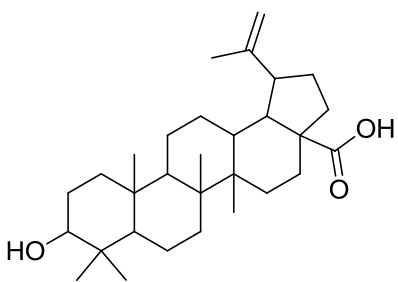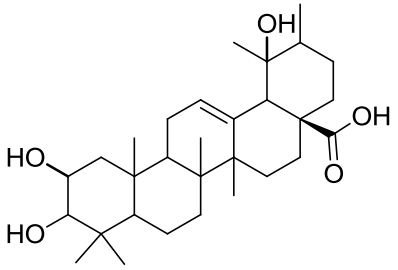# Supplementary Material

Tormentic acid used in this study was obtained by column chromatography from leaf extracts of *C. citrinus* in a previous study in our laboratory [8]. The chemical structure, formula and data from mass spectrometry for the fractions obtained from column chromatography are shown in Table 1.

**Table 1: Identity of fractions obtained from *C. citrinus* obtained from column chromatography**

| Fraction | Yield (g) | Identity | m/z | Theoretical Mass | Chemical Formula |
|---|---|---|---|---|---|
| D1 181-183 | 0.0148 | Betulinic acid | 456.3619 | 456.3603 | $C_{30}H_{48}O_3$ |



| Fraction | Yield (g) | Identity | m/z | Theoretical Mass | Chemical Formula |
|---|---|---|---|---|---|
| H1 200-214 | 0.4484 | Betulinic acid | 456.3617 | 456.3603 | $C_{30}H_{48}O_3$ |
| G2 259 | 0.0227 | Betulinic acid | 456.3617 | 456.3603 | $C_{30}H_{48}O_3$ |
| B1 163-169 | 0.0089 | Betulinic acid | 456.3617 | 456.3603 | $C_{30}H_{48}O_3$ |
| CC 190-192 | 0.0212 | Betulinic acid | 456.3611 | 456.3603 | $C_{30}H_{48}O_3$ |
| R2 335-339 | 0.1196 | Tormentic acid | | 488.3502 | $C_{30}H_{48}O_5$ |



| Fraction | Yield (g) | Identity | m/z | Theoretical Mass | Chemical Formula |
|---|---|---|---|---|---|
| O2 317-325 | 0.0297 | Tormentic acid | 488.3502 | 488.3502 | $C_{30}H_{48}O_5$ |
| J2 282-284 | 0.0380 | Tormentic acid | 488.3502 | 456.3603 | $C_{30}H_{48}O_3$ |

| | | | | | | |
|---|---|---|---|---|---|---|
| **P2 326-330** | 0.0297 | Tormentic acid | | | 488.3502 | $C_{30}H_{48}O_5$ |
| **K2 285-287** | 0.1422 | Tormentic acid | | | 488.3502 | $C_{30}H_{48}O_5$ |
| **L2 290-294** | 0.1557 | Tormentic acid | | | 488.3502 | $C_{30}H_{48}O_5$ |
| **M2 295-307** | 0.4117 | Tormentic acid | | | 488.3502 | $C_{30}H_{48}O_5$ |
| **N2 308-316** | 0.3797 | Tormentic acid | | | 488.3502 | $C_{30}H_{48}O_5$ |
| **I2 274-281** | 0.2281 | 23-hydroxyurs-12-en-24-oic | 472.9872 |  | 472.6997 | $C_{30}H_{48}O_4$ |

A total mass of 100 g leaf extract of *C. citrinus* was loaded on silica gel. The column was developed using a gradient of 100 % hexane to 100 % ethyl acetate and then finally 10 % methanol. A total of 469 fractions were obtained. Fractions were typically labelled as: fraction 181-183 (D1) identified as betulinic acid, fractions 335-339 (R2) identified as tormentic acid and fraction 274-281 (I2) identified as 23-hydroxyurs-12-en-24-oic using mass spectrometry and nuclear magnetic resonance.

Data from Table 1 indicates that from the isolated and identified compounds, tormentic acid was the most abundant with a total yield of 1.3 % of the loaded sample.

**Spectral data for tormentic acid obtained by nuclear magnetic resonance:**

white powder; ^{1}H-NMR (DMSO, 400 MHz) δ (ppm): 5.14 (1H, *br* s, H-12), 3.49 (1H, m), 2.74 (1H, d, *J* = 9.2, H-3), 2.12 (1H, d, *J* = 11.2, H-18), 2.00-1.20 ($CH_2$ and CH region), 1.04 (3H, s, H-27), 0.93 (3H, s, H-23), 0.93 (3H, s, H-25), 0.92 (3H, s, H-30), 0.83 (3H, d, *J* = 6.4, H-29), 0.77 (1H, t, H-5), 0.75 (3H, s, H-26), 0.72 (3H, s, H-24). ^{13}C-NMR (DMSO, 100 MHz) δ (ppm); 178.7 (C-28), 138.7 (C-13), 124.9 (C-12), 82.7 (C-3), 70.2 (C-20), 67.6 (C-2), 55.2 (C-5), 52.8 (C-18) ,47.5 (C-17), 47.5 (C-1), 47.4 (C-9), 46.4 (C-14), 40.5 (C-10), 39.4 (C-8), 39.3 (C-4), 38.9 (C-21), 38.8 (C-19), 36.8 (C-22), 33.0 (C-7), 30.6 (C-16), 29.3 (C-23), 27.9 (C-15), 23.7 (C-27), 23.4 (C-11), 21.5 (C-30), 18.6 (C-6), 17.6 (C-24), 17.5 (C-26), 17.4 (C-24) , 16.9 (C-29), 16.9 (C-25).
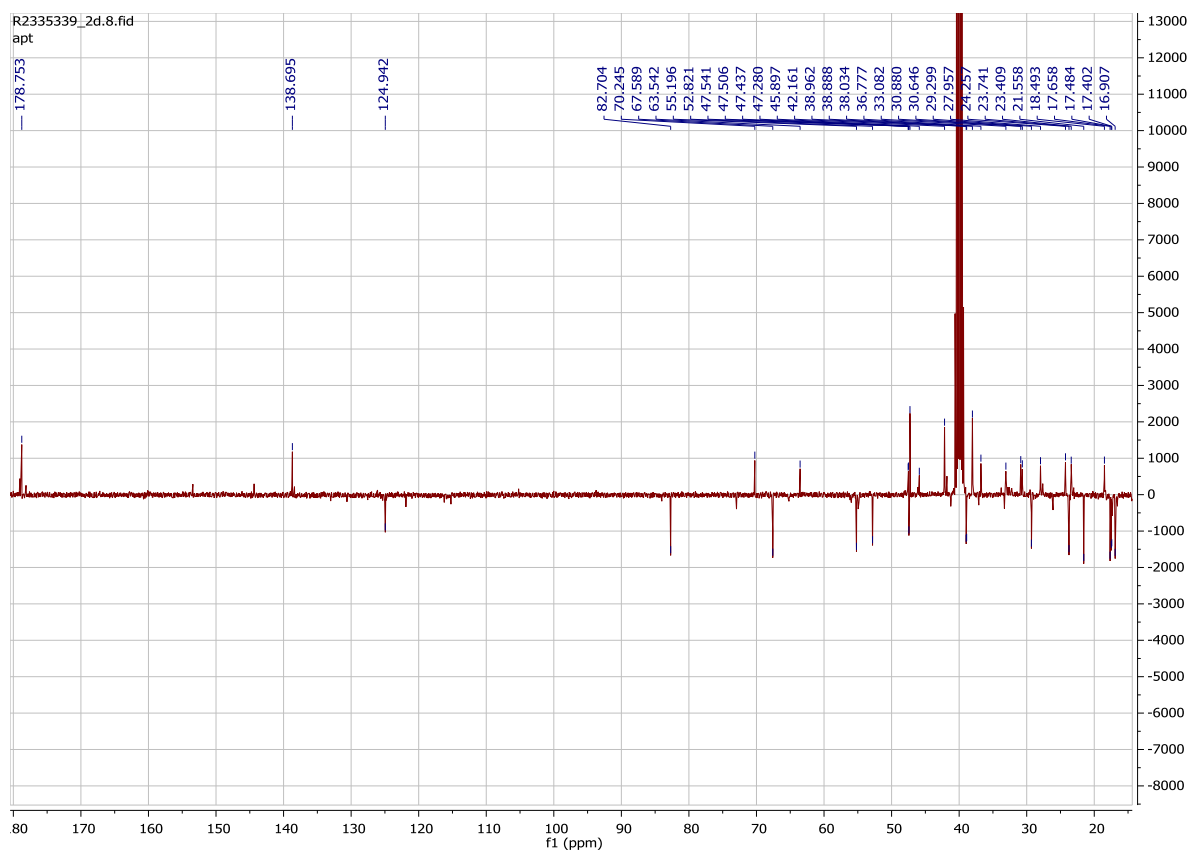
Spectra:
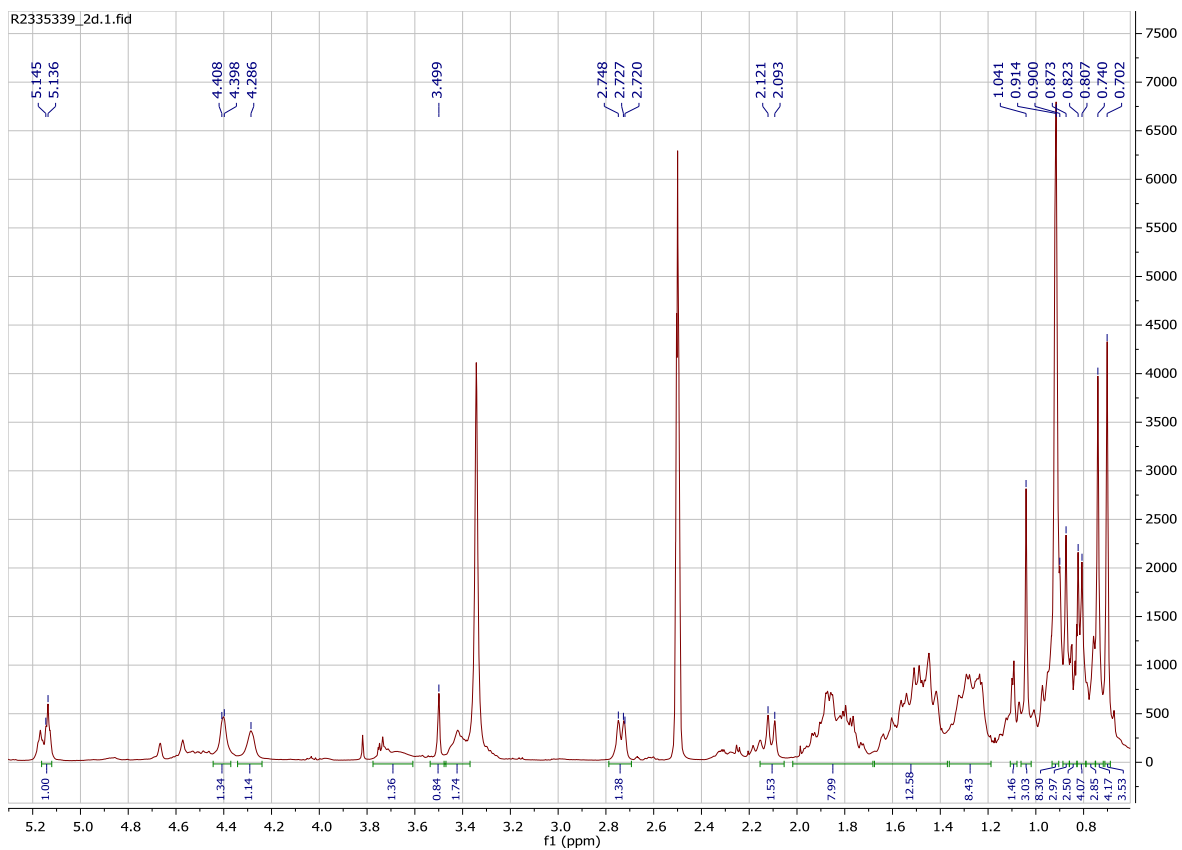
$^1$H NMR (DMSO, 400 MHz) Spectrum of R2 335-339.
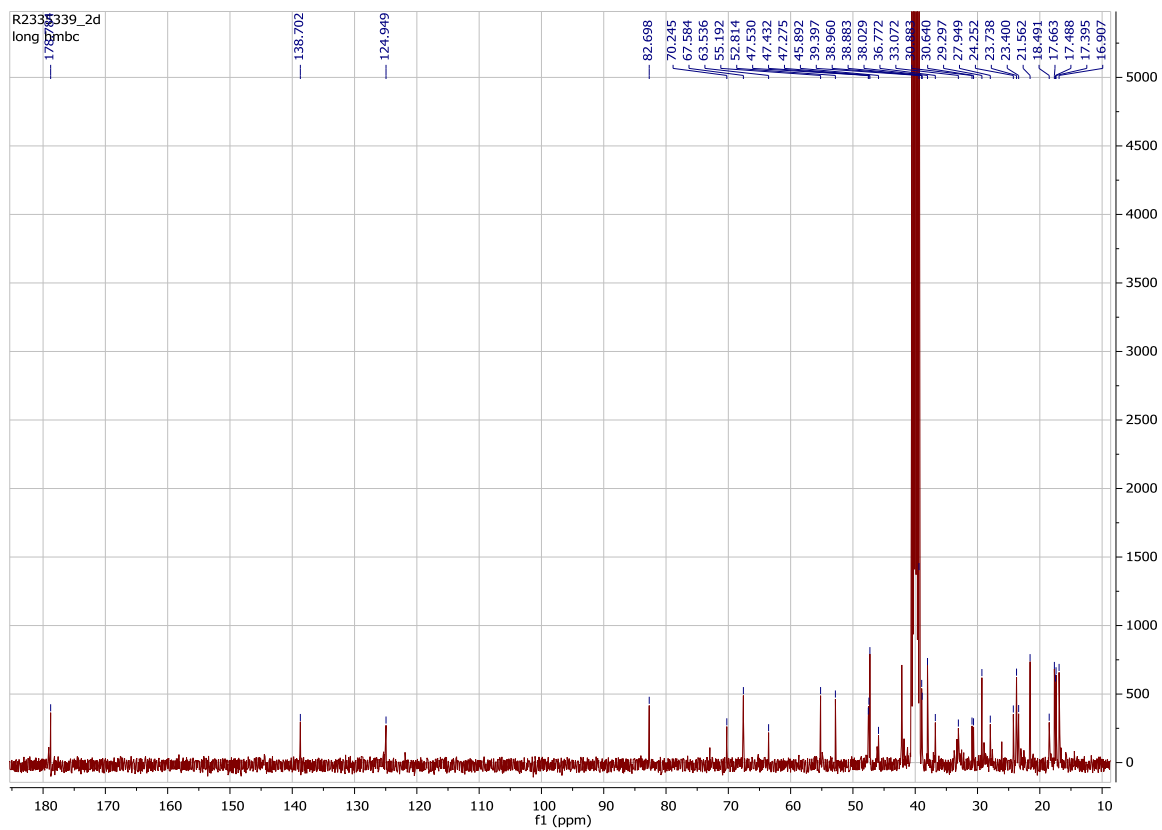


$^{13}$C NMR (DMSO, 100 MHz) Spectrum for R2 335-339.

$^{13}$C APT-NMR (DMSO, 100 MHz) Spectrum for R2 335-339.