Supporting Information

Phosphotungstic acid as a novel acidic catalyst for carbohydrate protection and glycosylation

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| NMR spectrum of important compounds          | 2-45 |
| Parameter            | Value                |
|----------------------|----------------------|
| Origin               | Varian               |
| Spectrometer         | mercury              |
| Solvent              | cdcl3                |
| Temperature          | 25.0                 |
| Pulse Sequence       | s2pul                |
| Experiment           | 1D                   |
| Number of Scans      | 16                   |
| Receiver Gain        | 36                   |
| Relaxation Delay     | 1.0000               |
| Acquisition Time     | 2.5575               |
| Spectrometer Frequency| 400.43              |
| Spectral Width       | 6406.1               |
| Lowest Frequency     | -800.3               |
| Nucleus              | 1H                   |
Parameter | value
--- | ---
Origin | Varian
Spectrometer | vnmrs
Solvent | cdc13
Temperature | 20.0
Pulse Sequence | s2pul
Experiment | 1D
Number of Scans | 216
Receiver Gain | 30
Relaxation Delay | 2.0000
Acquisition Time | 1.3107
Spectrometer Frequency | 100.53
Spectral Width | 25000.0
Lowest Frequency | -1441.7
Nucleus | 13C
Parameter | Value
--- | ---
Origin | Varian
Spectrometer | mercury
Solvent | cdcl3
Temperature | 25.0
Pulse Sequence | s2pul
Experiment | 1D
Number of Scans | 20
Receiver Gain | 36
Relaxation Delay | 1.0000
Acquisition Time | 2.5575
Spectrometer Frequency | 400.43
Spectral Width | 6406.1
Lowest Frequency | -800.3
Nucleus | 1H
Parameter | Value
---|---
Origin | Varian
Spectrometer | Vnmrs
Solvent | CDCl3
Temperature | 20.0
Pulse Sequence | S2pul
Experiment | 1D
Number of Scans | 176
Receiver Gain | 30
Relaxation Delay | 2.0000
Acquisition Time | 1.3107
Spectrometer Frequency | 100.53
Spectral Width | 25000.0
Lowest Frequency | -1455.5
Nucleus | 13C
Parameter | value 
--- | --- 
Origin | Varian 
Spectrometer | vnmrs 
Solvent | cdcl3 
Temperature | 20.0 
Pulse Sequence | s2pul 
Experiment | 1D 
Number of Scans | 144 
Receiver Gain | 30 
Relaxation Delay | 2.0000 
Acquisition Time | 1.3107 
Spectrometer Frequency | 100.53 
Spectral Width | 25000.0 
Lowest Frequency | -1459.3 
Nucleus | 13C 

![NMR Spectrum](image-url)
Parameter | Value
--- | ---
Origin | Varian
Spectrometer | mercury
Solvent | cdcl3
Temperature | 25.0
Pulse Sequence | s2pul
Experiment | 1D
Number of Scans | 16
Receiver Gain | 30
Relaxation Delay | 1.0000
Acquisition Time | 2.5575
Spectrometer Frequency | 400.43
Spectral Width | 6406.1
Lowest Frequency | -800.0
Nucleus | 1H
Parameter                  value
Origin                      Varian
Spectrometer                vnmrs
Solvent                     cdcl3
Temperature                 20.0
Pulse Sequence              s2pul
Experiment                  1D
Number of Scans             168
Receiver Gain               30
Relaxation Delay            2.0000
Acquisition Time            1.3107
Spectrometer Frequency      100.53
Spectral Width              25000.0
Lowest Frequency            -1451.3
Nucleus                     13C
Parameter | Value
---|---
Origin | Varian
Spectrometer | mercury
Solvent | cdcl3
Temperature | 25.0
Pulse Sequence | s2pul
Experiment | 1D
Number of Scans | 28
Receiver Gain | 26
Relaxation Delay | 1.0000
Acquisition Time | 2.5575
Spectrometer Frequency | 400.43
Spectral Width | 6406.1
Lowest Frequency | -800.0
Nucleus | 1H
Parameter | value
---|---
Origin | Varian
Spectrometer | vnmrs
Solvent | cdcl3
Temperature | 20.0
Pulse Sequence | s2pul
Experiment | 1D
Number of Scans | 96
Receiver Gain | 30
Relaxation Delay | 2.0000
Acquisition Time | 1.3107
Spectrometer Frequency | 100.53
Spectral Width | 25000.0
Lowest Frequency | -1449.0
Nucleus | 13C
Parameter | value
--- | ---
Origin | Varian
Spectrometer | vnmrs
Solvent | cdcl3
Temperature | 20.0
Pulse Sequence | s2pul
Experiment | 1D
Number of Scans | 40
Receiver Gain | 48
Relaxation Delay | 1.0000
Acquisition Time | 2.5559
Spectrometer Frequency | 399.76
Spectral Width | 6410.3
Lowest Frequency | -799.4
Nucleus | 1H
Parameter | value
--- | ---
Origin | Varian
Spectrometer | vnmrs
Solvent | cdcl3
Temperature | 20.0
Pulse Sequence | s2pul
Experiment | 1D
Number of Scans | 8
Receiver Gain | 30
Relaxation Delay | 1.0000
Acquisition Time | 2.5559
Spectrometer Frequency | 399.76
Spectral Width | 6410.3
Lowest Frequency | -806.6
Nucleus | 1H
| Parameter     | Value   |
|---------------|---------|
| Origin        | Varian  |
| Spectrometer  | vnmrs   |
| Solvent       | cdcl3   |
| Temperature   | 20.0    |
| Pulse Sequence| s2pul   |
| Experiment    | 1D      |
| Number of Scans| 1072   |
| Receiver Gain | 30      |
| Relaxation Delay| 2.0000 |
| Acquisition Time| 1.3107 |
| Spectrometer Frequency| 100.53 |
| Spectral Width  | 25000.0 |
| Lowest Frequency| -1413.9 |
| Nucleus       | 13C     |
Parameter | Value
---|---
1 Origin | Varian
2 Spectrometer | vnmrs
3 Solvent | cdcl3
4 Temperature | 20.0
5 Pulse Sequence | s2pul
6 Experiment | 1D
7 Number of Scans | 20
8 Receiver Gain | 30
9 Relaxation Delay | 1.0000
10 Acquisition Time | 2.5559
11 Spectrometer Frequency | 399.76
12 Spectral Width | 6410.3
13 Lowest Frequency | -806.6
14 Nucleus | 1H
Parameter | Value
--- | ---
1 Origin | Varian
2 Spectrometer | vnmrs
3 Solvent | D2O
4 Temperature | 20.0
5 Pulse Sequence | s2pul
6 Experiment | 1D
7 Number of Scans | 1024
8 Receiver Gain | 30
9 Relaxation Delay | 2.0000
10 Acquisition Time | 1.3107
11 Spectrometer Frequency | 100.53
12 Spectral Width | 25000.0
13 Lowest Frequency | -1443.0
14 Nucleus | 13C
Parameter | Value
--- | ---
1. Origin | Varian
2. Spectrometer | vnmrs
3. Solvent | cdcl3
4. Temperature | 20.0
5. Pulse Sequence | s2pul
6. Experiment | 1D
7. Number of Scans | 36
8. Receiver Gain | 30
9. Relaxation Delay | 1.0000
10. Acquisition Time | 2.5559
11. Spectrometer Frequency | 399.76
12. Spectral Width | 6410.3
13. Lowest Frequency | -798.6
14. Nucleus | 1H
| Parameter       | Value                      |
|-----------------|----------------------------|
| 1 Origin        | Varian                     |
| 2 Spectrometer  | vnmrs                      |
| 3 Solvent       | cdcl3                      |
| 4 Temperature   | 20.0                       |
| 5 Pulse Sequence| s2pul                      |
| 6 Experiment    | 1D                         |
| 7 Number of Scans| 80                        |
| 8 Receiver Gain | 30                         |
| 9 Relaxation Delay | 2.0000                  |
| 10 Acquisition Time | 1.3107                |
| 11 Spectrometer Frequency | 100.53          |
| 12 Spectral Width  | 25000.0                   |
| 13 Lowest Frequency    | -1452.2                   |
| 14 Nucleus       | 13C                        |
Parameter       value
Origin          Varian
Spectrometer    vnmrs
Solvent        cdc13
Temperature     20.0
Pulse Sequence  s2pul
Experiment      1D
Number of Scans 1204
Receiver Gain   30
Relaxation Delay 2.0000
Acquisition Time 1.3107
Spectrometer Frequency 100.53
Spectral Width 25000.0
Lowest Frequency -1450.9
Nucleus         13C
Parameter | value
---|---
Origin | Varian
Spectrometer | mercury
Solvent | cdcl3
Temperature | 25.0
Pulse Sequence | s2pul
Experiment | 1D
Number of Scans | 104
Receiver Gain | 30
Relaxation Delay | 1.0000
Acquisition Time | 2.5575
Spectrometer Frequency | 400.43
Spectral Width | 6406.1
Lowest Frequency | -846.9
Nucleus | 1H
| Parameter          | Value       |
|--------------------|-------------|
| Origin             | Varian      |
| Spectrometer       | vnmrs       |
| Solvent            | cdc13       |
| Temperature        | 20.0        |
| Pulse Sequence     | s2pul       |
| Experiment         | 1D          |
| Number of Scans    | 732         |
| Receiver Gain      | 30          |
| Relaxation Delay   | 2.0000      |
| Acquisition Time   | 1.3107      |
| Spectrometer Frequency | 100.53   |
| Spectral Width     | 25000.0     |
| Lowest Frequency   | -1446.3     |
| Nucleus            | 13C         |

![Chemical Structure](image)
Parameter | value
--- | ---
Origin | Varian
Spectrometer | mercury
Solvent | cdcl3
Temperature | 25.0
Pulse Sequence | s2pul
Experiment | 1D
Number of Scans | 28
Receiver Gain | 39
Relaxation Delay | 1.0000
Acquisition Time | 2.5575
Spectrometer Frequency | 400.43
Spectral Width | 6406.1
Lowest Frequency | -800.3
Nucleus | 1H
| Parameter        | Value     |
|------------------|-----------|
| Origin           | Varian    |
| Spectrometer     | vnmrs     |
| Solvent          | cdcl3     |
| Temperature      | 20.0      |
| Pulse Sequence   | s2pul     |
| Experiment       | 1D        |
| Number of Scans  | 120       |
| Receiver Gain    | 30        |
| Relaxation Delay | 2.0000    |
| Acquisition Time | 1.3107    |
| Spectrometer Frequency | 100.53 |
| Spectral Width   | 25000.0   |
| Lowest Frequency | -1454.3   |
| Nucleus          | 13C       |

![NMR spectrum](image-url)
Parameter | value
--- | ---
Origin | Varian
Spectrometer | mercury
Solvent | cdcl3
Temperature | 25.0
Pulse Sequence | s2pul
Experiment | 1D
Number of Scans | 24
Receiver Gain | 39
Relaxation Delay | 1.0000
Acquisition Time | 2.5575
Spectrometer Frequency | 400.43
Spectral Width | 6406.1
Lowest Frequency | -800.0
Nucleus | 1H
Parameter | value
--- | ---
Origin | Varian
Spectrometer | vnmrs
Solvent | cdcl3
Temperature | 20.0
Pulse Sequence | s2pul
Experiment | 1D
Number of Scans | 80
Receiver Gain | 30
Relaxation Delay | 2.0000
Acquisition Time | 1.3107
Spectrometer Frequency | 100.53
Spectral Width | 25000.0
Lowest Frequency | -1418.8
Nucleus | 13C
Parameter value
Origin Varian
Spectrometer mercury
Solvent cdc13
Temperature 25.0
Pulse Sequence s2pul
Experiment 1D
Number of Scans 64
Receiver Gain 39
Relaxation Delay 1.0000
Acquisition Time 2.5575
Spectrometer Frequency 400.43
Spectral Width 6406.1
Lowest Frequency -799.6
Nucleus 1H
Parameter | value
--- | ---
Origin | Varian
Spectrometer | vnmrs
Solvent | cdcl3
Temperature | 20.0
Pulse Sequence | s2pul
Experiment | 1D
Number of Scans | 60
Receiver Gain | 30
Relaxation Delay | 2.0000
Acquisition Time | 1.3107
Spectrometer Frequency | 100.53
Spectral Width | 25000.0
Lowest Frequency | -1446.7
Nucleus | 13C
Parameter value
Origin Varian
Spectrometer mercury
Solvent cdcl3
Temperature 25.0
Pulse Sequence s2pul
Experiment 1D
Number of Scans 72
Receiver Gain 39
Relaxation Delay 1.0000
Acquisition Time 2.5575
Spectrometer Frequency 400.43
Spectral Width 6406.1
Lowest Frequency -800.7
Nucleus 1H
| Parameter          | Value          |
|--------------------|----------------|
| Origin             | Varian         |
| Spectrometer       | vnmrs          |
| Solvent            | cdcl3          |
| Temperature        | 20.0           |
| Pulse Sequence     | z2pul          |
| Experiment         | 1D             |
| Number of Scans    | 448            |
| Receiver Gain      | 30             |
| Relaxation Delay   | 2.0000         |
| Acquisition Time   | 1.3107         |
| Spectrometer Frequency | 100.53  |
| Spectral Width     | 25000.0        |
| Lowest Frequency   | -1443.0        |
| Nucleus            | 13C            |

The image contains a spectrum with chemical shifts ranging from 20.897 to 138.320 ppm. A chemical structure labeled '6d' is also present in the image.
| Parameter                  | Value         |
|----------------------------|---------------|
| Origin                     | Varian        |
| Spectrometer               | vnmrs         |
| Solvent                    | cdcl3         |
| Temperature                | 20.0          |
| Pulse Sequence             | s2pul         |
| Experiment                 | 1D            |
| Number of Scans            | 40            |
| Receiver Gain              | 30            |
| Relaxation Delay           | 1.0000        |
| Acquisition Time           | 2.5559        |
| Spectrometer Frequency     | 399.76        |
| Spectral Width             | 6410.3        |
| Lowest Frequency           | -799.4        |
| Nucleus                    | 1H            |

The diagram shows a 1D NMR spectrum with peaks at various ppm values. The chemical structure of compound 6e is also shown.
| Parameter                     | Value   |
|-------------------------------|---------|
| Origin                        | Varian  |
| Spectrometer                  | vnmrs   |
| Solvent                       | cdc13   |
| Temperature                   | 20.0    |
| Pulse Sequence                | s2pul   |
| Experiment                    | 1D      |
| Number of Scans               | 208     |
| Receiver Gain                 | 30      |
| Relaxation Delay              | 2.0000  |
| Acquisition Time              | 1.3107  |
| Spectrometer Frequency        | 100.53  |
| Spectral Width                | 25000.0 |
| Lowest Frequency              | -1443.1 |
| Nucleus                       | 13C     |
Parameter | Value
--- | ---
Origin | Varian
Spectrometer | vnmrs
Solvent | cdcl3
Temperature | 20.0
Pulse Sequence | s2pul
Experiment | 1D
Number of Scans | 28
Receiver Gain | 58
Relaxation Delay | 1.0000
Acquisition Time | 2.5559
Spectrometer Frequency | 399.76
Spectral Width | 6410.3
Lowest Frequency | -799.4
Nucleus | 1H
| Parameter       | Value          |
|-----------------|----------------|
| Origin          | Varian         |
| Spectrometer    | vnmrs          |
| Solvent         | cdcl3          |
| Temperature     | 20.0           |
| Pulse Sequence  | s2pul          |
| Experiment      | 1D             |
| Number of Scans | 240            |
| Receiver Gain   | 30             |
| Relaxation Delay| 2.0000         |
| Acquisition Time| 1.3107         |
| Spectrometer Frequency | 100.53     |
| Spectral Width  | 25000.0        |
| Lowest Frequency| -1445.5        |
| Nucleus         | 13C            |
1. Origin: Varian
2. Spectrometer: vnmrs
3. Solvent: cdcl3
4. Temperature: 20.0
5. Pulse Sequence: s2pul
6. Experiment: 1D
7. Number of Scans: 88
8. Receiver Gain: 30
9. Relaxation Delay: 1.0000
10. Acquisition Time: 2.5559
11. Spectrometer Frequency: 399.76
12. Spectral Width: 6410.3
13. Lowest Frequency: -799.0
14. Nucleus: 1H
| Parameter       | Value               |
|-----------------|---------------------|
| 1   Origin      | Varian              |
| 2   Spectrometer| vnmrs               |
| 3   Solvent     | cdcl₃               |
| 4   Temperature | 20.0                |
| 5   Pulse Sequence| s2pul               |
| 6   Experiment  | 1D                  |
| 7   Number of Scans | 2016              |
| 8   Receiver Gain | 30                  |
| 9   Relaxation Delay | 2.0000            |
| 10  Acquisition Time | 1.3107           |
| 11  Spectrometer Frequency | 100.53          |
| 12  Spectral Width | 25000.0            |
| 13  Lowest Frequency | -1441.8            |
| 14  Nucleus     | 13C                 |
Parameters

| Parameter | Value |
|-----------|-------|
| 1 Origin  | Varian |
| 2 Spectrometer | vnmrs |
| 3 Solvent | cdcl3 |
| 4 Temperature | 20.0 |
| 5 Pulse Sequence | s2pul |
| 6 Experiment | 1D |
| 7 Number of Scans | 1360 |
| 8 Receiver Gain | 30 |
| 9 Relaxation Delay | 2.0000 |
| 10 Acquisition Time | 1.3107 |
| 11 Spectrometer Frequency | 100.53 |
| 12 Spectral Width | 25000.0 |
| 13 Lowest Frequency | -1443.1 |
| 14 Nucleus | 13C |
Parameter | value
--- | ---
Origin | Varian
Spectrometer | mercury
Solvent | CDCl3
Temperature | 29.0
Pulse Sequence | s2pul
Experiment | 1D
Number of Scans | 80
Receiver Gain | 20
Relaxation Delay | 0.0000
Acquisition Time | 2.8000
Spectrometer Frequency | 400.44
Spectral Width | 6006.0
Lowest Frequency | -476.4
Nucleus | 1H
Parameter       value
Origin           Varian
Spectrometer     vnmrs
Solvent          cdcl3
Temperature      20.0
Pulse Sequence   s2pul
Experiment       1D
Number of Scans  612
Receiver Gain    30
Relaxation Delay 2.0000
Acquisition Time 1.3107
Spectrometer Frequency 100.53
Spectral Width   25000.0
Lowest Frequency -1443.2
Nucleus          13C
Parameter | Value
--- | ---
1 Origin | Varian
2 Spectrometer | vnms
3 Solvent | cdcl3
4 Temperature | 20.0
5 Pulse Sequence | s2pul
6 Experiment | 1D
7 Number of Scans | 52
8 Receiver Gain | 18
9 Relaxation Delay | 1.0000
10 Acquisition Time | 2.5559
11 Spectrometer Frequency | 399.76
12 Spectral Width | 6410.3
13 Lowest Frequency | -797.8
14 Nucleus | 1H
| Parameter       | Value          |
|-----------------|----------------|
| Origin          | Varian         |
| Spectrometer    | vnmrs          |
| Solvent         | cdcl3          |
| Temperature     | 20.0           |
| Pulse Sequence  | s2pul          |
| Experiment      | 1D             |
| Number of Scans | 440            |
| Receiver Gain   | 30             |
| Relaxation Delay| 2.0000         |
| Acquisition Time| 1.3107         |
| Spectrometer Frequency | 100.53   |
| Spectral Width  | 25000.0        |
| Lowest Frequency| -1454.3        |
| Nucleus         | 13C            |

Parameter 10: Spectrometer Frequency
Parameter 12: Spectral Width
Parameter 13: Lowest Frequency
Parameter 14: Nucleus
Parameter | Value
--- | ---
1 Origin | Varian
2 Spectrometer | vnmrs
3 Solvent | cdcl3
4 Temperature | 20.0
5 Pulse Sequence | s2pul
6 Experiment | 1D
7 Number of Scans | 24
8 Receiver Gain | 30
9 Relaxation Delay | 1.0000
10 Acquisition Time | 2.5559
11 Spectrometer Frequency | 399.76
12 Spectral Width | 6410.3
13 Lowest Frequency | -806.6
14 Nucleus | 1H
Parameter | Value
---|---
1 Origin | Varian
2 Spectrometer | vnmrs
3 Solvent | cdcl3
4 Temperature | 20.0
5 Pulse Sequence | s2pul
6 Experiment | 1D
7 Number of Scans | 2408
8 Receiver Gain | 30
9 Relaxation Delay | 2.0000
10 Acquisition Time | 1.3107
11 Spectrometer Frequency | 100.53
12 Spectral Width | 25000.0
13 Lowest Frequency | -1451.3
14 Nucleus | 13C