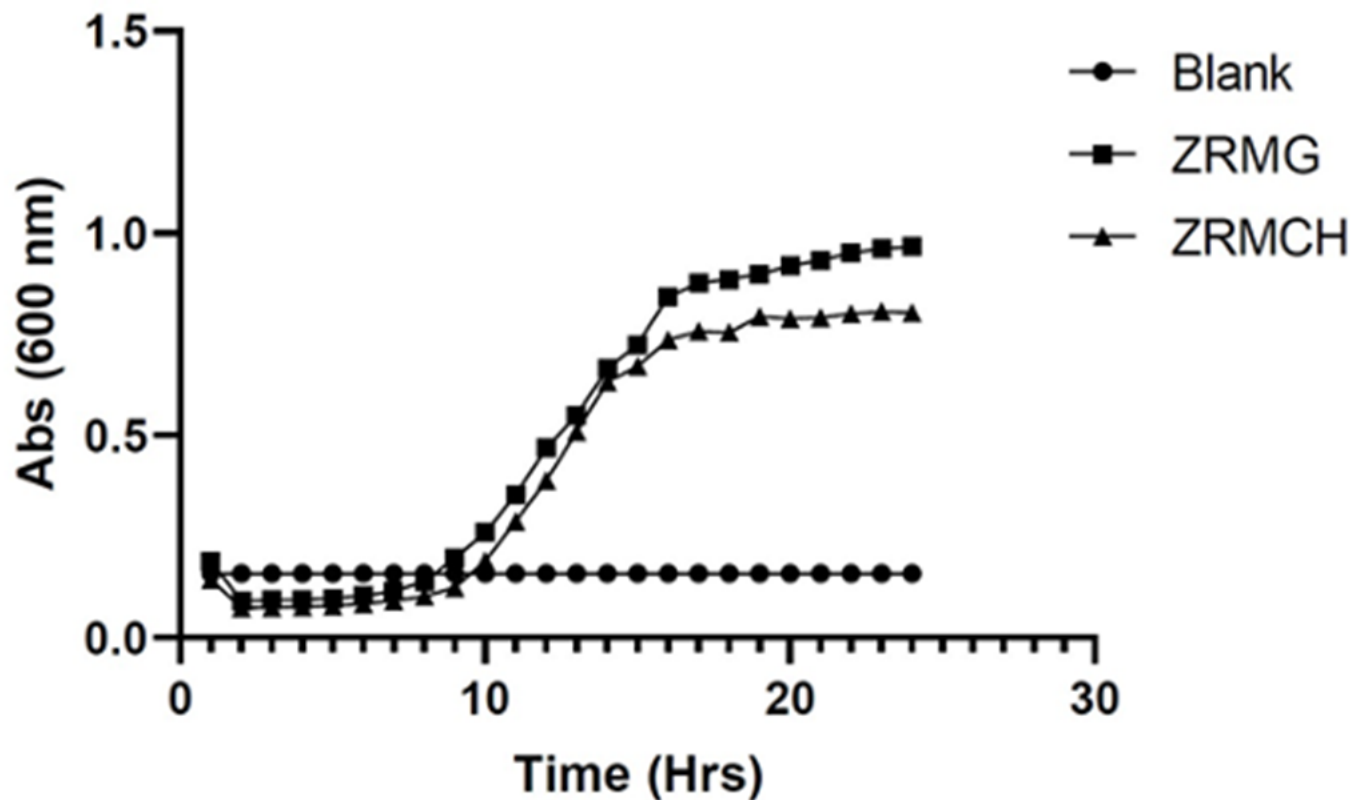
— Lignin

— Cellulose

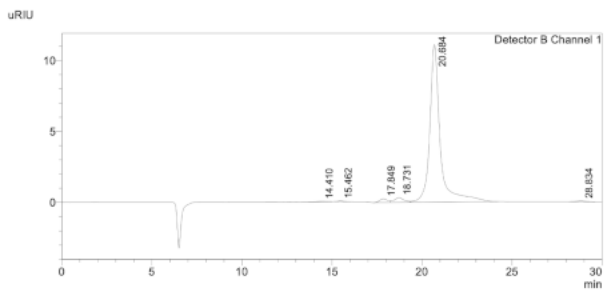
— Lignin/Hemicellulose



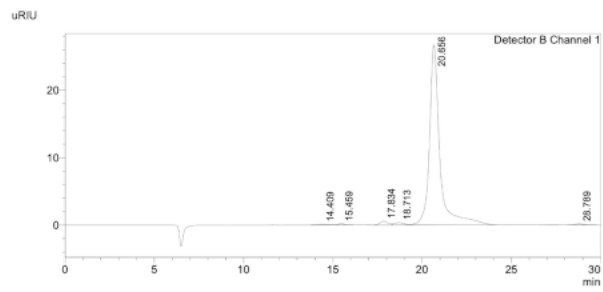
Growth of Zm4 in glucose & Hydrolysate



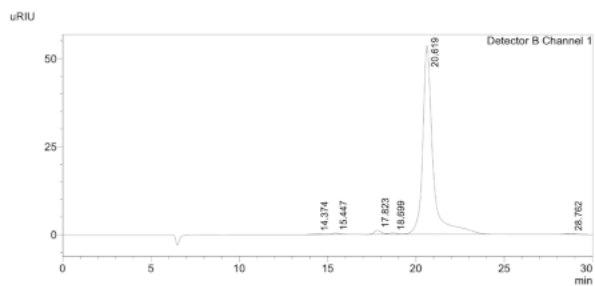
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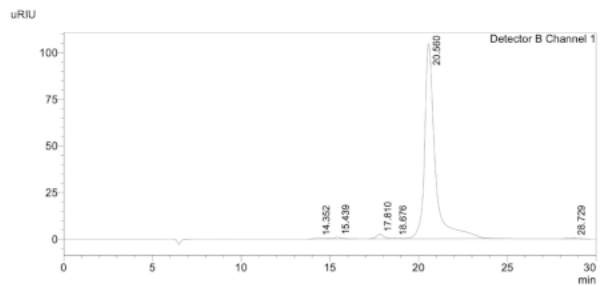
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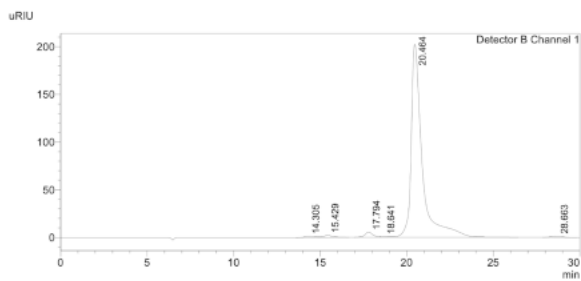
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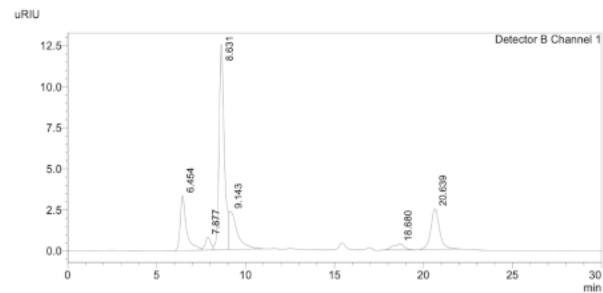
D



E



F



G

