Bumitama Gunajaya Agro

Institut Teknologi Sepuluh Nopember

NANO CHITOSAN OLIGOSACCHARIDE SEBAGAI BIOCONTROL ORGANIC UNTUK MENINGKATKAN KUALITAS TANAMAN DAN PRODUKTIVITAS TANAMAN SAWIT

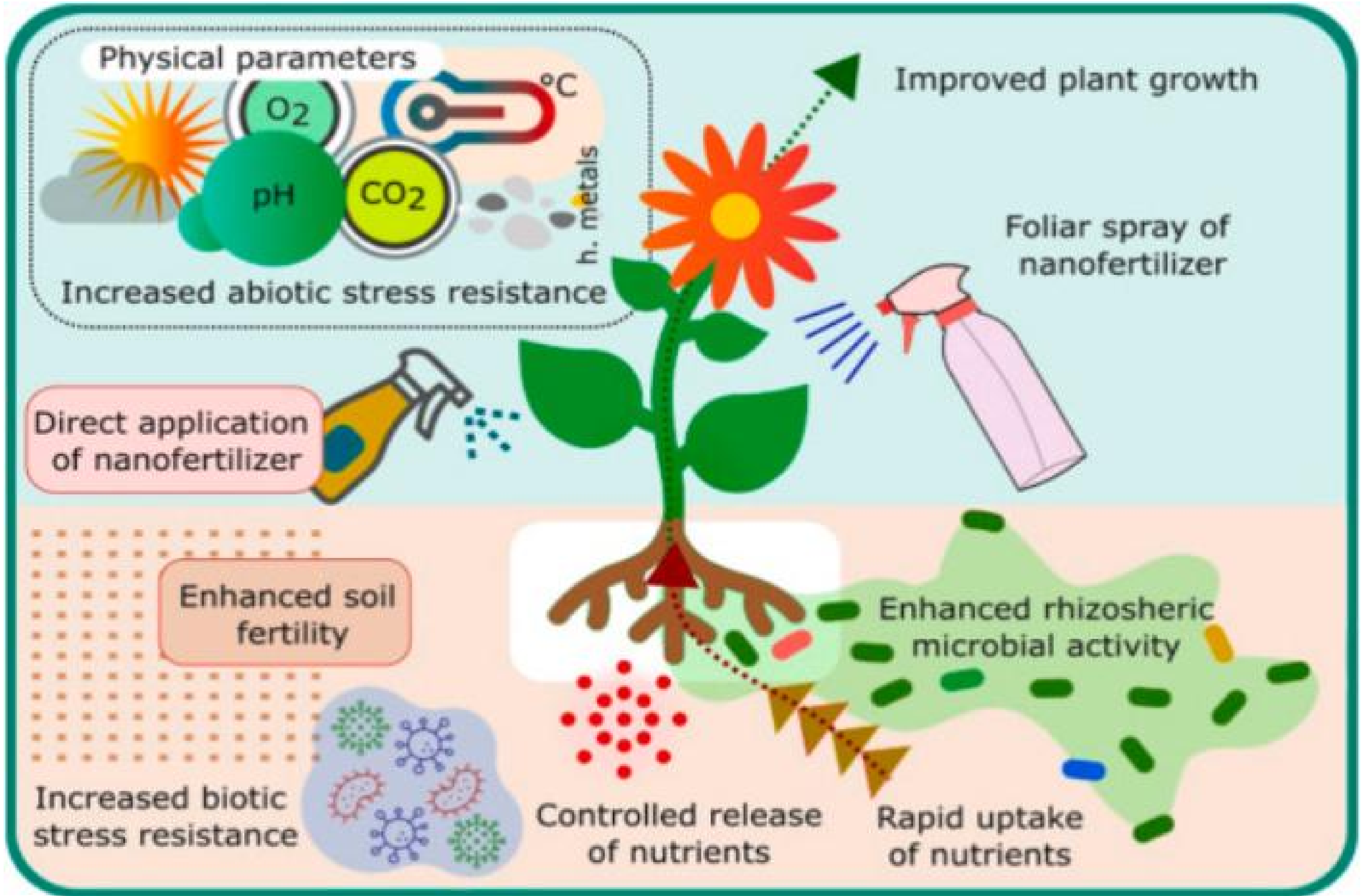
Oleh
Yuli Setiyorini, ST., MPhil., PhD. Eng.
Prof. Sungging Pintowantoro, ST., MT., PhD. Eng.
Vania Mitha Pratiwi, ST., MT.

TUJUAN PROJECT

1. Kemandirian dalam memproduksi nano chitosan oligosaccharide (nano COS) sebagai biocontrol untuk agriculture sawit
2. Mengurangi penggunaan bahan baku kimia sintesis di agriculture sawit
3. Menjawab tantangan yang sedangn di hadapi oleh BGA:

- Vitamin atau stimulant untuk mencegah tanaman
- Teknologi untuk pupuk khusus
- Memaksimalkan serapan hara dengan biostimulan
- Memaksimalkan fruitset dengan fitihormon

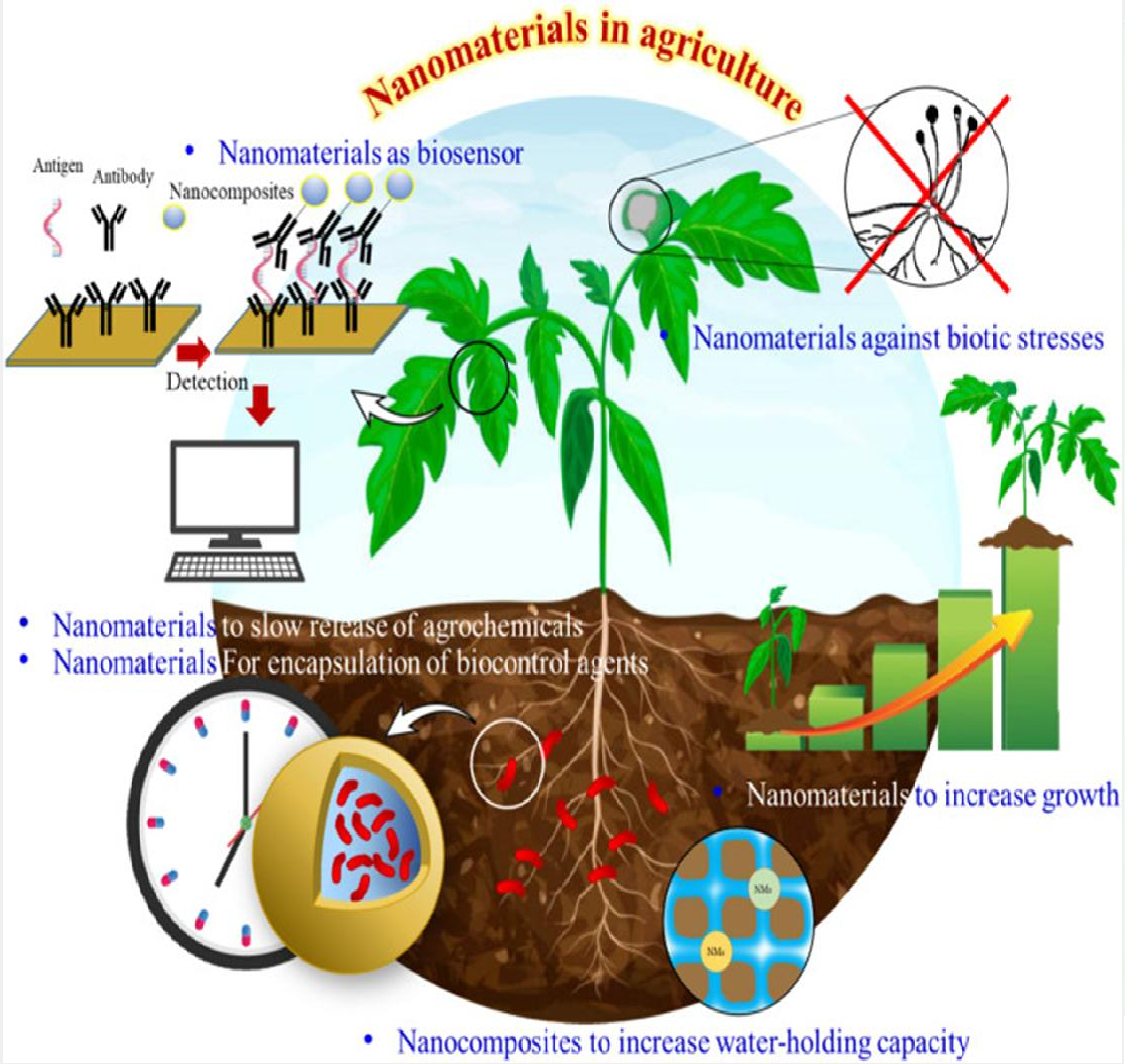
nano chitosan oligosaccharide (**nano COS**)

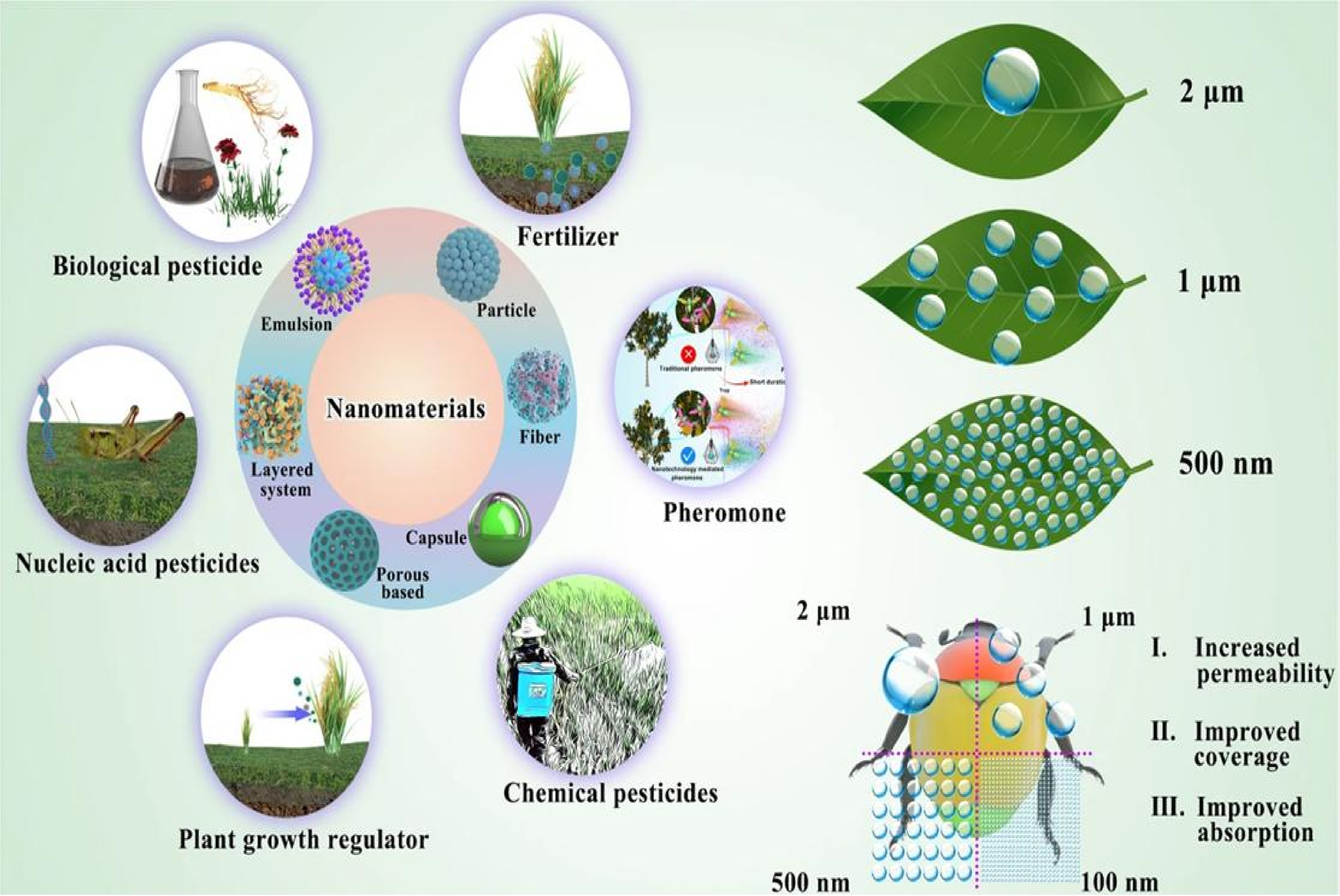


JUSTIFIKASI RISET/PROJECT

Hasil - hasil Riset/Project sebelumnya yang dilakukan orang lain dan posisi kita di depan melakukan Riset/Project seperti apa.

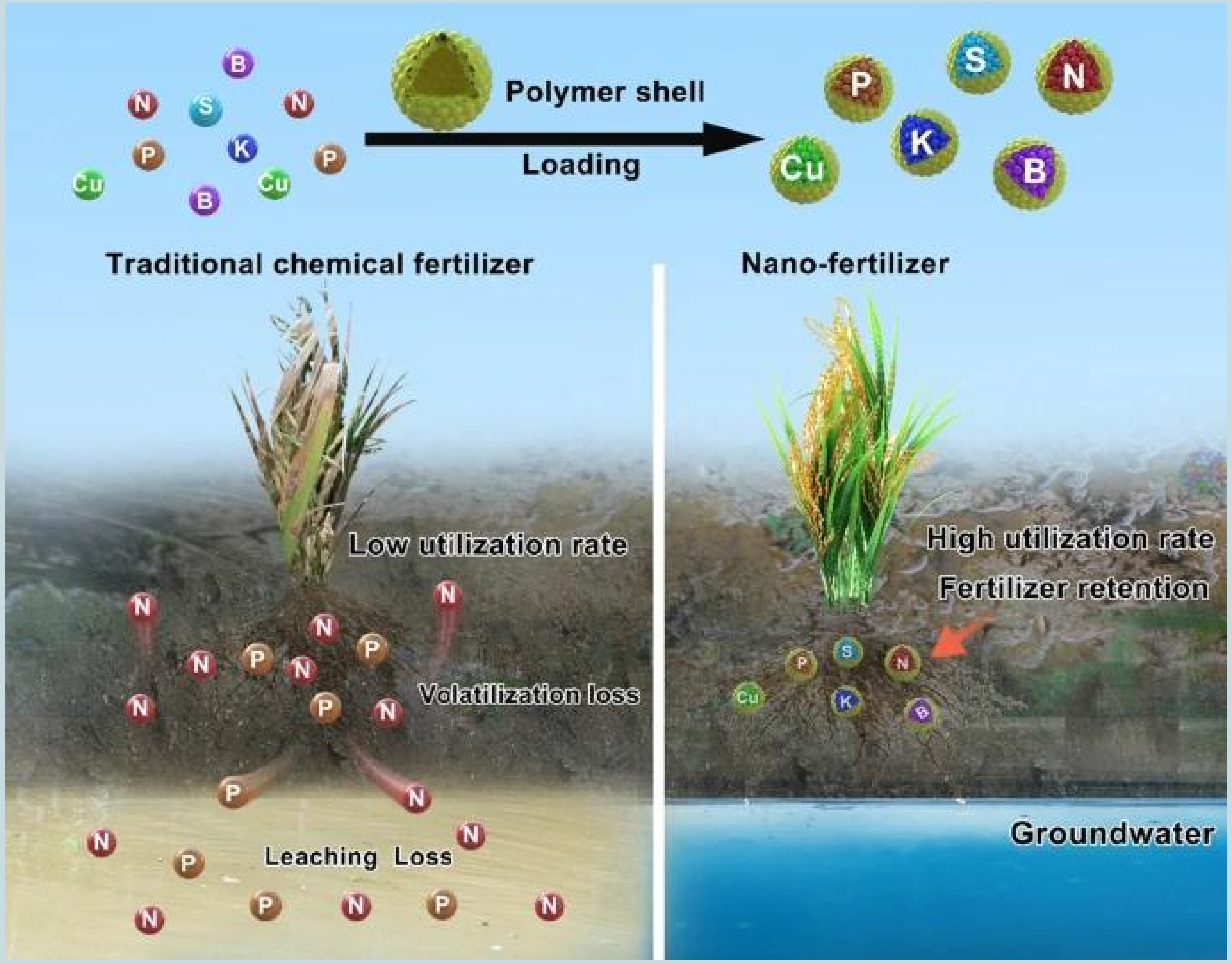
NANO MATERIAL IN AGRICULTURE



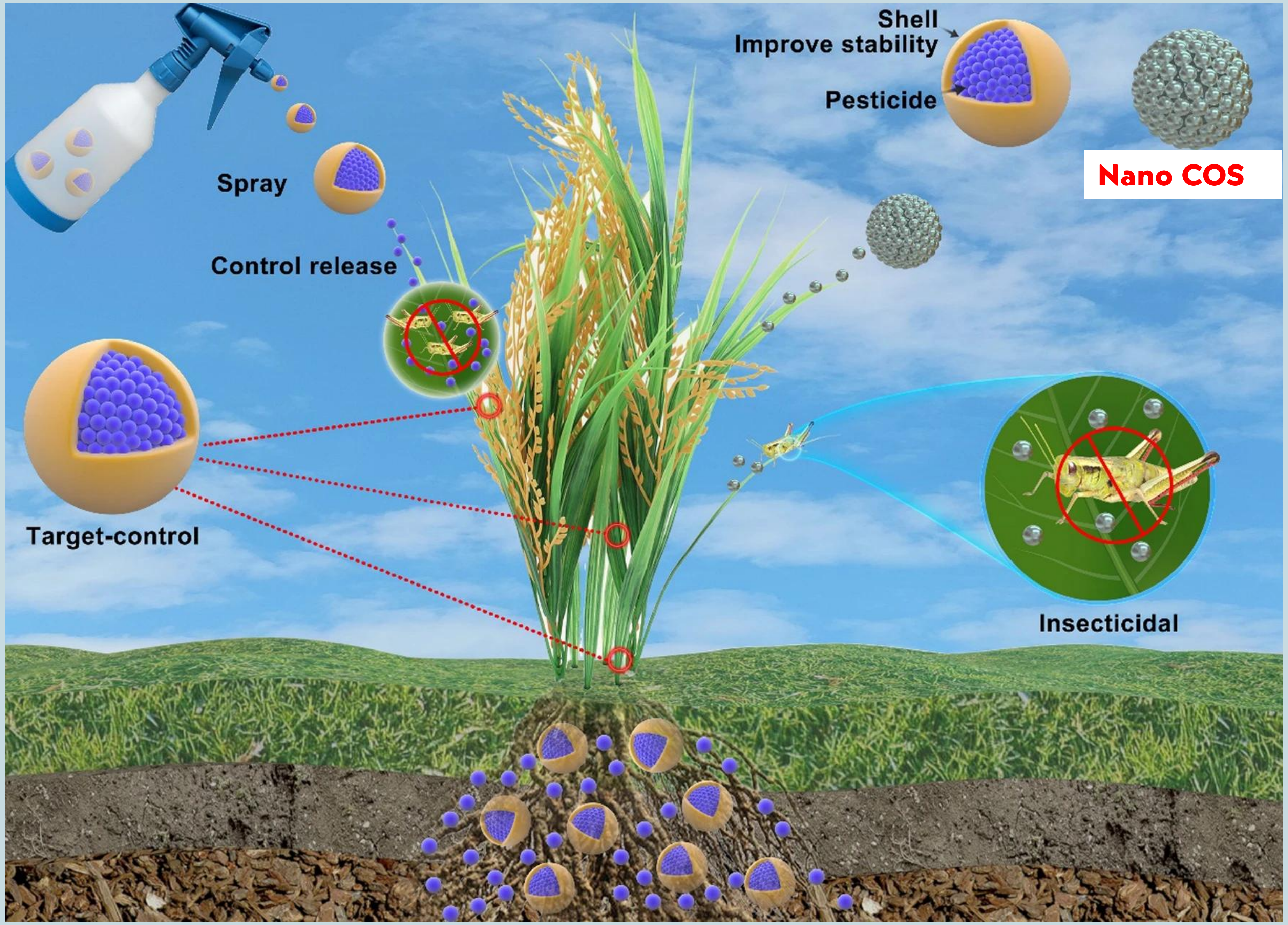


Nanomaterials loaded with various agrochemicals. Multiple release modes of active ingredients by modulating the structure of the loading system. The small size effect and large specific surface area of nanoparticles can adhere to the target as much as possible to improve the bioavailability of active ingredients

NANO MATERIAL FOR AGROCHEMICAL

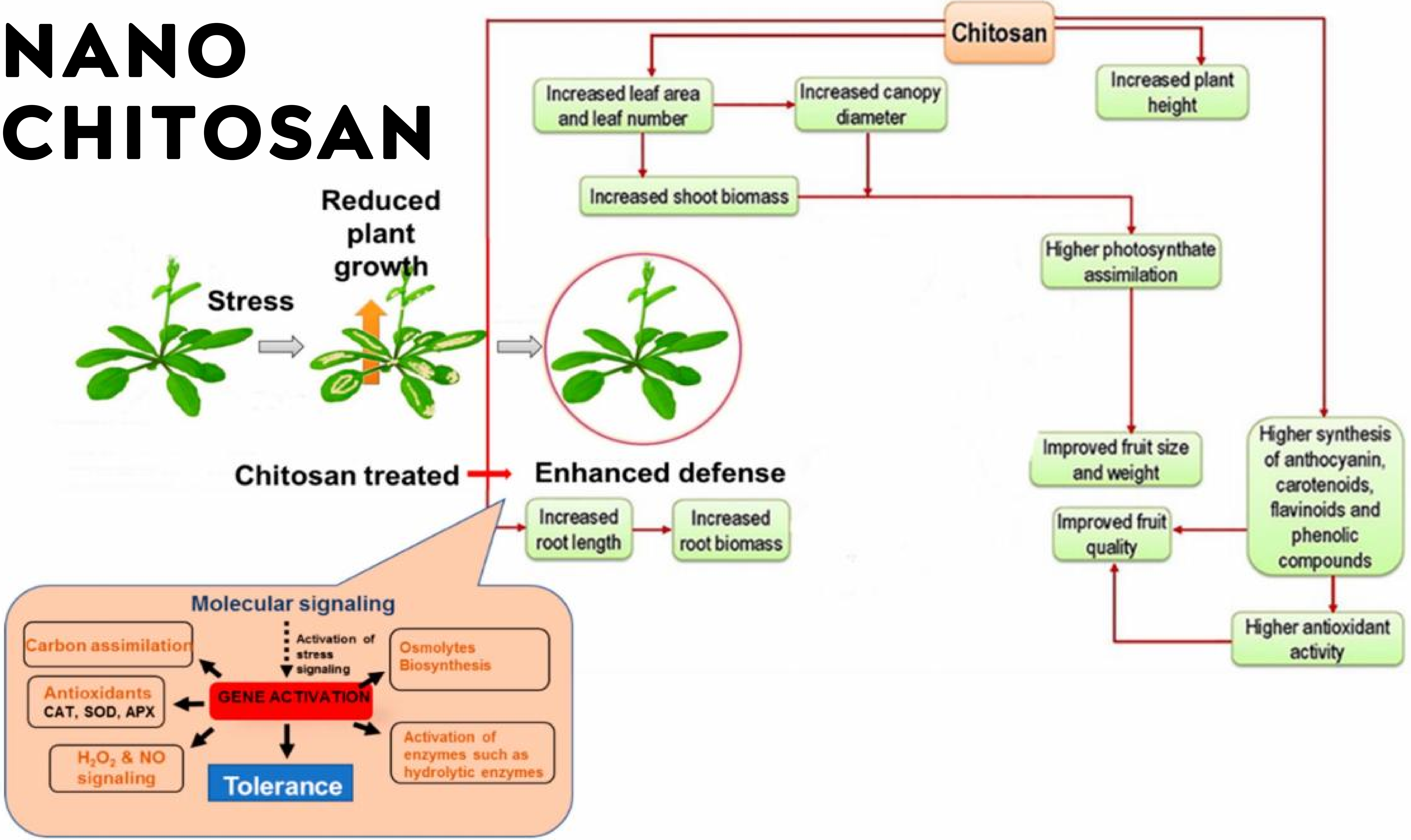


NANOMATERIALS LOADED WITH FERTILIZERS

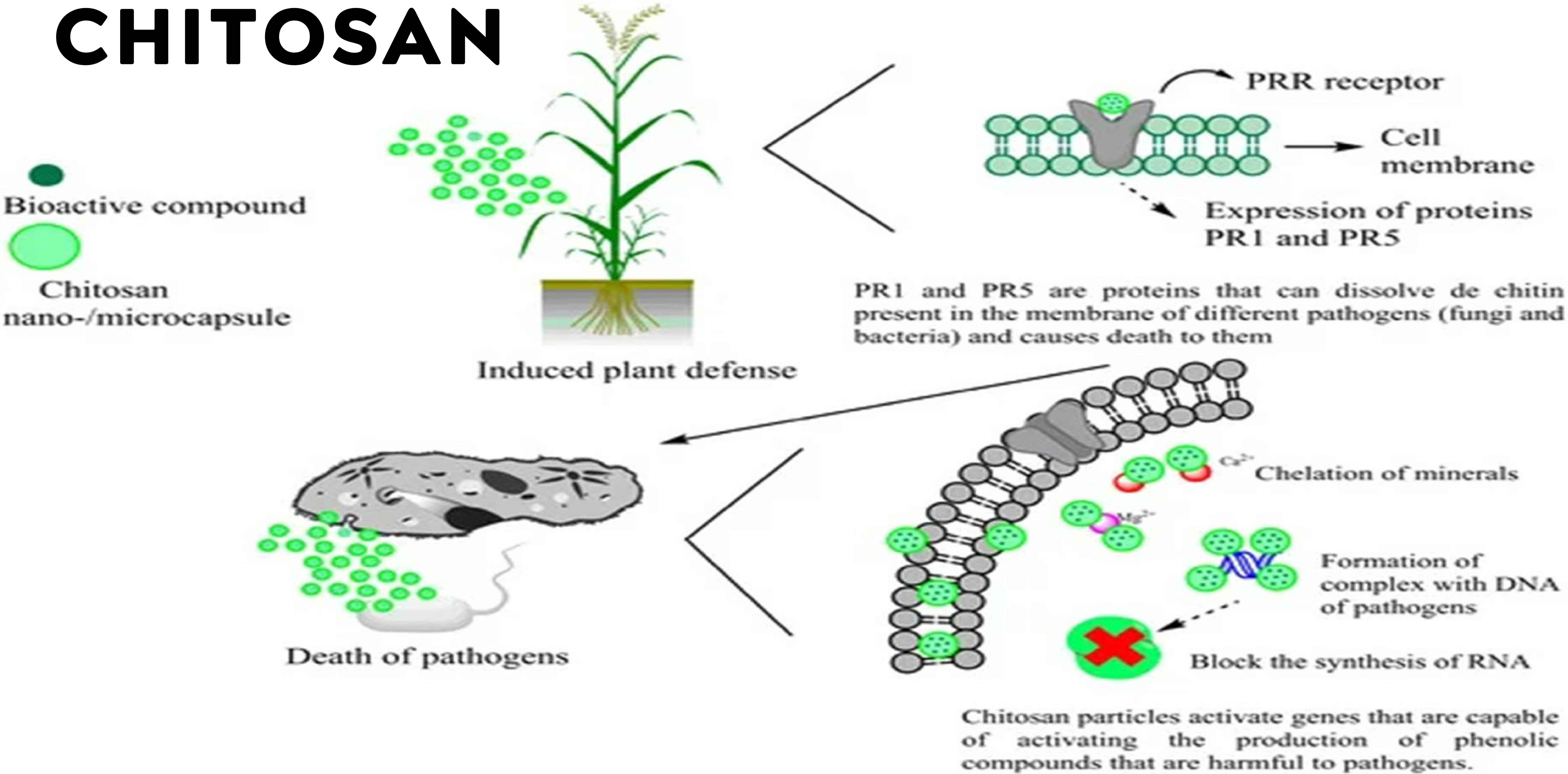


NANOMATERIALS LOADED WITH PESTICIDES

NANO CHITOSAN



NANO CHITOSAN



PROPERTIES PRODUK NANO CHITOSAN OLIGOSACCHARIDE (NANO COS)

di lab. Pengolahan mineral dan material its surabaya

Source	Number Average Molecular Weight (Mn)	Weight Average Molecular Weight (Mw) Dalton (Da)
Rajungan (crab shell)	267	385
Udang (Prawn waste)	289	449

Detail properties nano COS ditunjukkan pada lampiran

BIG PICTURE RISET/PROJECT

Milestone dan skala Riset/Projectnya apa bisa dilakukan terus -menerus (multiyears, contoh produk kapan bisa diimplementasikan se BGA dan tahun berapa.

- Skala riset/project di tahun pertama adalah experiment berupa parameter-parameter seperti type nano COS (amide dan amine), konsentrasi nano COS sebagai bio control, effect kombinasi (dengan fertilizer, pestiside, fungiside, growth factor) terhadap respon tanaman sawit dari bibit hingga sawit.

- Kesuksesan hasil di tahun pertama ini akan memberikian informasi pengembangan biocontrol nano COS untuk perkebunan sawit. Dan riset ini akan menghasilkan sustain proses yang dapat dilakukan secara terus menerus. Agar hasil dari riset ini bisa diimplementasikan pada se-BGA, maka hanya perlu meningkatkan kapasitas produksi biocontrol nano COS, sehingga meyongsong kemandirian dalam memperoduksi biocontrol tanaman sawit yang ramah lingkungan dan ramah tubuh.

GANTT CHART PELAKSANAAN

Rencana activity pelaksanaan Riset/Project ditampilkan secara d

No.	Aktivitas dalam 1 tahun
1.	Pembuatan nano chitosan oligosaccharide (nano COS) dalam skala lebih home industri
2.	Melakukan riset penggunaan nano COS pada treatment tanaman sawit, mulai dari bibit, hingga tanaman dewasa. Dengan mengamati parameter type nano COS, konsentrasi nano COS, effect combination (dengan fertilizer, pestiside, growth factor)
3.	Effect treatment akan diamati setiap time monitoring pada masing-masing group experiment

RAB RISET/PROJECT (BIAYA, MPP, ALAT DAN BAHAN)

No.	Jenis	Item	Harga satuan (Rp)	Harga total (Rp)
A	Bahan habis			
	Pembelian bahan limbah udang dan cangkang rajungan	1 paket	30.000.000	30.000.000
	Pembelian chemical untuk proses produksi nano COS	1 paket	7.000.000	7.000.000
B	Peralatan penunjang			
	Microwave untuk proses produksi nano COS	1 paket	350.000.000	350.000.000
	Pembuatan Evaporator	1 paket	15.000.000	15.000.000
	Crusher mesin	1 paket	7.000.000	7.000.000
	Sieving mesin	1 paket	7.000.000	7.000.000
C	Perjalanan			
	Pengambilan sampel	1 paket	10.000.000	10.000.000
	Pengamatan sampel experiment	1 paket	10.000.000	10.000.000
D	Jasa			
	Pengujian dan Analisis produk nano COS yang akan digunakan sebagai biocontrol	1 paket	40.000.000	40.000.000
	Experiment kinerja biocontrol pada tanaman sawit	1 paket	70.000.000	70.000.000
	TOTAL			546.000.000

DAMPAK RISET/PROJECT

Mengalisa dampak dari Riset/Project yang dilakukan baik secara financial dan non-financil secara rinci.

Finansial	Non-finansial
✓Dengan keberhasilan biocontrol, maka akan menghasilkan tanaman sawit dengan kualitas dan performa yang bagus sehingga dapat menjaga kualitas dan panen sawit dengan kualitas yang bagus	✓Penggunaan biocontrol nanoCOS yang merupakan bahan organic, maka akan mengggurangi kandungan kimia sintesis pada tanaman sawit, sehingga tanaman lebih sehat dan kualitas buah yang juga terjaga dari kimia sintesis, misal dari pestiside, fungiside, fertilizer kimia sintesis sehingga kualitas sawit lebih organic dan aman di konsusmsi bagi tubuh.
✓Kemandirian dalam mengembangkan biocontrol organic akan menambah sektor bisnis BGA, guna pemenuhan biocontrol bagi bisnis sawit BGA.	✓Mengurangi polusi kimia sintesis pada lingkungan yang biasanya berasal dari sintesis fertilizer, sintesis pestiside dan fungiside.
✓Dengan kemandirian, akan memotong rantai ketergantungan suplai fertilizer, pestiside, fungiside dan stimulant terutama masih menggunakan bahan baku import.	✓Menghasilkan tanaman sawit yang lebih tangguh dan tidak mudah stress yang di karenakan perubahan iklim global saat ini.

Bumitama Gunajaya Agro

THANK YOU

LAMPIRAN:

PROPERTIES NANO CHITOSAN OLIGOSACCHARIDE (NANO COS)

GPC (Gel Permeation Chromatography) Analysis

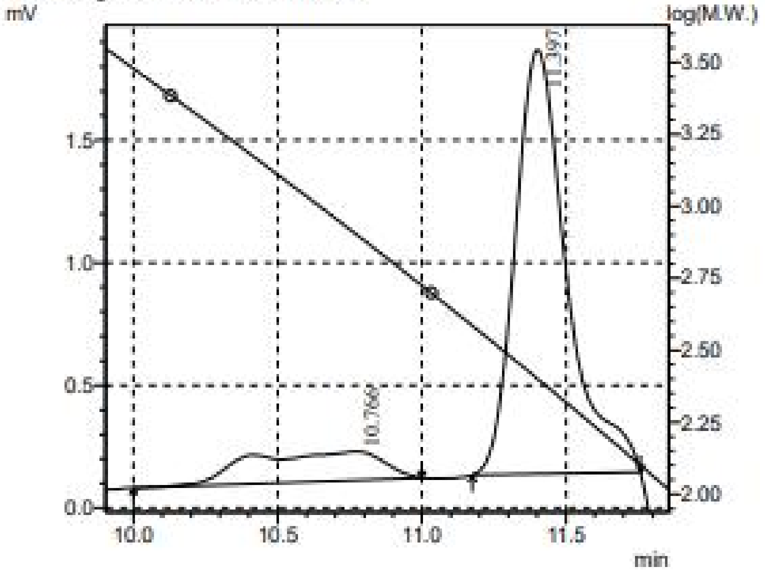
Source	Number Average Molecular Weight (Mn)	Weight Average Molecular Weight (Mw) Dalton (Da)
Rajungan (crab shell)	267	385
Udang (Prawn waste)	289	449

Crab waste

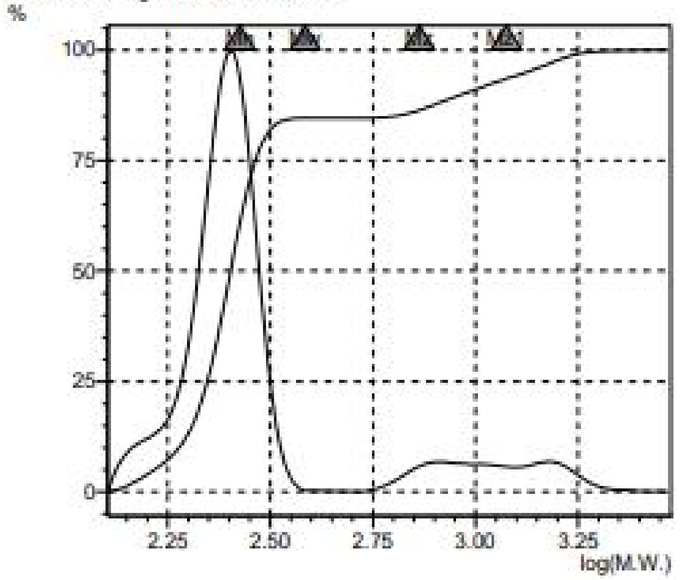
==== Shimadzu LabSolutions GPC Analysis Report ====

Acquired by	: System Administrator
Sample Name	: Chitosan Rajungan
Sample ID	: Chitosan Rajungan
Vail#	: 4
Injection Volume	: 20 uL
Data Filename	: Chitosan Rajungan.lcd
Method Filename	: GPC CALIB ok_160221.lcm
Batch Filename	: Batch 160221.lcb
Report Filename	: DEFAULT.lsr
Date Acquired	: 16/02/2021 14:31:14
Data Processed	: 16/02/2021 14:51:17

Chromatogram and Calibration Curve



Molecular Weight Distribution Curve



Peak Report

Detector A Channel 1

Peak#	Ret. Time	Area	Height	Area %	Height %
1	10.766	3916	117	15.369	6.354
2	11.397	21562	1730	84.631	93.646
Total		25478	1848	100.000	100.000

GPC Calculation Results

Peak#:1 (Detector A Channel 1)
[Peak Information]

	Time(min)	Volume(mL)	Molecular Weight	Height
Start	10.000	10.000	3009	81
Top	10.766	10.766	809	117
End	11.000	11.000	531	123

Area : 3916
Area% : 15.3691

[Average Molecular Weight]

Number Average Molecular Weight(Mn)	1047
Weight Average Molecular Weight(Mw)	1160
Z Average Molecular Weight(Mz)	1282
Z+1 Average Molecular Weight(Mz1)	1401
Mw/Mn	1.10791
Mv/Mn	0.00000
Mz/Mw	1.10459

Peak#:2 (Detector A Channel 1)
[Peak Information]

	Time(min)	Volume(mL)	Molecular Weight	Height
Start	11.175	11.175	385	134

	Time(min)	Volume(mL)	Molecular Weight	Height
Top	11.397	11.397	254	1730
End	11.758	11.758	126	146

Area : 21562
Area% : 84.6309

[Average Molecular Weight]

Number Average Molecular Weight(Mn)	235
Weight Average Molecular Weight(Mw)	244
Z Average Molecular Weight(Mz)	251
Z+1 Average Molecular Weight(Mz1)	258
Mw/Mn	1.03605
Mv/Mn	0.00000
Mz/Mw	1.03098

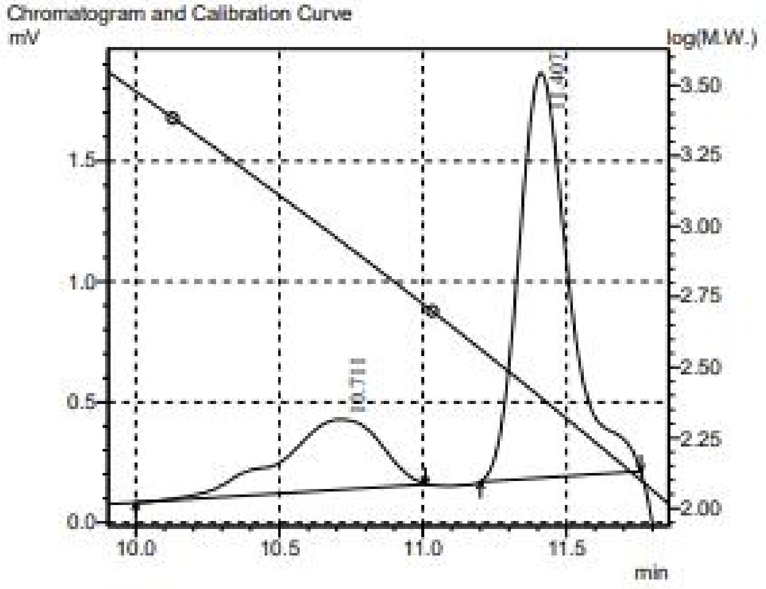
Detector A Channel 1
[Average Molecular Weight(Total)]

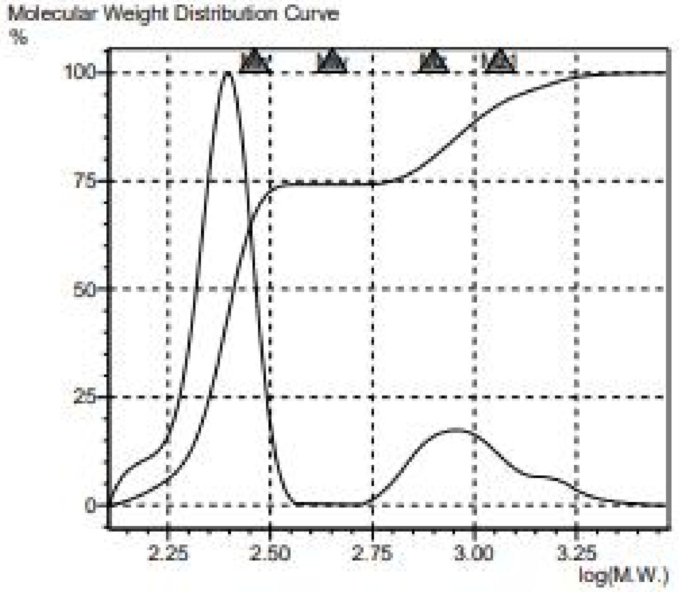
Number Average Molecular Weight(Mn)	267
Weight Average Molecular Weight(Mw)	385
Z Average Molecular Weight(Mz)	729
Z+1 Average Molecular Weight(Mz1)	1190
Mw/Mn	1.44044
Mv/Mn	0.00000
Mz/Mw	1.89642

Shrimp waste

==== Shimadzu LabSolutions GPC Analysis Report ====

Acquired by	: System Administrator
Sample Name	: Chitosan Udang
Sample ID	: Chitosan Udang
Vail#	: 3
Injection Volume	: 20 uL
Data Filename	: Chitosan Udang.lcd
Method Filename	: GPC CALIB ok_160221.lcm
Batch Filename	: Batch 160221.lcb
Report Filename	: DEFAULT.lsr
Date Acquired	: 16/02/2021 14:10:39
Data Processed	: 16/02/2021 14:30:42





Peak Report

Detector A Channel 1

Peak#	Ret. Time	Area	Height	Area %	Height %
1	10.711	7086	291	25.796	14.759
2	11.407	20384	1679	74.204	85.241
Total		27470	1970	100.000	100.000

GPC Calculation Results

Peak#:1 (Detector A Channel 1)
[Peak Information]

	Time(min)	Volume(mL)	Molecular Weight	Height
Start	10.000	10.000	3009	84
Top	10.711	10.711	891	291
End	11.008	11.008	523	160

Area : 7086
Area% : 25.7962

[Average Molecular Weight]

Number Average Molecular Weight(Mn)	960
Weight Average Molecular Weight(Mw)	1047
Z Average Molecular Weight(Mz)	1156
Z+1 Average Molecular Weight(Mz1)	1284
Mw/Mn	1.09129
Mv/Mn	0.00000
Mz/Mw	1.10399

Peak#:2 (Detector A Channel 1)
[Peak Information]

	Time(min)	Volume(mL)	Molecular Weight	Height
Start	11.200	11.200	367	169

	Time(min)	Volume(mL)	Molecular Weight	Height
Top	11.407	11.407	249	1679
End	11.758	11.758	126	214

Area : 20384
Area% : 74.2038

[Average Molecular Weight]

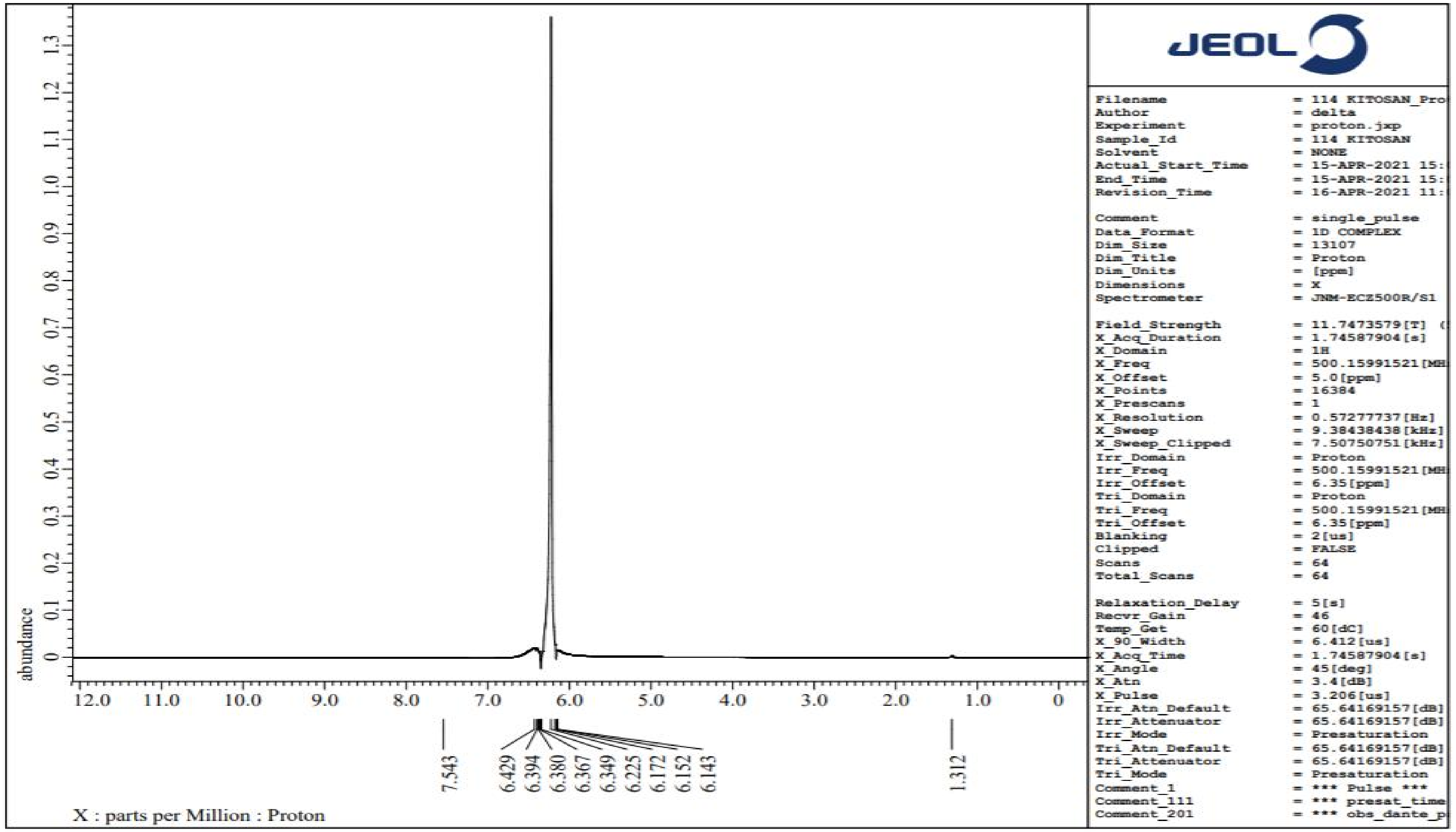
Number Average Molecular Weight(Mn)	233
Weight Average Molecular Weight(Mw)	240
Z Average Molecular Weight(Mz)	247
Z+1 Average Molecular Weight(Mz1)	253
Mw/Mn	1.03282
Mv/Mn	0.00000
Mz/Mw	1.02850

Detector A Channel 1
[Average Molecular Weight(Total)]

Number Average Molecular Weight(Mn)	289
Weight Average Molecular Weight(Mw)	449
Z Average Molecular Weight(Mz)	795
Z+1 Average Molecular Weight(Mz1)	1157
Mw/Mn	1.55036
Mv/Mn	0.00000
Mz/Mw	1.77145

H-NMR analysis

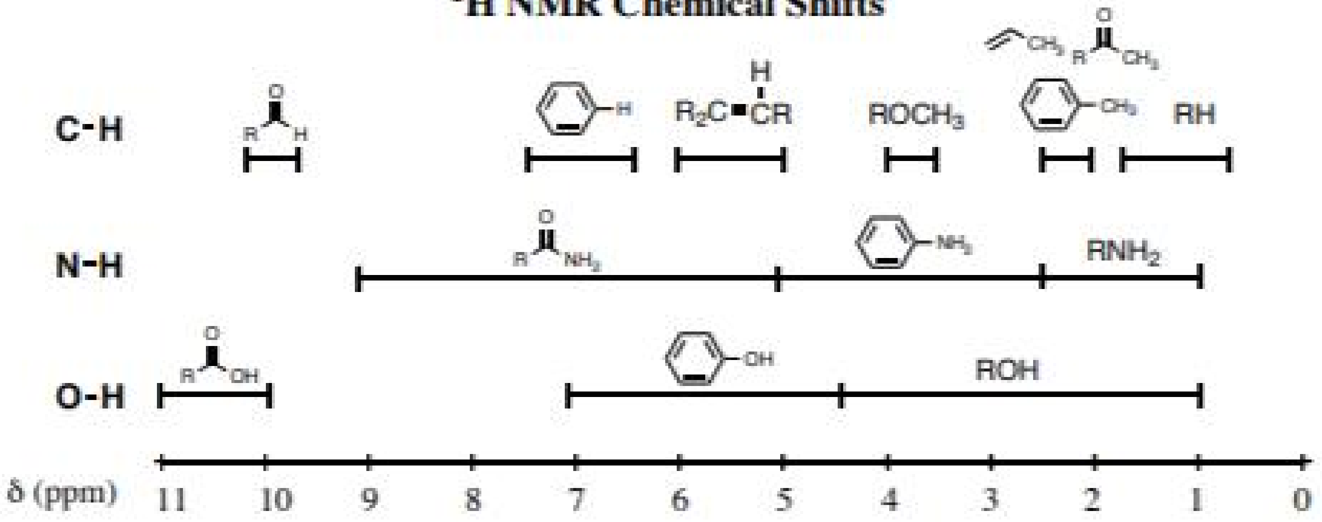
Crab waste



California State Polytechnic University, Pomona

Dr. Laurie S. Starkey, Organic Chemistry Lab CHM 318L

^{1}H NMR Chemical Shifts



Protons on Carbon

Type of C-H	δ (ppm)	Description of Proton
R–CH_3	0.9	alkyl (methyl)
R–CH_2–R	1.3	alkyl (methylene)
R_3C–H	1.5-2	alkyl (methine)
C=C–CH_3	1.8	allylic (C is next to a pi bond)
R–C(=O)–CH_3	2-2.3	α to carbonyl (C is next to C=O)
Ar–CH_3	2.3	benzylic (C is next to Ph)
RC≡C–H	2.5	alkynyl
R_2N–CH_3	2-3	α to nitrogen (C is attached to N)
R–CH_2–X	2-4	α to halogen (C is attached to Cl, Br, I)
RO–CH_3	3.8	α to oxygen (C is attached to O)
R–CH_2–F	4.5	α to fluorine (C is attached to F)
R_2C=C(H)R	5-5.3	vinylic (H is attached to alkene C)
Ar–H	7.3	aromatic (H is on phenyl ring)
R–C(=O)–H	9.7	aldehyde (H is on C=O)

Note: aldehyde (-CHO) proton usually does not couple with neighboring H's so appears as a singlet

Protons on Oxygen/Nitrogen*

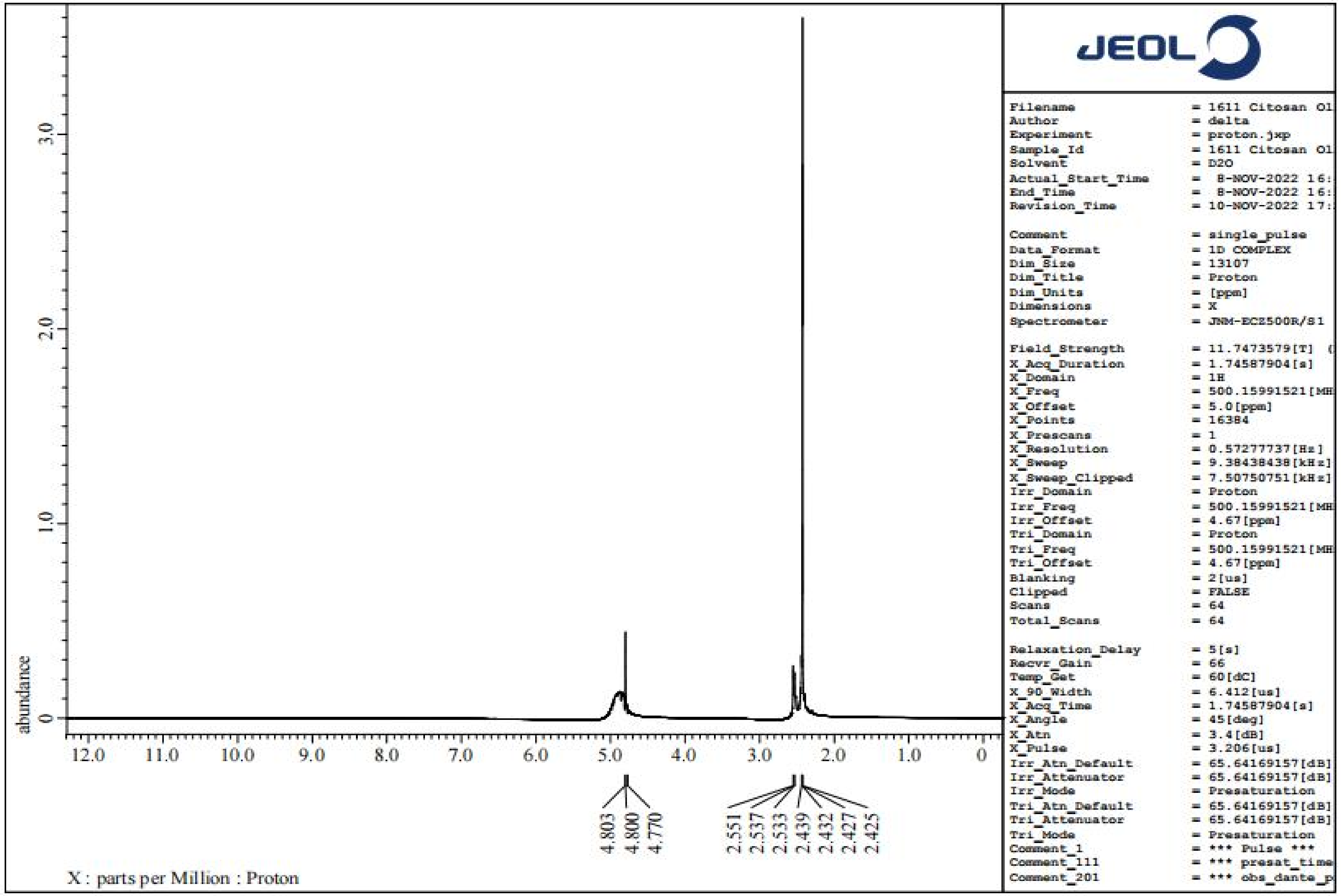
Type of H	δ (ppm)	Description
ROH	0.5-5	alcohol
ArOH	4-7	phenol
R–C(=O)–OH	10-13	carb. acid
RNH_2	0.5-5	amine
$ArNH_2$	3-5	aniline
R–C(=O)–NHR	5-9	amide

**Protons on N or O typically have wide ranges of expected chemical shifts; the actual δ value depends on the solvent used, the concentration, temperature, etc. Because these protons are acidic and, therefore, exchangeable, they may be broad peaks and usually do not couple with neighboring protons (typically they are broad singlets). If a protic deuterated solvent is used (e.g., D_2O or CD_3OD), then the NH and OH protons will exchange with the deuterium and the peaks will shrink or disappear entirely, since D (^{2}H) does not show up in the ^{1}H NMR spectrum.*

R = alkyl group
Ar = aromatic ring, such as phenyl (Ph)

H-NMR analysis

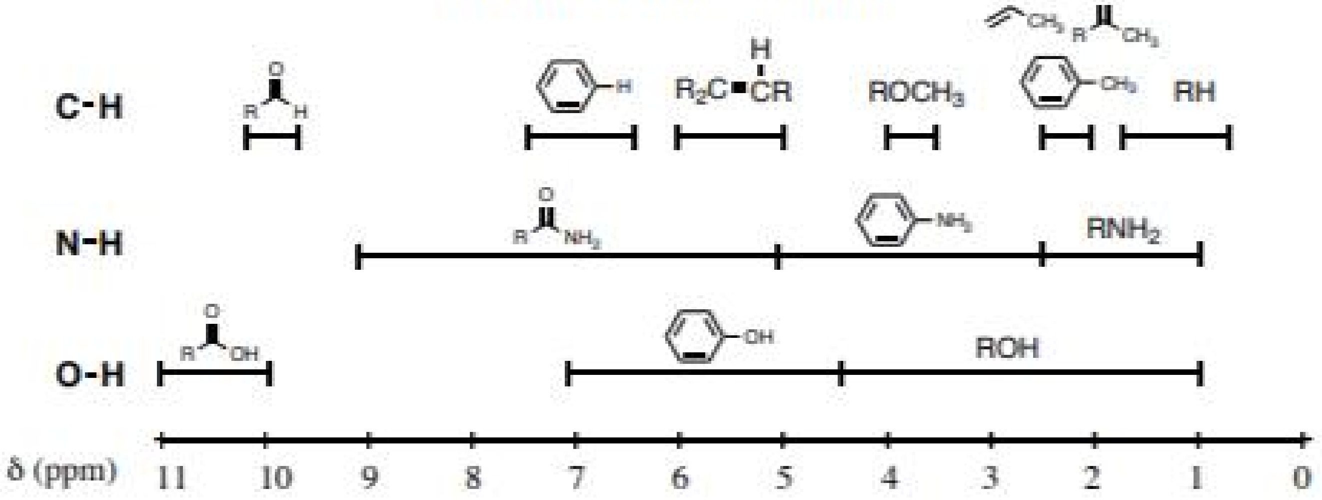
Shrimp waste



California State Polytechnic University, Pomona

Dr. Laurie S. Starkey, Organic Chemistry Lab CHM 318L

^{1}H NMR Chemical Shifts



Protons on Carbon

Type of C-H	δ (ppm)	Description of Proton
$R-CH_3$	0.9	alkyl (methyl)
$R-CH_2-R$	1.3	alkyl (methylene)
R_3C-H	1.5-2	alkyl (methine)
CH_3 (allylic)	1.8	allylic (C is next to a pi bond)
$R-C(=O)-CH_3$	2-2.3	α to carbonyl (C is next to C=O)
$Ar-CH_3$	2.3	benzylic (C is next to Ph)
$RC\equiv C-H$	2.5	alkynyl
R_2N-CH_3	2-3	α to nitrogen (C is attached to N)
$R-CH_2-X$	2-4	α to halogen (C is attached to Cl, Br, I)
$RO-CH_3$	3.8	α to oxygen (C is attached to O)
$R-CH_2-F$	4.5	α to fluorine (C is attached to F)
$R_2C=CR$ (H)	5-5.3	vinylic (H is attached to alkene C)
$Ar-H$	7.3	aromatic (H is on phenyl ring)
$R-C(=O)-H$	9.7	aldehyde (H is on C=O)

Note: aldehyde (-CHO) proton usually does not couple with neighboring H's so appears as a singlet

Protons on Oxygen/Nitrogen*

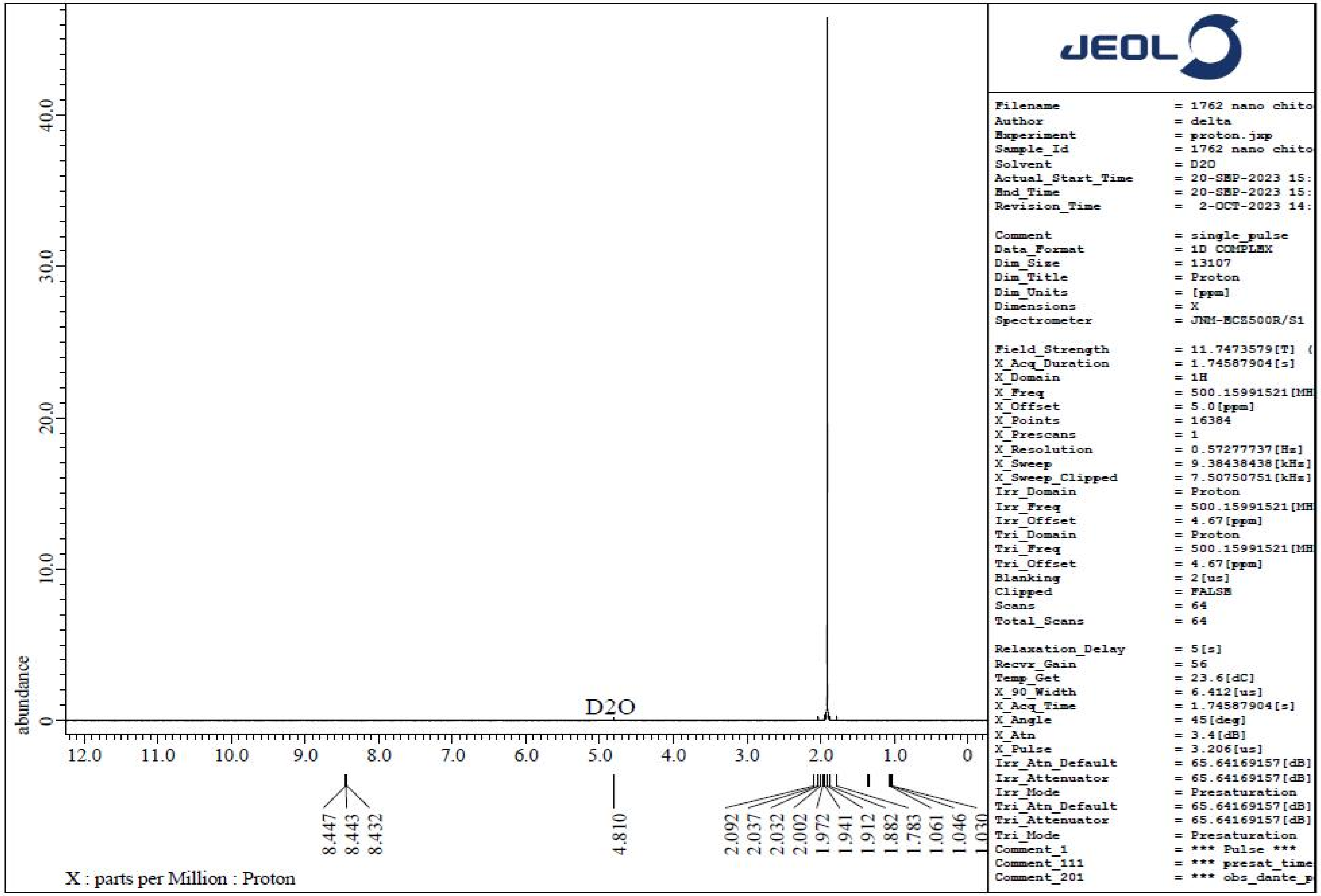
Type of H	δ (ppm)	Description
ROH	0.5-5	alcohol
ArOH	4-7	phenol
$R-C(=O)-OH$	10-13	carb. acid
RNH_2	0.5-5	amine
$ArNH_2$	3-5	aniline
$R-C(=O)-NHR$	5-9	amide

**Protons on N or O typically have wide ranges of expected chemical shifts; the actual δ value depends on the solvent used, the concentration, temperature, etc. Because these protons are acidic and, therefore, exchangeable, they may be broad peaks and usually do not couple with neighboring protons (typically they are broad singlets). If a protic deuterated solvent is used (e.g., D_2O or CD_3OD), then the NH and OH protons will exchange with the deuterium and the peaks will shrink or disappear entirely, since D (^2H) does not show up in the ^1H NMR spectrum.*

R = alkyl group
Ar = aromatic ring, such as phenyl (Ph)

H-NMR analysis

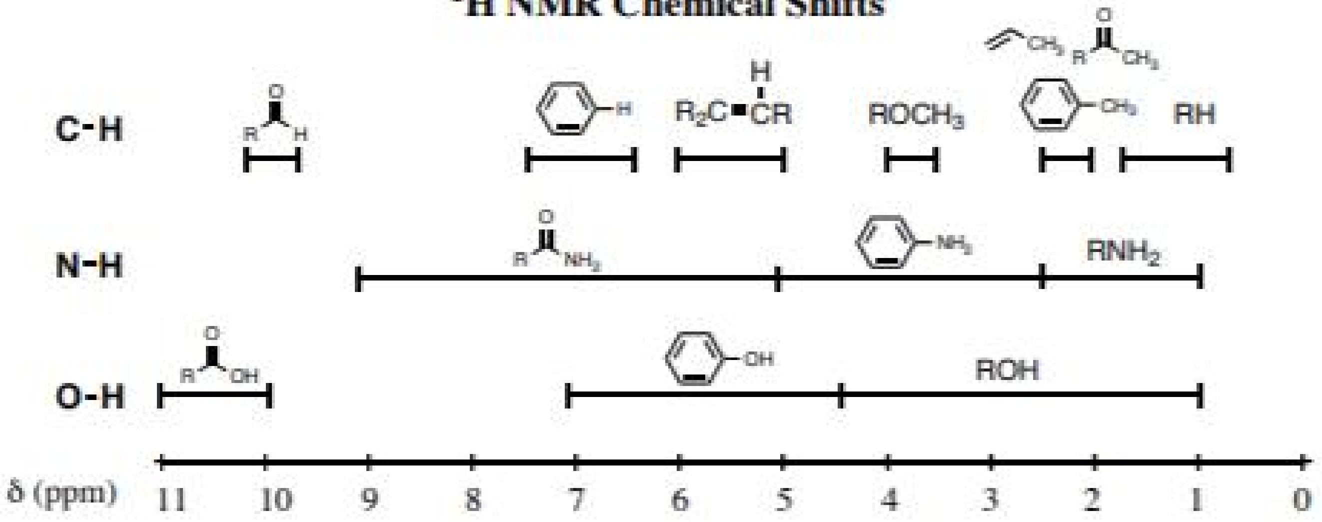
BSF waste



California State Polytechnic University, Pomona

Dr. Laurie S. Starkey, Organic Chemistry Lab CHM 318L

^{1}H NMR Chemical Shifts



Protons on Carbon

Type of C-H	δ (ppm)	Description of Proton
R−CH₃	0.9	alkyl (methyl)
R−CH₂−R	1.3	alkyl (methylene)
R₃C−H	1.5-2	alkyl (methine)
=/CH₃	1.8	allylic (C is next to a pi bond)
R−C(=O)−CH₃	2-2.3	α to carbonyl (C is next to C=O)
Ar−CH₃	2.3	benzylic (C is next to Ph)
RC≡C−H	2.5	alkynyl
R₂N−CH₃	2-3	α to nitrogen (C is attached to N)
R−CH₂−X	2-4	α to halogen (C is attached to Cl, Br, I)
RO−CH₃	3.8	α to oxygen (C is attached to O)
R−CH₂−F	4.5	α to fluorine (C is attached to F)
R₂C=C(H)R	5-5.3	vinylic (H is attached to alkene C)
Ar−H	7.3	aromatic (H is on phenyl ring)
R−C(=O)−H	9.7	aldehyde (H is on C=O)

Note: aldehyde (-CHO) proton usually does not couple with neighboring H's so appears as a singlet

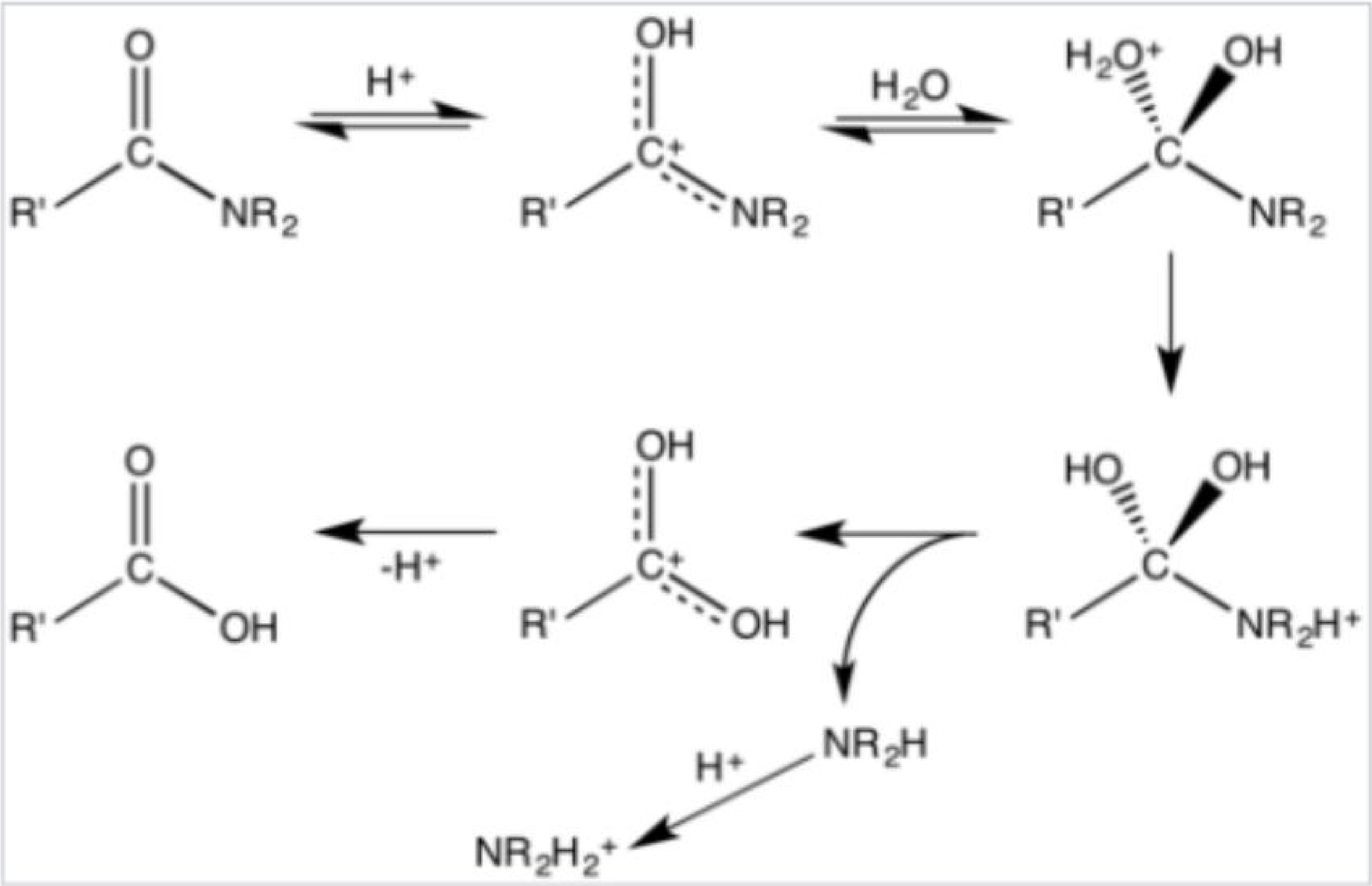
Protons on Oxygen/Nitrogen*

Type of H	δ (ppm)	Description
ROH	0.5-5	alcohol
ArOH	4-7	phenol
R−C(=O)−OH	10-13	carb. acid
RNH₂	0.5-5	amine
ArNH₂	3-5	aniline
R−C(=O)−NHR	5-9	amide

**Protons on N or O typically have wide ranges of expected chemical shifts; the actual δ value depends on the solvent used, the concentration, temperature, etc. Because these protons are acidic and, therefore, exchangeable, they may be broad peaks and usually do not couple with neighboring protons (typically they are broad singlets). If a protic deuterated solvent is used (e.g., D_2O or CD_3OD), then the NH and OH protons will exchange with the deuterium and the peaks will shrink or disappear entirely, since D (^{2}H) does not show up in the ^{1}H NMR spectrum.*

R = alkyl group
Ar = aromatic ring, such as phenyl (Ph)

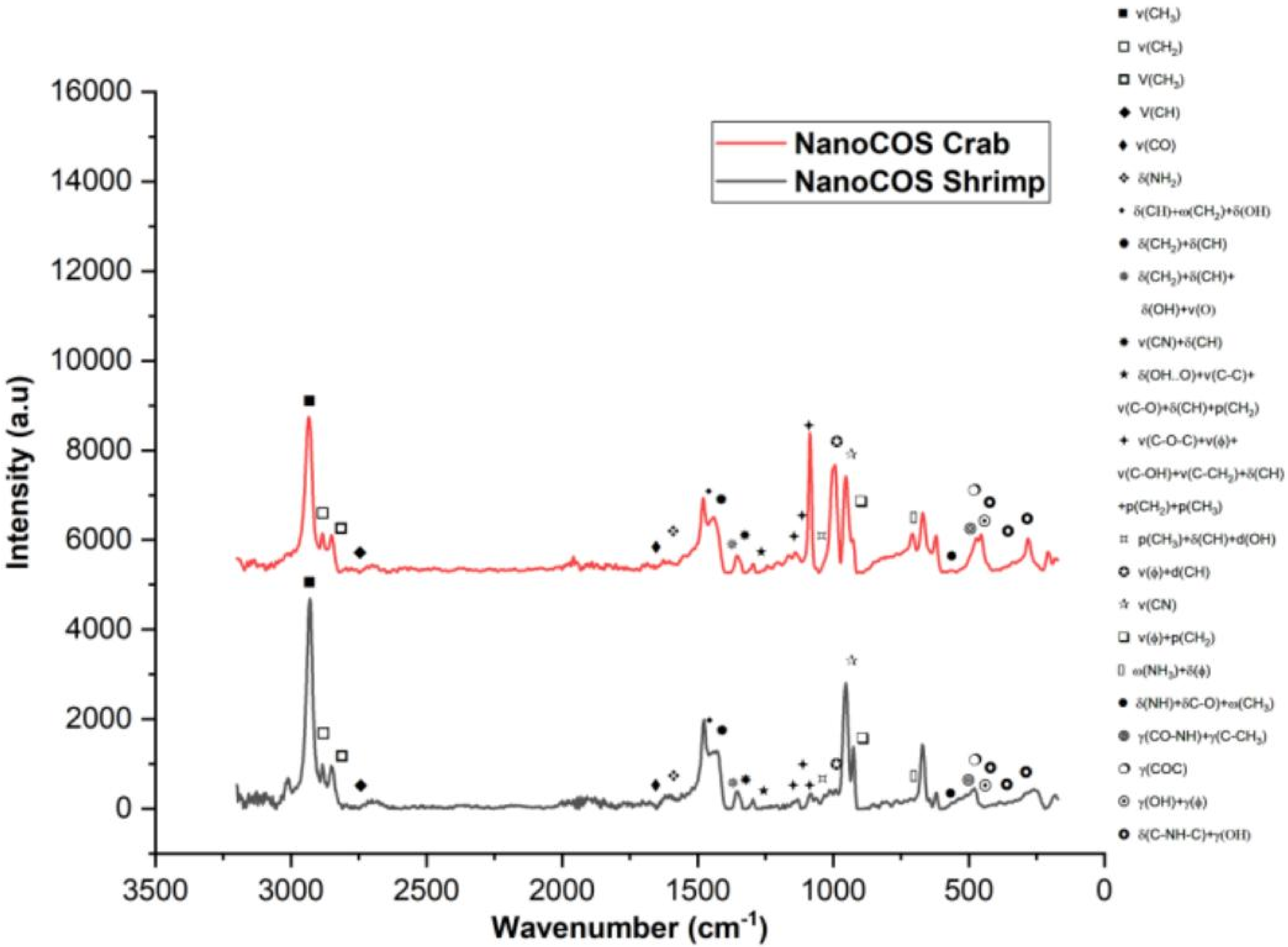
Mechanism for acid-mediated hydrolysis of an amide



Using chemical reaction need long route

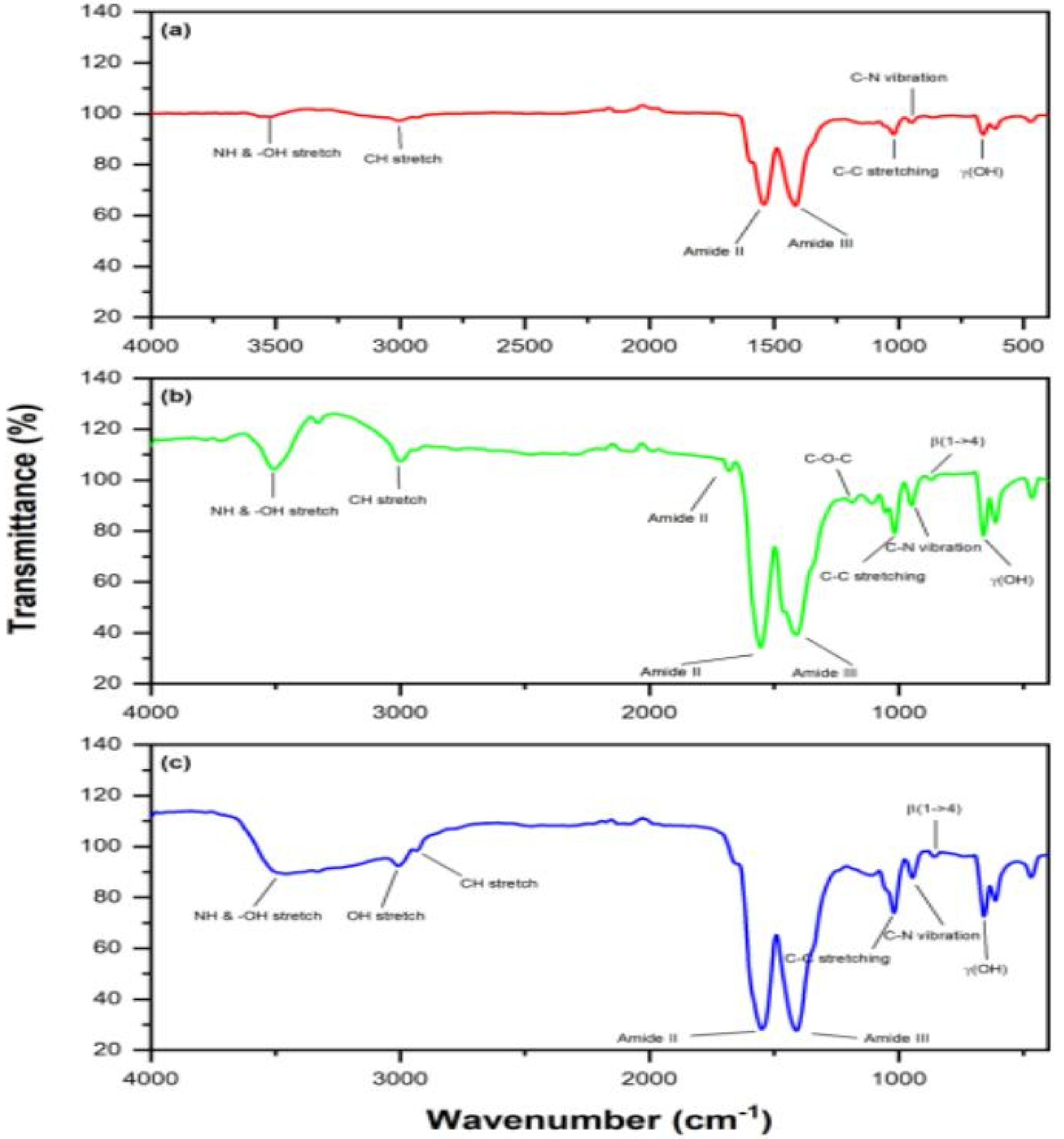
Smith, Michael B.; March, Jerry (2007), *Advanced Organic Chemistry: Reactions, Mechanisms, and Structure* (6th ed.), New York: Wiley-Interscience, ISBN 978-0-471-72091-1

Raman analysis



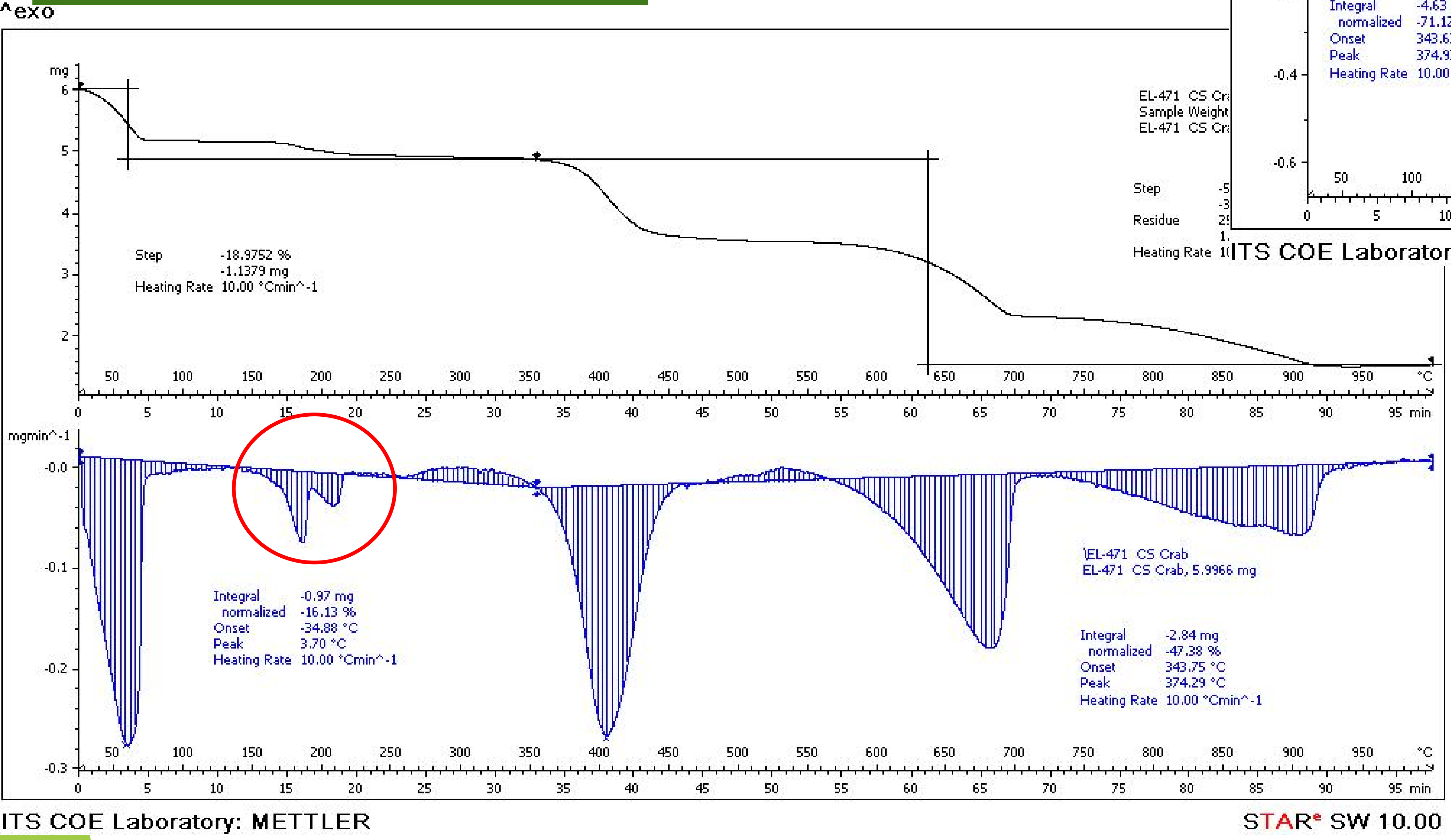
FTIR analysis

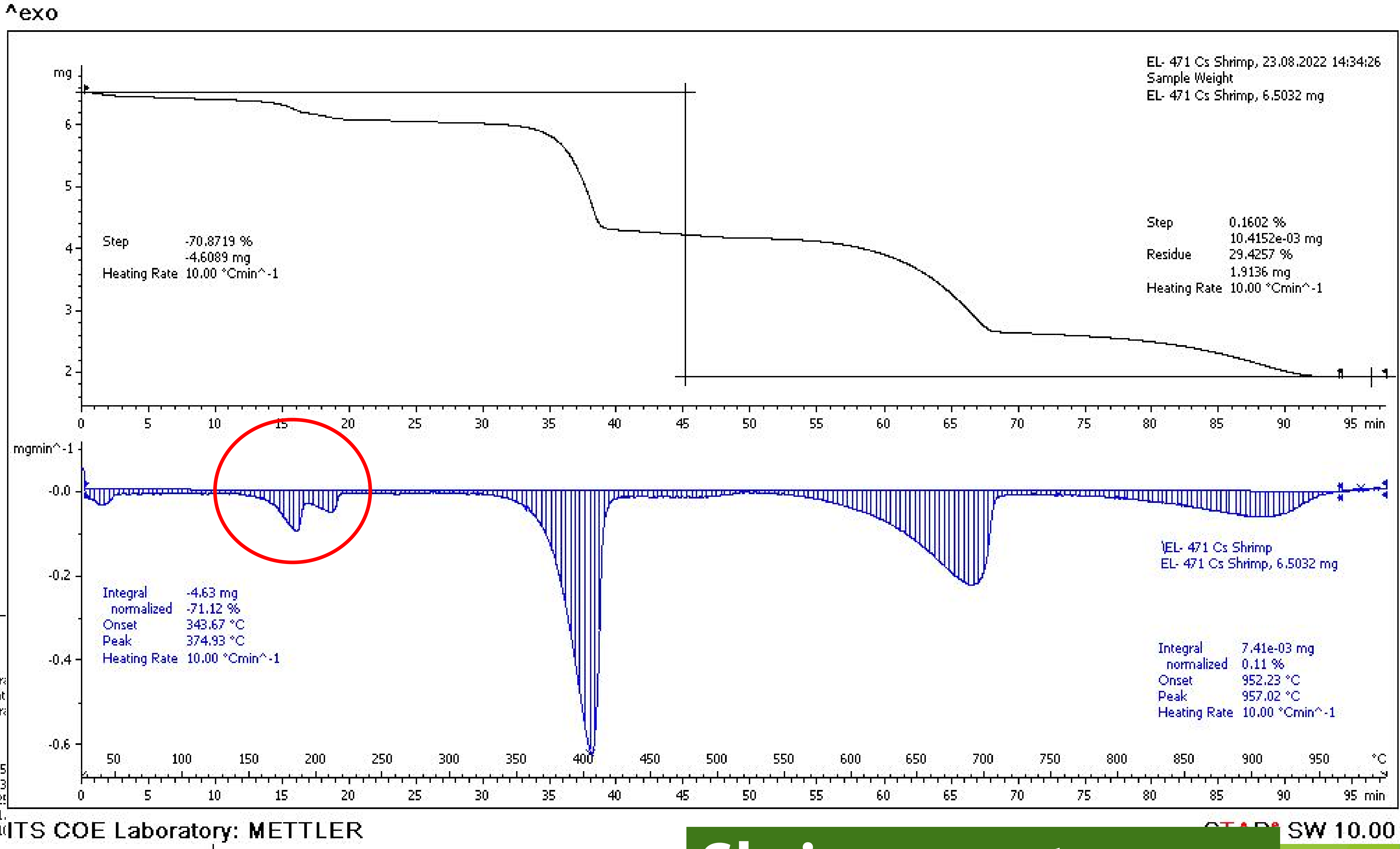
NanoCOS	A1629	A3450	Degree of Deacetylation
Shrimp	88,861	89,319	98,99 %
Crab	100,108	-0,000468785	98,82 %
BSF	97,512	0,010941936	99 %



Analisis FTIR Raw Material NanoCOS: (a) Shrimp, (b) Crab, (c) BSF

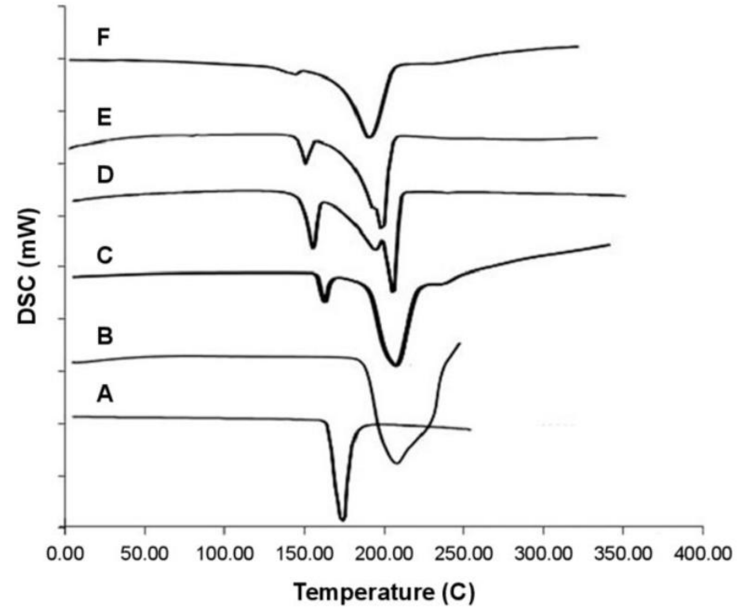
Crab waste





Shrimp waste

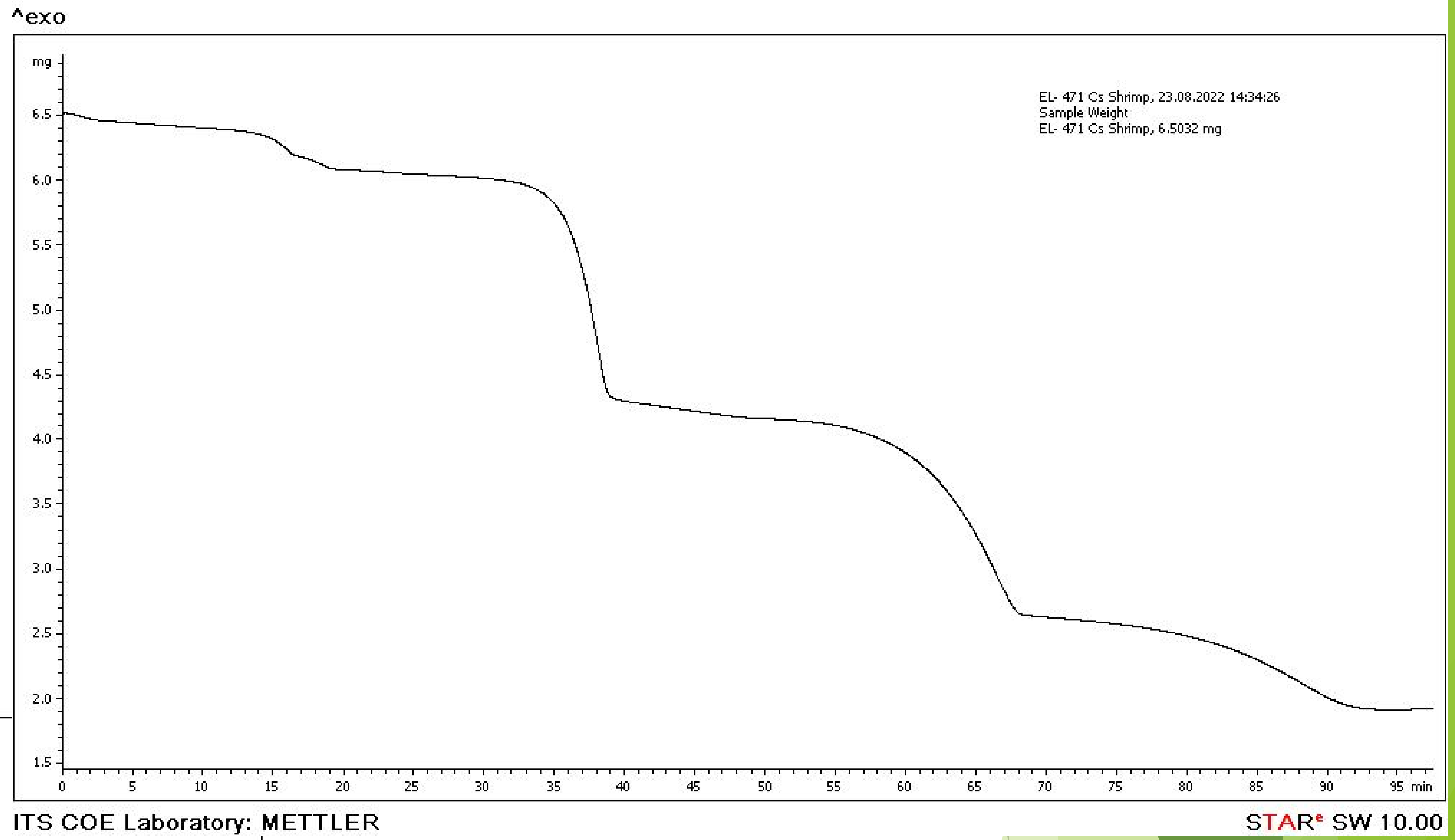
Drug Design, Development and Therapy 2018:12:3071-3084



Figure

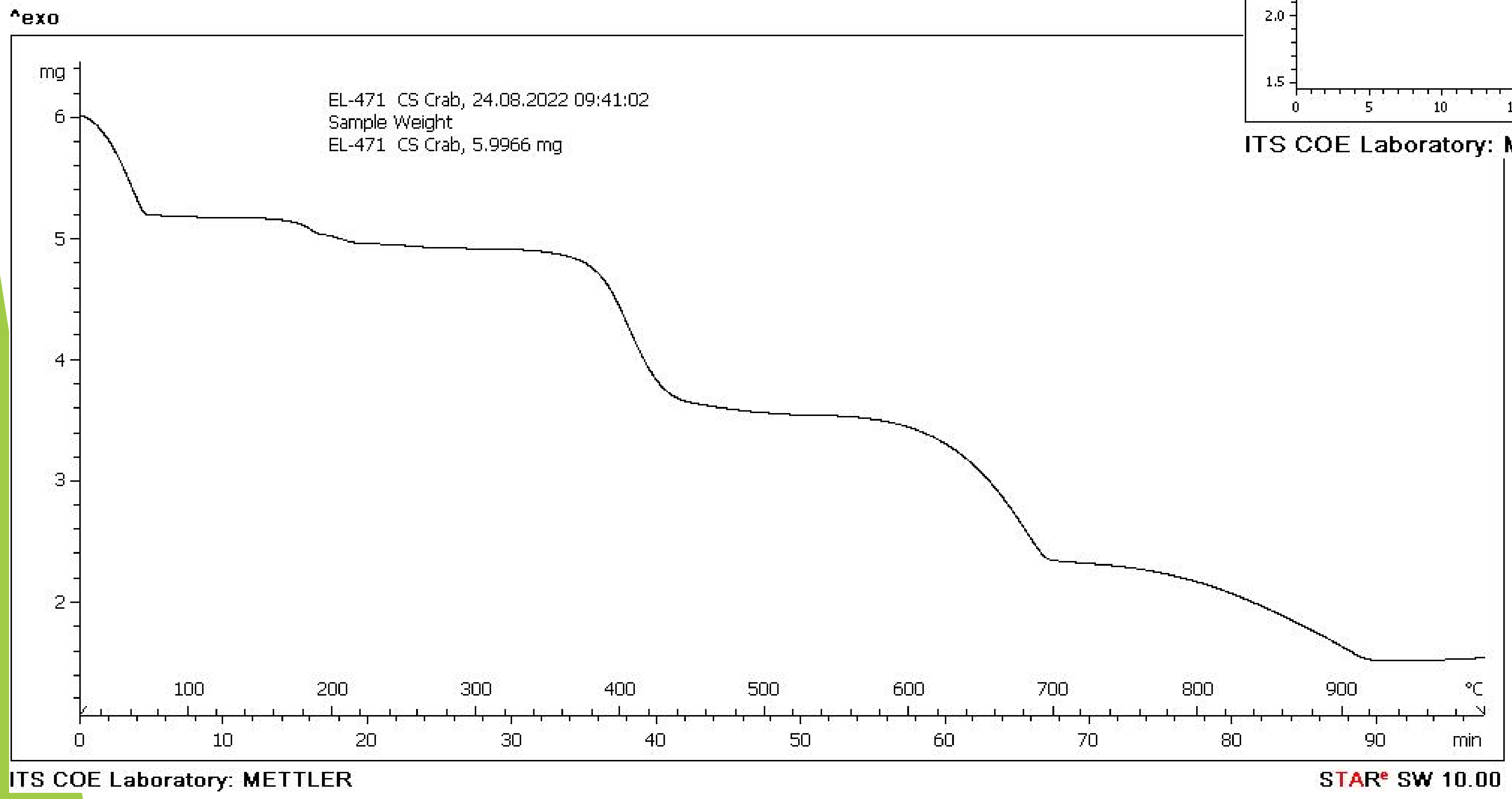
Caption

Figure 3 Dsc thermograms of (A) paracetamol; (B) glucosamine; (C) physical mixture (1:4 Mr); (D) sPD1 (1:1 Mr); (E) sPD2 (1:2 Mr); and (F) sPD5 (1:4 Mr) solid dispersions. Abbreviation: Dsc, differential scanning calorimetry; Mr, molar ratio; sPD, spray dried dispersion.



waste

Crab waste



Crab waste

c:\edax32\genesis\genspc.spc
Label : Chlorite (Nrm.%= 38.86, 20.96, 34.83, 1.14, 3.84, 0.28)
Acquisition Time : 12:45:58 Date: 4-Oct-2022

kV : 20.00 Tilt: 0.00 Take-off:35.00 AmpT : 12.8
Detector Type:SDD Apollo X Resolution:128.59 Lsec 1

EDAX ZAF Quantification (Standardless)
Element Normalized
SEC Table : Default

Element	Wt %	At %	K-Ratio	Z	A	F
C K	10.76	19.99	0.0212	1.0598	0.1858	1.0005
O K	29.20	40.72	0.0414	1.0420	0.1362	1.0003
NaK	11.96	11.60	0.0412	0.9751	0.3533	1.0010
ClK	11.44	7.20	0.1031	0.9423	0.9312	1.0265
K K	6.43	3.67	0.0596	0.9482	0.9318	1.0483
CaK	30.20	16.81	0.2722	0.9704	0.9287	1.0000
Total	100.00	100.00				

Element	Net Inte.	Bkgd Inte.	Inte. Error	P/B
C K	151.00	5.00	8.40	30.20
O K	487.00	7.00	4.60	69.57
NaK	630.00	20.00	4.11	31.50
ClK	1157.00	70.00	3.11	16.53
K K	560.00	66.00	4.70	8.48
CaK	2310.00	60.00	2.13	38.50

c:\edax32\genesis\genspc.spc
Label : Chlorite (Nrm.%= 38.86, 20.96, 34.83, 1.14, 3.84, 0.28)
Acquisition Time : 12:43:35 Date: 4-Oct-2022

kV : 20.00 Tilt: 0.00 Take-off:35.00 AmpT : 12.8
Detector Type:SDD Apollo X Resolution:128.59 Lsec 1

EDAX ZAF Quantification (Standardless)
Element Normalized
SEC Table : Default

Element	Wt %	At %	K-Ratio	Z	A	F
C K	7.39	14.37	0.0261	1.0553	0.3349	1.0011
O K	34.89	50.94	0.0428	1.0375	0.1182	1.0001
NaK	1.97	2.00	0.0058	0.9708	0.3035	1.0009
ClK	2.01	1.32	0.0186	0.9394	0.9400	1.0485
K K	2.84	1.70	0.0296	0.9447	0.9839	1.1213
CaK	50.90	29.67	0.4847	0.9667	0.9851	1.0000
Total	100.00	100.00				

Element	Net Inte.	Bkgd Inte.	Inte. Error	P/B
C K	210.00	5.00	7.06	42.00
O K	567.00	7.00	4.25	81.00
NaK	100.00	14.00	11.31	7.14
ClK	235.00	50.00	7.79	4.70
K K	314.00	55.00	6.56	5.71
CaK	4639.00	48.00	1.48	96.65

Shrimp waste

NANO CRYSTAL MEASUREMENT

Debye Scherrer Theory:

$$D = \frac{k * \alpha}{\beta * \cos\theta}$$

Keterangan:

D: Ukuran Kristal (nm)

k: Faktor Bentuk Kristal (0,9 - 1)

α: Panjang Gelombang Sinar-X (0,15406)

β: FWHM (Rad.)

θ: Sudut Difraksi (Derajat)

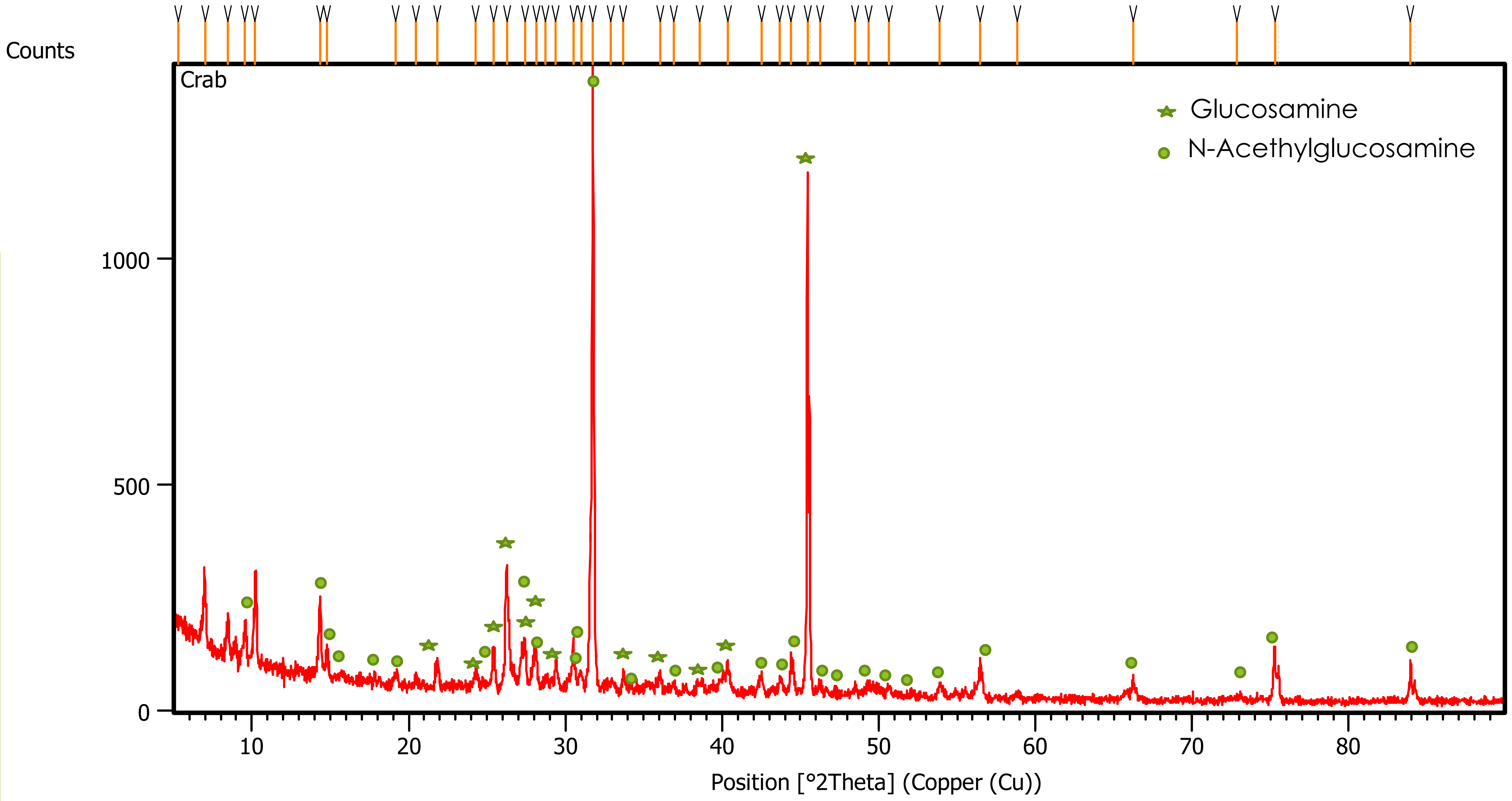
Sample	Peak Position [2° Theta]	FWHM (Rad)	Crystal Size (nm)
Crab	35,21	0,2007	41,52789381
Shrimp	24,26	0,1338	60,73026082

References:

Satoshi Horikoshi and Nick Serpone, *Microwaves in Nanoparticle Synthesis*, First Edition. Edited by Satoshi Horikoshi and Nick Serpone, Wiley-VCH Verlag GmbH & Co. KGaA, 2013, Chap. 1.

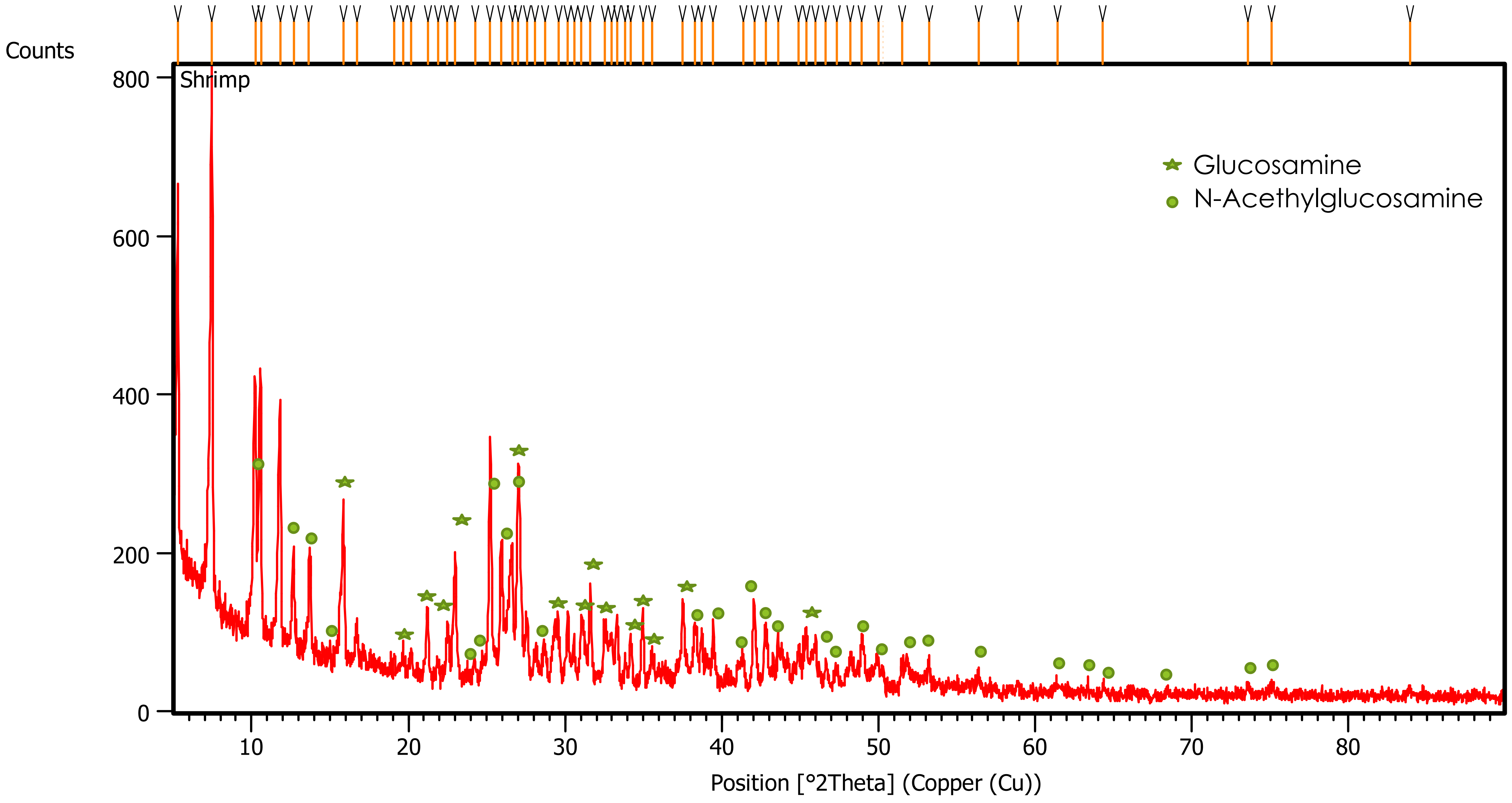
V. S. Vinila, Reenu Jacob, Anusha Mony, Harikrishnan G. Nair, Sheelakumari Issac, Sam Rajan, Anitha S. Nair, D. J. Satheesh1, Jayakumari Isac, Ceramic Nanocrystalline Superconductor Gadolinium Barium Copper Oxide (GdBaCuO) at Different Treating Temperatures, *Journal of Crystallization Process and Technology*, vol. 4, 2014, pp. 168- 176. http://dx.doi.org/10.4236/jcpt.2014.43021

XRD analysis



Pos. [°2Th.]	Height [cts]	FWHM Left [°2Th.]	d-spacing [Å]	Rel. Int. [%]
5.2789	107.28	0.5353	16.74112	7.69
6.9898	201.24	0.0669	12.64662	14.42
8.4793	126.03	0.0836	10.42820	9.03
9.5661	109.10	0.1004	9.24572	7.82
10.2198	219.28	0.1171	8.65579	15.72
14.3516	167.23	0.0669	6.17173	11.99
14.7964	59.70	0.1338	5.98720	4.28
19.1991	24.02	0.2676	4.62300	1.72
20.4814	22.96	0.2007	4.33638	1.65
21.8603	49.75	0.2342	4.06586	3.57
24.3050	42.04	0.2007	3.66216	3.01
25.4384	88.53	0.1673	3.50151	6.35
26.2595	275.07	0.1338	3.39385	19.72
27.4265	108.49	0.1004	3.25204	7.78
28.1217	89.88	0.2007	3.17320	6.44
28.7563	25.24	0.2007	3.10460	1.81
29.3951	62.10	0.1338	3.03857	4.45
30.4963	113.50	0.0836	2.93131	8.14
30.9969	42.75	0.2007	2.88511	3.06
31.7425	1395.21	0.0836	2.81902	100.00
32.9268	17.60	0.4015	2.72029	1.26
33.7221	43.02	0.1673	2.65793	3.08
36.0238	35.63	0.1338	2.49321	2.55
36.9366	20.53	0.1673	2.43367	1.47
38.6055	20.59	0.4015	2.33222	1.48
40.3800	52.11	0.2676	2.23373	3.73
42.5356	40.92	0.2676	2.12539	2.93
43.7057	30.80	0.2007	2.07117	2.21
44.3871	60.44	0.1004	2.04094	4.33
45.4589	1179.13	0.0612	1.99363	84.51
45.5836	632.46	0.0612	1.99340	45.33
46.2709	19.23	0.2448	1.96052	1.38
48.4816	16.78	0.2448	1.87616	1.20

XRD analysis



Pos. [°2Th.]	Height [cts]	FWHM Left [°2Th.]	d-spacing [Å]	Rel. Int. [%]
5.2971	584.15	0.1004	16.68338	75.04
7.4639	778.42	0.1506	11.84447	100.00
10.2430	367.49	0.1673	8.63619	47.21
10.5830	380.41	0.0836	8.35947	48.87
11.8251	352.15	0.0836	7.48406	45.24
12.6786	175.24	0.1004	6.98211	22.51
13.6681	167.49	0.0836	6.47879	21.52
15.8496	244.79	0.0502	5.59163	31.45
16.7323	78.96	0.1673	5.29860	10.14
19.1008	40.89	0.1004	4.64658	5.25
19.6691	41.58	0.2007	4.51358	5.34
20.2039	44.30	0.1338	4.39531	5.69
21.2191	95.42	0.1004	4.18725	12.26
21.9249	29.91	0.1673	4.05403	3.84
22.5081	83.01	0.1004	3.95029	10.66
23.0054	166.26	0.1004	3.86601	21.36
24.2373	33.06	0.2007	3.67223	4.25
25.2133	314.90	0.1673	3.53225	40.45
25.9586	184.50	0.1171	3.43250	23.70
26.6459	157.11	0.0669	3.34550	20.18
27.0273	275.37	0.2342	3.29916	35.38
27.5773	79.33	0.1673	3.23460	10.19
28.1157	46.97	0.2676	3.17387	6.03
28.7240	55.09	0.2342	3.10802	7.08
29.5794	78.21	0.1673	3.02006	10.05
30.1779	97.41	0.1338	2.96151	12.51
30.5606	53.78	0.1004	2.92530	6.91
31.0483	83.58	0.2342	2.88045	10.74
31.6075	123.62	0.1338	2.83075	15.88
32.5083	75.45	0.1338	2.75434	9.69
32.9650	64.94	0.1673	2.71722	8.34
33.3088	86.62	0.1338	2.68996	11.13
33.8644	33.43	0.1004	2.64709	4.30

Drug Design, Development and Therapy 2018:12:3071-3084

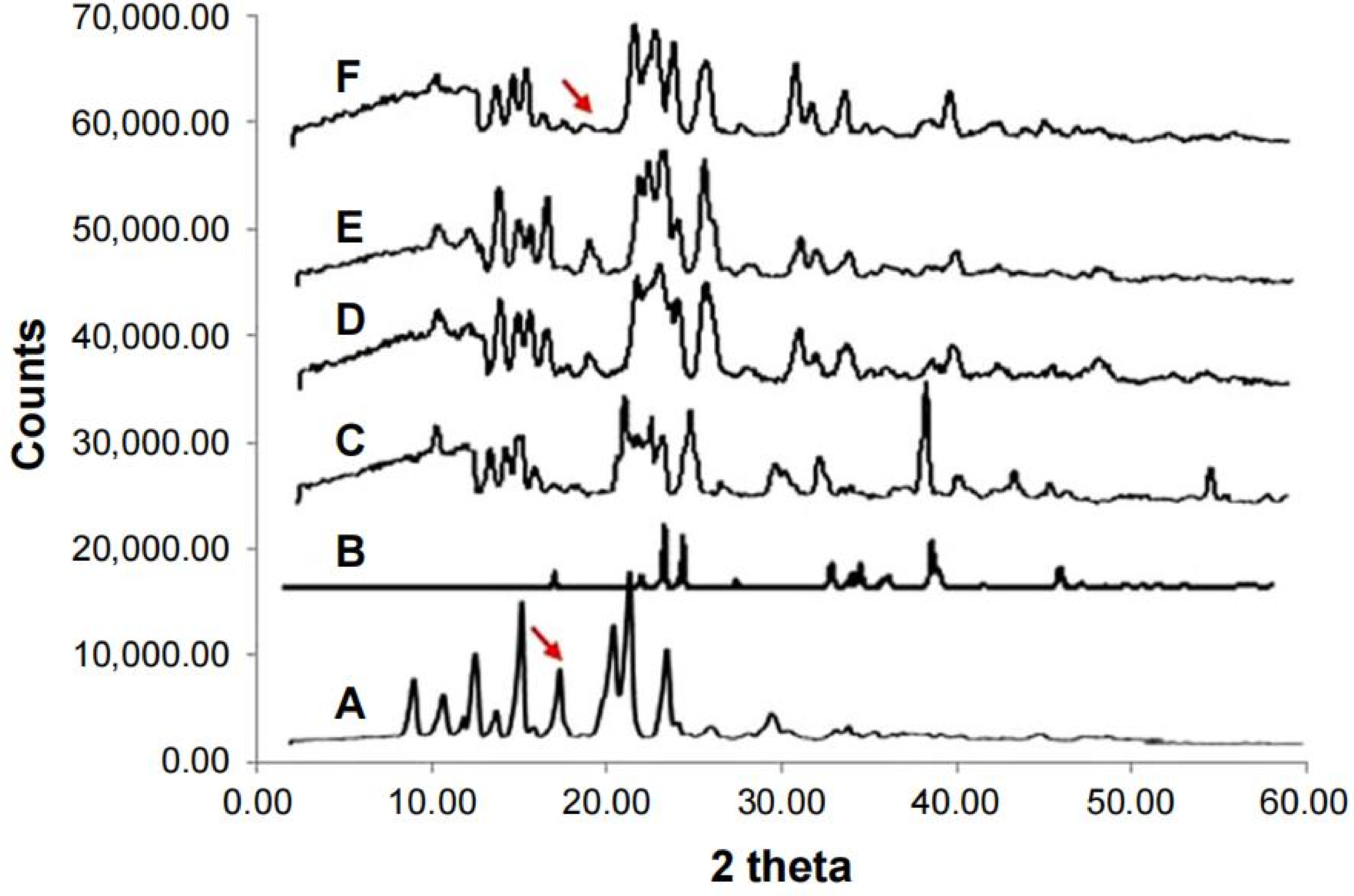


Figure 5 XRD patterns of (**A**) paracetamol; (**B**) glucosamine; (**C**) physical mixture (1:4 Mr); (**D**) SPD1 (1:1 Mr); (**E**) SPD2 (1:2 Mr); and (**F**) SPD5 (1:4 Mr) solid dispersions.

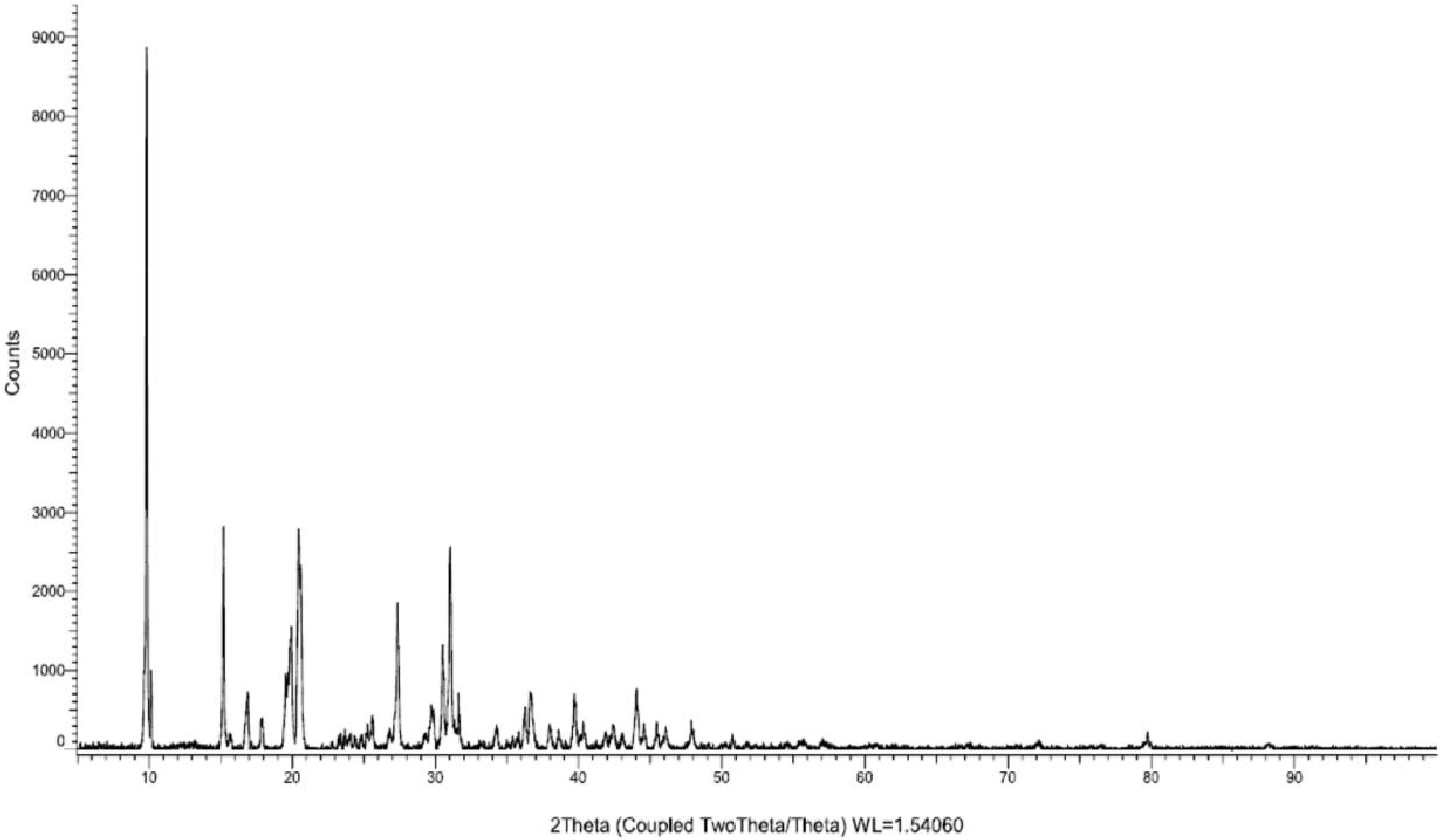


Fig.-6: XRD chromatogram of N-Acetil glucosamine

International Journal of Science and Research (IJSR)
ISSN: 2319-7064
ResearchGate Impact Factor (2018): 0.28 | SJIF (2018): 7.426

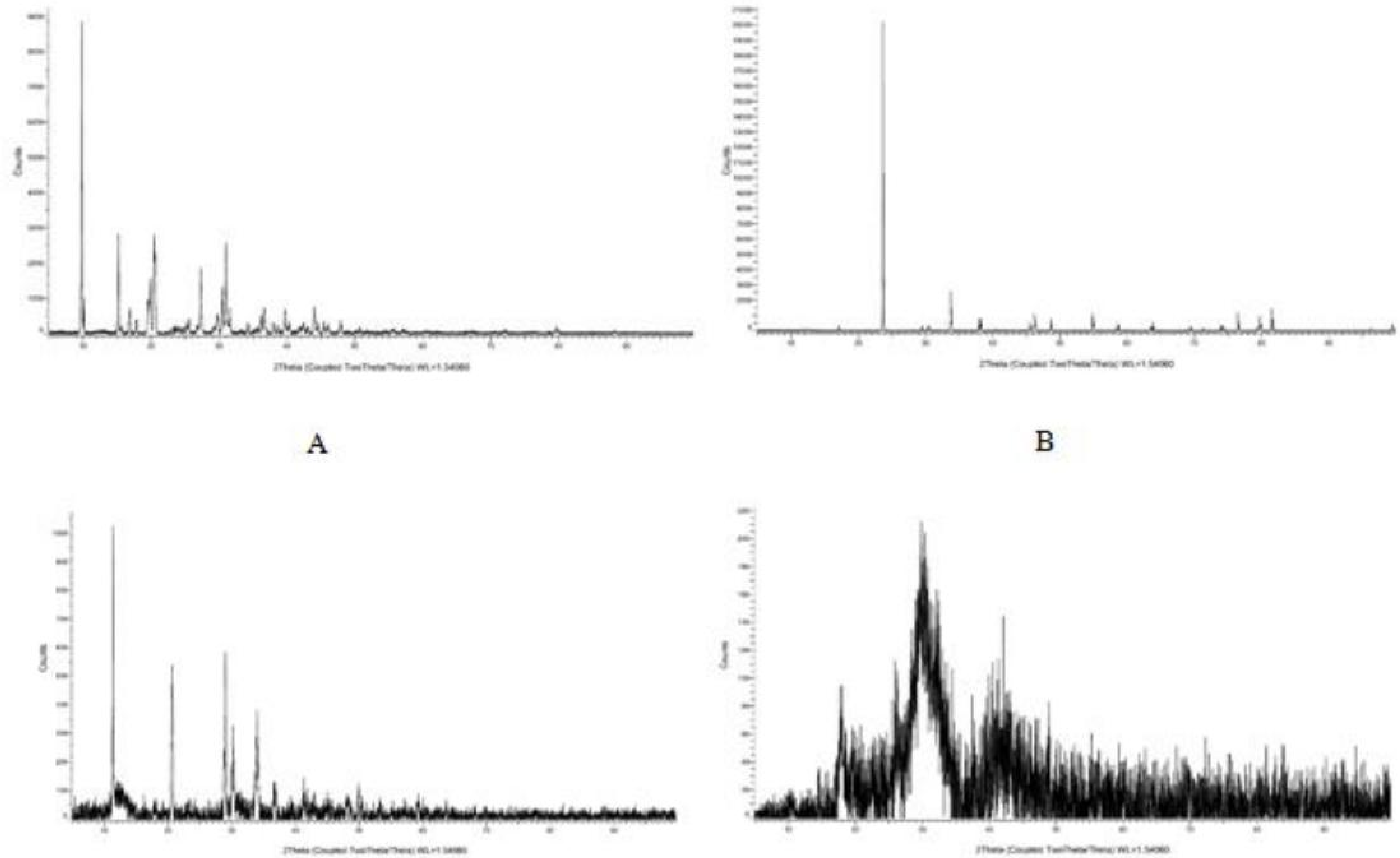


Figure 3: XRD chromatogram results of N-Acetyl Glucosamine standart (A), ethanol purification (B) acetone purification (C) and acetonitrile purification(D)

DLS analysis

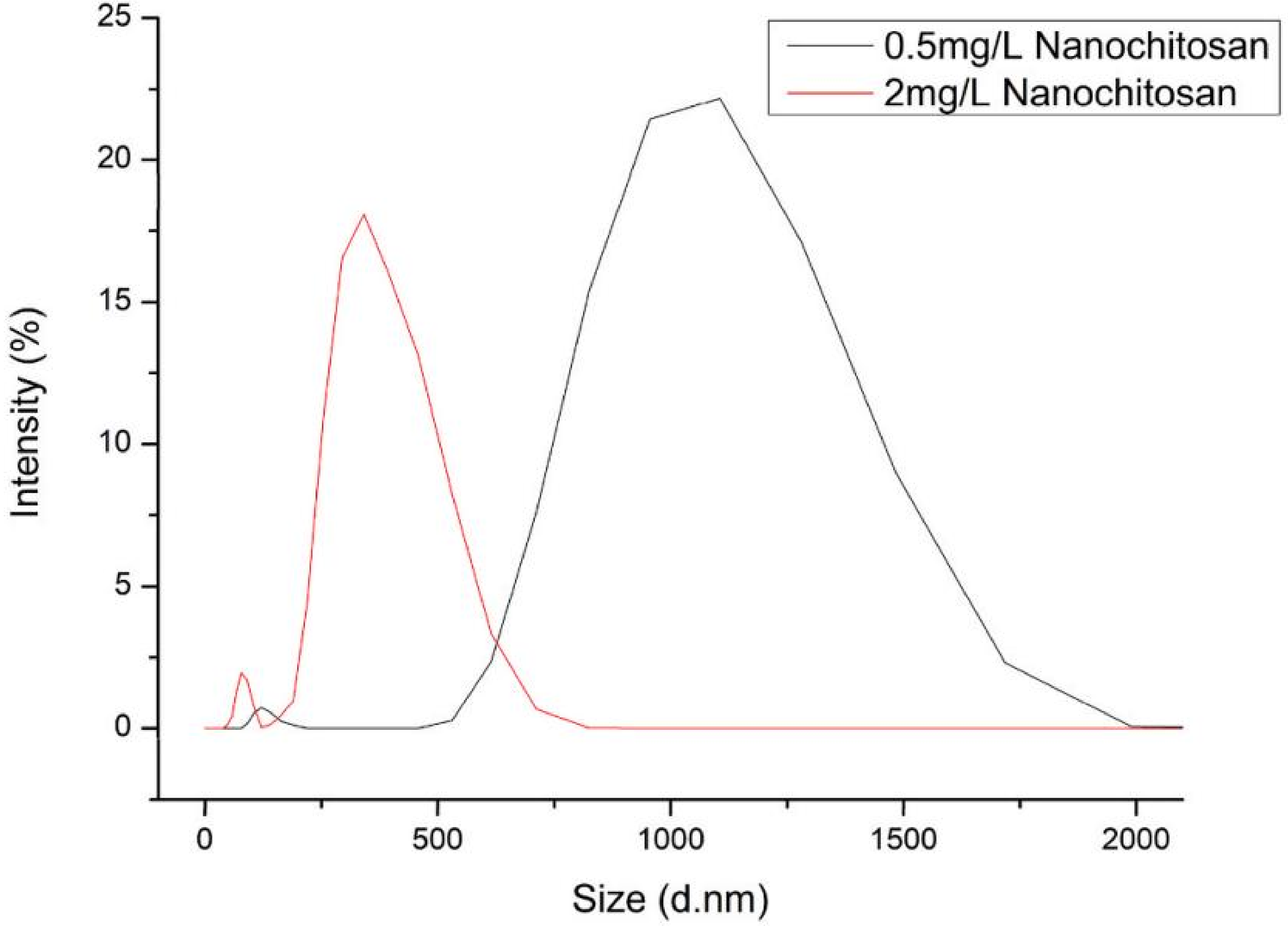


Fig. 8. Particles size distribution of nano chitosan in deionized water.

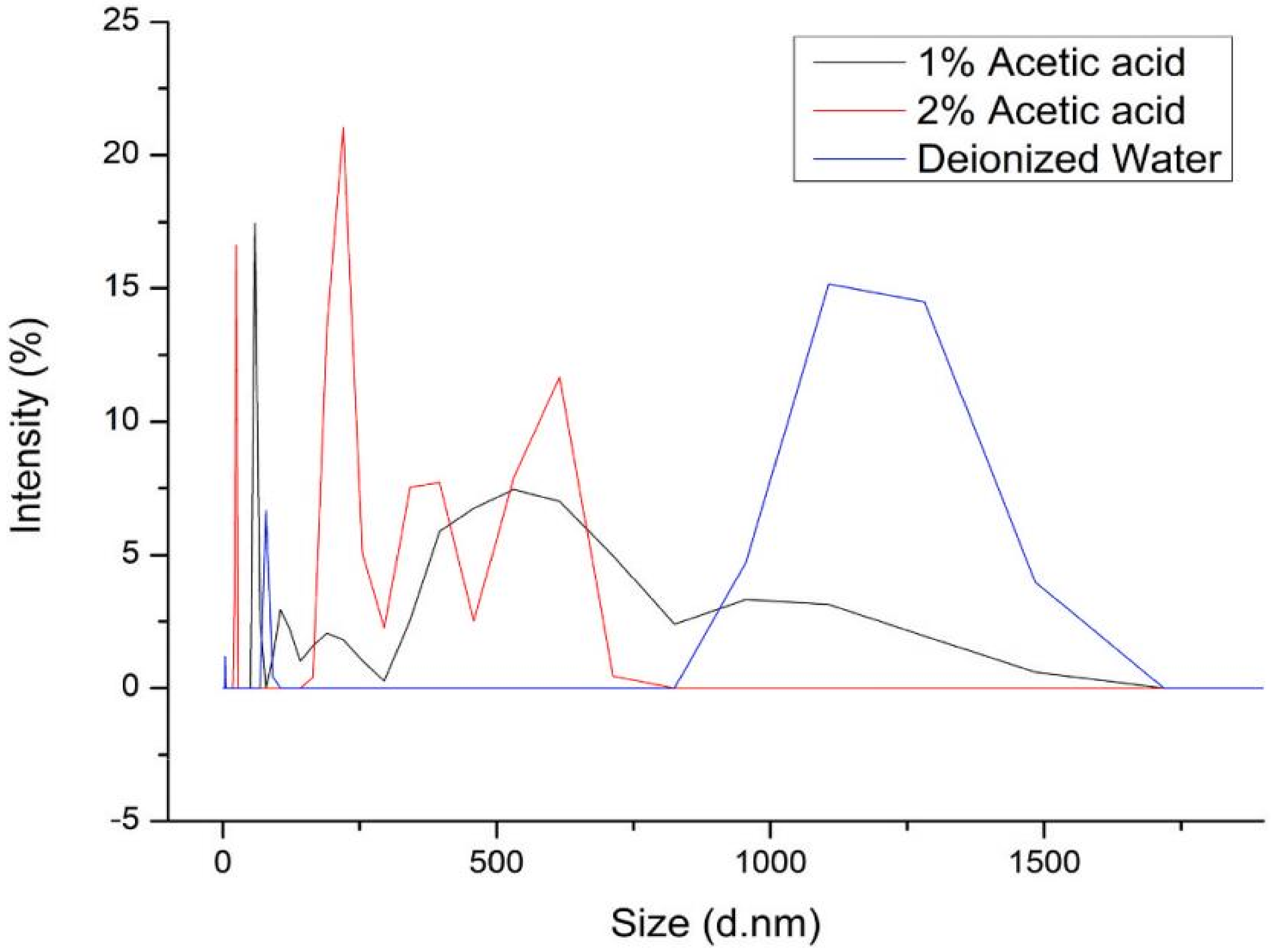


Fig. 9. Particles size distribution of nano chitosan (2 mg of nano chitosan powder into 50 ml of solvent) in various solvents.

...g Pintowantoro; Results in ...ering 13 (2022) 100352 ...016/j.rineng.2022.100352

DLS analysis

Average particles size, zeta and its Pdl of nano chitosan in deionized water with same viscosity.

Concentration nano chitosan	Average particle size (nm)	Pdl	Zeta (d. nm)	Pdl
0.5 mg/L	1346.8	0.5328	1346.80	0.5328
2 mg/L	542.1	0.6044	542.14	0.6044

Average particles size and Pdl of nano chitosan in acetate acid 1 wt%, acetate acid 2 wt% and deionized water in the same concentration of nano chitosan.

Concentration nano chitosan	Average particle size (nm)	Pdl	Viscosity cP
1 wt % acetate acid	2119.4	0.8742	1.2200
2 wt % acetate acid	4069.8	0.943	1.2200
Deionized water	7397.4	0.2598	0.8878

Yuli Setiyorini, Amelia Anggraeni, Sungging Pintowantoro; Results in Engineering 13 (2022) 100352
https://doi.org/10.1016/j.rineng.2022.100352