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SYNTHESIS AND BIOLOGICAL EVALUATION OF MARUMOSIDE A ISOLATED FROM *MORINGA OLEIFERA* AND ITS LIPID DERIVATIVES

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Keywords:

Moringa oleifera, Marumoside A, Trichloroacetimidate, Anti-inflammatory, Oleoyl amine, Fatty amines.

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ABSTRACT: In the present study, Marumoside A isolated from *Moringa oleifera*, a traditional medicinal plant, was synthesized for the first time using trichloroacetimidate donor as a key step. The aglycone 4-hydroxy phenylacetamide was prepared from 4-hydroxyphenyl acetic acid using oxallyl chloride and aqueous ammonia. The lipid derivatives of Marumoside A were synthesized using different fatty amines. The anti-inflammatory activity of the Marumoside A and its lipid derivatives was evaluated for the inhibition of TNF-α and IL-1β secretion levels. Among all the synthesized molecules, the oleoyl amine lipid (unsaturated) derivative showed significant inhibition of TNF-α and IL-1β secretion with IC_{50} value of 16.7 µM and 23.4 µM, respectively, when compared to Marumoside A and its saturated lipid derivatives. Further, the Marumoside A and its lipid derivatives also showed DPPH radical scavenging activity.

INTRODUCTION: *Moringa oleifera* (horseradish tree) is a fast-growing, multipurpose tree native to tropical and subtropical areas [1, 2] for human, animal feeding and medicinal uses [3, 4]. The green pods, flowers and leaves are used as vegetables in many countries. This plant is known to have a high nutritional value, due to the presence of protein and Vitamins [5].

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In folklore medicine, the various parts of the plant have long been recognized for ailments like pain and inflammation [1, 6-11]. From the different parts of *Moringa oleifera* plant, several types of bioactive compounds have been isolated. In particular, the fruits and leaves, have been reported to contain antiinflammatory and antitumor compounds (i.e., niazirin, niazimicin, niazirin A) of the glycoside type [12, 13].

This plant has been reviewed for the phytochemical composition, medicinal use, pharmacological properties and various pharmaceutical applications [5, 14]. Constituents of this plant like carbamate and thiocarbamate glycosides were extensively studied for different biological activities such as anti-

tumor, antiinflammatory, antimicrobial, antioxidant and antihypertensive activities [11, 13-17]. Recently, Marumoside A and other compounds were isolated from the leaves of *Moringa oleifera* of Thai origin [18]. In Marumoside A, 4-hydroxyphenylethanamide was glycosylated at anomeric hydroxyl group of L-rhamnose in α-configuration.

Further, 4-hydroxyphenylethanamide is structurally related to bioactive compounds like homovanillic acid amides (Capsaicin) [19, 20] and hydroxyphenylacetamides [21, 22]. These compounds have profound antiinflammatory, antinociceptive, analgesic and antiirritant activities. All the above bioactive compounds were derivatives of different lipids (fatty amines and fatty acids) and these lipids are essential for the bioactivity [21, 22]. Moreover, Ben oil is obtained from the seeds of the *Moringa oleifera* in which the principal fatty acids are oleic, palmitic, stearic and behenic acids.

Considering the above facts, in the present study we report the synthesis of Marumoside A and its lipid derivatives and evaluation of antiinflammatory and antioxidant activities for the first time.

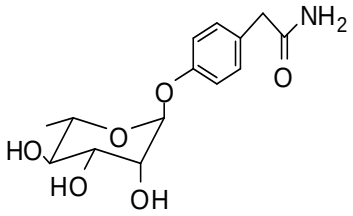


FIG. 1: MARUMOSIDE A STRUCTURE

MATERIALS AND METHODS:

General Materials:

All the chemicals were of analytical grade obtained from different commercial sources and were used without any further purification. All the dry reactions were carried out under nitrogen atmosphere using anhydrous freshly distilled solvents and sieved through molecular sieves (4 Å) in flame dried glassware using standard gas-light syringes and septa. Reactions were monitored on TLC plates (coated with TLC grade silica gel, obtained from Merck) and the spots were detected by iodine vapors. Column chromatography was performed on silica gel (100-200 mesh) procured from Qualigens (India) using freshly distilled solvents. All the ^{1}H-NMR and ^{13}C-NMR spectra were recorded on a Bruker UXNMR (Operating for ^{1}H-NMR at 300 MHz, 500 MHz and for ^{13}C-NMR at 75 MHz, 125 MHz) spectrometer, using TMS (δ = 0) as internal standard for chemical shifts (δ) in $CDCl_3$ at 25 °C. Mass spectra were recorded with HRMS (Electron Spray Ionization Technique). IR spectra were recorded with a Perkin-Elmer FT-IR spectrum BX. The melting points were determined on a Barnstead Electro thermal 9200 instrument.

4-hydroxy phenylacetamide (1):

To a stirred solution of 4-hydroxyphenylacetic acid (5 g) in dichloromethane (50 mL), oxallyl chloride (1.5 eq.) and catalytic amount of DMF was added under N_2 atmosphere and the reaction mixture was stirred at RT for 3h. Later the DCM was evaporated under high vacuum and 35% aq. NH_3 solution was added dropwise under nitrogen atmosphere for disappearance of white fumes. The reaction mixture was stirred for one more hour. Then the reaction mixture was filtered and the filtrate was dissolved in methanol and concentrated under reduced pressure.

The crude product was purified by silica gel column chromatography using a gradient of ethyl acetate: methanol (96: 4, v/v) to give the title compound as white solid (3.52 g, 70%). mp: 173-175 °C, ^{1}H-NMR (300 MHz, DMSO-d_6) δ 8.83 (br s, 1H), 7.0 (d, *J* = 8.12 Hz, 2H), 6.68 (d, *J* = 6.8 Hz, 2H), 6.31 (br d, 1H), 3.31 (s, 2H); ^{13}C-NMR (100 MHz, DMSO-d_6) δ 174, 156.1, 130.3, 126.8, 115.3, 41.7; IR(KBr) 3393.5, 3216.7, 1661, 1612.3, 1514.8, 1412.5, 1229.5, 1177.8, 797.6, 681.7 cm^{-1}; HRMS (ESI) *m/z* [M + H]-calc for $C_8H_{10}O_2N$ = 152.0706 found 152.07008.

General procedure for synthesis of N-alkyl-2-(4-hydroxyphenyl) acetamide:

A mixture of 4-hydroxyphenylacetic acid (1 mmol), and hydroxybenzotriazole (HOBt) (1.2 mmol) in anhydrous DCM (40 mL) was kept at 0°C for 10 min under nitrogen atmosphere with stirring. Then the fatty amine (1.1 mmol) and N-(3-Dimethylaminopropyl) - N′ - ethylcarbodiimide hydrochloride (EDC) (1.2 mmol) was added to the reaction mixture. The reaction mixture was allowed to stir at RT for overnight. After completion of all the starting materials, the reaction mixture was dissolved in DCM (40 mL) and washed with 5**%**

$NaHCO_3$ solution and saturated NaCl solution. The organic layer was dried over anhydrous Na_2SO_4 and evaporated under reduced pressure. The mixture was purified by silica gel column chromatography using a gradient of $CHCl_3$: MeOH (98: 2, v/v) to give title compounds **(2-10)** as light yellowish solids with 80-90% yields.

N-butyl-2-(4-hydroxyphenyl) acetamide (2):
The title compound was obtained in $CHCl_3$: MeOH (98: 2, v/v) solvent system as light yellowish solid with 90% yield (0.621 g). mp: 68-70 °C, ^{1}H-NMR (500 MHz, $CDCl_3$) δ 8.2 (br s, 1H), 7.04 (d, *J* = 8.54 Hz, 2H), 6.84 (d, *J* = 8.54 Hz, 2H), 5.7 (br s, 1H), 3.49 (s, 2H), 3.21 (q, *J* = 7.01, 12.9 Hz, 2H), 1.37–1.43 (m, 2H), 1.21-1.28 (m, 2H), 0.86 (t, *J* = 7.48 Hz, 3H); ^{13}C-NMR (75 MHz, $CDCl_3$) δ 172.7, 172.6, 156.2, 130.5, 125.4, 116.1, 42.7, 39.5, 31.3, 19.8, 13.6; IR(KBr) 3300.6, 3076.5, 2957, 2927.9, 1642.1, 1550.1, 1512.2, 1252.2, 1166.8, 828.1 cm^{-1}; HRMS (ESI) *m/z* [M + H]-calc for $C_{12}H_{18}O_2N$ = 208.1332 found 208.1322.

N-hexyl-2-(4-hydroxyphenyl) acetamide (3):
The title compound was obtained in $CHCl_3$: MeOH (98: 2, v/v) solvent system as light yellowish solid with 88% yield (0.69 g). mp: 80-82 °C, ^{1}H-NMR (500 MHz, $CDCl_3$) δ 8.01 (br s, 1H), 7.05 (d, *J* = 8.39 Hz, 2H), 6.84 (d, *J* = 8.39 Hz, 2H), 5.65 (br s, 1H), 3.5 (s, 2H), 3.2 (q, *J* = 6.86, 13.58 Hz, 2H), 1.38–1.44 (m, 2H), 1.21-1.27 (m, 6H), 0.85 (t, *J* = 6.71 Hz, 3H); ^{13}C-NMR (75 MHz, $CDCl_3$) δ 172.7, 156.2, 130.5, 125.1, 116.1, 42.7, 39.8, 31.2, 29.1, 26.3, 22.4, 13.6; IR(KBr) 3300.6, 3076.5, 2957, 2927.9, 1642.1, 1550.1, 1512.2, 1252.2, 1166.8, 828.1cm^{-1}; ESI-MS *m/z* at 258.32 [M + Na].

N-octyl-2-(4-hydroxyphenyl) acetamide (4):
The title compound was obtained in $CHCl_3$: MeOH (98: 2, v/v) solvent system as light yellowish solid with 89 % yield (0.781 g). mp: 89-91 °C, ^{1}H-NMR (500 MHz, $CDCl_3$) δ 8.2 (br s, 1H), 7.05 (d, *J* = 7.6 Hz, 2H), 6.84 (d, *J* = 8.39 Hz, 2H), 5.67 (br s, 1H), 3.5 (s, 2H), 3.2 (q, *J* = 6.4, 13.1 Hz, 2H), 1.4–1.44 (m, 2H), 1.22-1.27 (m, 10H), 0.86 (t, *J* = 6.8 Hz, 3H); ^{13}C-NMR (75 MHz, $CDCl_3$) δ 172.7, 156.2, 130.5, 125.1, 116.1, 42.6, 39.8, 31.6, 29.2, 29.06, 26.6, 22.5, 14.0; IR(KBr) 3298.8, 3076.9, 2957.6, 2921.3, 2851.6, 1641.2, 1550.8, 1513.1, 1254, 1167.2, 828.4 cm^{-1}; HRMS (ESI) *m/z* [M + H]-calc for $C_{16}H_{26}O_2N$ = 264.1958 found 264.1945.

N-decyl-2-(4-hydroxyphenyl) acetamide (5):
The title compound was obtained in $CHCl_3$: MeOH (98: 2, v/v) solvent system as light yellowish solid with 86% yield (0.835 g). mp: 99-101 °C, ^{1}H-NMR (500 MHz, $CDCl_3$+DMSO-d_6) δ 9.0 (br s, 1H), 7.48 (br s, 1H), 7.05 (d, *J* = 8.2 Hz, 2H), 6.7 (d, *J* = 6.7 Hz, 2H), 3.3 (s, 2H), 3.09 (q, *J* = 5.9, 12.5 Hz, 2H), 1.39–1.45 (m, 2H), 1.24 (s, 14H), 0.87 (t, *J* = 6.5 Hz, 3H); ^{13}C-NMR (75 MHz, $CDCl_3$+DMSO-d_6) δ 169.7, 154.5, 128.4, 124.9, 113.7, 40.3, 37.8, 30.1, 27.8, 27.6, 25.2, 20.9, 12.6; IR(KBr) 3298.8, 3076.9, 2957.6, 2921.3, 2851.6, 1641.2, 1550.8, 1513.1, 1254, 1167.2, 828.4 cm^{-1}; HRMS (ESI) *m/z* [M + H]-calc for $C_{18}H_{30}O_2N$ = 292.2271 found 292.2256.

N-dodecyl-2-(4-hydroxyphenyl) acetamide (6):
The title compound was obtained in $CHCl_3$: MeOH (98: 2, v/v) solvent system as light yellowish solid with 87% yield (0.926 g). mp: 103-105 °C, ^{1}H-NMR (500 MHz, $CDCl_3$+DMSO-d_6) δ 9.0 (br s, 1H), 7.52 (br s, 1H), 7.05 (d, *J* = 8.2 Hz, 2H), 6.7 (d, *J* = 8.3 Hz, 2H), 3.3 (s, 2H), 3.08 (q, *J* = 6.4, 12.8 Hz, 2H), 1.39–1.44 (m, 2H), 1.24 (s, 18H), 0.87 (t, *J* = 5.5 Hz, 3H); ^{13}C-NMR (125 MHz, $CDCl_3$+DMSO-d_6) δ 170, 154.7, 128.6, 125.08, 114.06, 40.9, 37.9, 30.4, 28.09, 27.8, 25.4, 21.1, 12.8; IR(KBr) 3400.2, 3292, 3070.2, 2956.6, 2919.5, 2849.8, 1655.7, 1629.8, 1562.1, 1513.4, 1253.8, 1165.1, 823.3 cm^{-1}; HRMS (ESI) *m/z* [M + H]-calc for $C_{20}H_{34}O_2N$ = 320.2584 found 320.2572.

N-tetradecyl-2-(4-hydroxyphenyl) acetamide (7):
The title compound was obtained in $CHCl_3$: MeOH (98: 2, v/v) solvent system as light yellowish solid with 85% yield (0.984 g). mp: 105.5-107 °C, ^{1}H-NMR (300 MHz, $CDCl_3$+DMSO-d_6) δ 8.87 (br s, 1H), 7.07 (d, *J* = 7.55 Hz, 2H), 6.81 (d, *J* = 7.55 Hz, 2H), 6.07 (br s, 1H), 3.43 (s, 2H), 3.14 (q, *J* = 6.4, 12.6 Hz, 2H), 1.37–1.44 (m, 2H), 1.24 (s, 22H), 0.88 (t, *J* = 4.5 Hz, 3H); ^{13}C-NMR (75 MHz, $CDCl_3$+DMSO-d_6) δ 171.06, 155.7, 129.6, 125.2, 115.1, 42.08, 38.8, 31.2, 28.9, 28.6, 26.1, 22, 13.5; IR(KBr) 3400.2, 3292, 3070.2, 2956.6, 2919.5, 2849.8, 1655.7, 1629.8, 1562.1, 1513.4, 1253.8,

1165.1, 823.3 cm^{-1}; HRMS (ESI) *m/z* [M + H]-calc for $C_{22}H_{38}O_2N$ = 348.2897 found 348.2885.

N-hexadecyl-2-(4-hydroxyphenyl) acetamide (8):
The title compound was obtained in $CHCl_3$: MeOH (98: 2, v/v) solvent system as light yellowish solid with 82% yield (1.02 g). mp: 108-111 °C, ^{1}H-NMR (500 MHz, $CDCl_3$+DMSO-d_6) δ 8.75 (br s, 1H), 7.06 (d, *J* = 8.08 Hz, 2H), 6.83 (d, *J* = 8.24 Hz, 2H), 5.73 (br s, 1H), 3.45 (s, 2H), 3.16 (q, *J* = 6.4, 13.12 Hz, 2H), 1.38–1.42 (m, 2H), 1.25 (s, 26H), 0.88 (t, *J* = 6.2 Hz, 3H); ^{13}C-NMR (125 MHz, $CDCl_3$+DMSO-d_6) δ 170.7, 155.5, 129.3, 125.3, 114.8, 41.8, 38.6, 31.04, 28.8, 28.4, 26.04, 21.8, 13.37; IR(KBr) 3421.6, 3293.4, 2918.9, 2849, 1634.1, 1559.4, 1514.3, 1256, 1167.7, 821.7 cm^{-1}; HRMS (ESI) *m/z* [M + H]-calc for $C_{24}H_{42}O_2N$ = 376.321 found 376.3207.

N-octadecyl-2-(4-hydroxyphenyl) acetamide (9):
The title compound was obtained in $CHCl_3$: MeOH (98: 2, v/v) solvent system as light yellowish solid with 80% yield (1.07 g). mp: 111-113 °C, ^{1}H-NMR (300 MHz, $CDCl_3$+DMSO-d_6) δ 9.05 (br s, 1H), 7.7 (br s, 1H), 7.04 (d, *J* = 8.3 Hz, 2H), 6.68 (d, *J* = 8.5 Hz, 2H), 3.28 (s, 2H), 3.06 (q, *J* = 6.6, 12.8 Hz, 2H), 1.39–1.43 (m, 2H), 1.25 (s, 30H), 0.88 (t, *J* = 6.2 Hz, 3H); ^{13}C-NMR (75 MHz, $CDCl_3$+DMSO-d_6) δ 169.5, 154.4, 128.3, 124.9, 113.6, 40.5, 37.5, 30.05, 27.8, 27.4, 25.1, 20.8, 12.5; IR(KBr) 3421.6, 3293.4, 2918.9, 2849, 1634.1, 1559.4, 1514.3, 1256, 1167.7, 821.7 cm^{-1}; HRMS (ESI) *m/z* [M + H]-calc for $C_{26}H_{46}O_2N$ = 404.3523 found 404.3518.

N-((Z)-octadec - 9 - enyl) - 2 - (4-hydroxyphenyl) acetamide (10):
The title compound was obtained in $CHCl_3$: MeOH (98: 2, v/v) solvent system as light yellowish solid with 84% yield (1.12 g). mp: 79-81 °C, ^{1}H-NMR (300 MHz, $CDCl_3$) δ 7.06 (d, *J* = 8.12 Hz, 2H), 6.83 (d, *J* = 8.3 Hz, 2H), 5.5 (br s, 1H), 5.32-5.37 (m, 2H), 3.5 (s, 2H), 3.2 (q, *J* = 6.8, 13.4 Hz, 2H), 1.95-2.05(m, 4H), 1.39–1.43 (m, 2H), 1.25 (s, 22H), 0.87 (t, *J* = 6.23 Hz, 3H); ^{13}C-NMR (75 MHz, $CDCl_3$) δ 172.6, 156.2, 130.5, 129.9, 129.6, 125.2, 116.1, 42.7, 39.8, 32.5, 31.8, 29.6, 29.4, 29.2, 29.1, 27.1, 26.7, 22.6, 14.06; IR(KBr) 3427.1, 3291.9, 3095.2, 2920.5, 2849.4, 1633.9, 1560.4, 1514.4, 1254.8, 1102.6, 820.5 cm^{-1}; HRMS (ESI) *m/z* [M + H]-calc for $C_{26}H_{44}O_2N$ = 402.336 found 402.336.

1,2,3,4 – tetra – O -acetate-L-rhamnopyranoside (11):
To a stirred solution of L-rhamnose monohydrate (2 g, 10.97 mmol) in pyridine (15 ml), acetic anhydride (15 ml) was added. The reaction mixture was stirred for 12 h at RT. After completion of the reaction, the reaction mixture was quenched with 1 M HCl. Then the reaction mixture was dissolved in EtOAc and the organic layer was extracted with 1 M HCl and water. The organic layer was dried over anhydrous Na_2SO_4 and concentrated under reduced pressure. The crude product was purified by silica gel chromatography using a gradient of hexane: EtOAc (60: 40, v/v) to semi solid (3.57 g, 98%). ^{1}H-NMR (300 MHz, $CDCl_3$) δ 6.01 (d, *J* = 1.7 Hz, 1H), 5.84 (d, *J* = 0.94 Hz, 1H), 5.24-5.33 (m, 1H), 5.07-5.15 (m, 1H), 3.64-4.15 (m, 1H), 2.23 (s, 3H), 2.16 (s, 3H), 2.07 (s, 3H), 2.01 (s, 3H), 1.22-1.28 (m, 3H); ^{13}C-NMR (75 MHz, $CDCl_3$) δ 170.1, 169.9, 169.6, 168.3, 168.2, 90.5, 90.2, 71.3, 70.5, 70.3, 70.1, 68.7, 68.6, 68.5, 20.7, 20.6, 20.5, 20.4, 17.3, 17.2; IR(Neat) 1752.3, 1433.8, 1371.6, 1222, 1150.1, 1087.8, 1055.5, 973.6 cm^{-1}; HRMS (ESI) *m/z* [M + Na]-calc for $C_{14}H_{20}O_9Na$ = 355.0999 found 355.0994.

2,3,4-tri- O - acetate - L - rhamnopyranose hemiacetal (12):
Hydrazine acetate (1.06 g, 11.59 mmol) was added to a solution of 1,2,3,4-tetra-*O*-acetate-L-rhamnopyranoside **(11)** (3.5 g, 10.54 mmol) in DMF (40 mL) at 50 °C and stirred the reaction for 2 h under N_2. When TLC (1:1, hexane-EtOAc, and v/v) showed the formation of product and the disappearance of starting material, the mixture was diluted with EtOAc, washed with aqueous 5% NaCl and water, dried over anhydrous Na_2SO_4 and concentrated to give yellow oil. This crude oil was subjected to silica gel column chromatography. The required product was eluted in solvent mixture (35: 65, EtOAc: Hexane, v/v) as syrup (92%, 2.81 g). ^{1}H-NMR (300 MHz, $CDCl_3$) δ 5.37 (dd, *J* = 3.4, 10.38 Hz, 1H), 5.27 (m, 1H), 5.16 (m, 1H), 5.01-5.11 (m, 1H), 4.08-4.18 (m, 1H), 2.16 (s, 3H), 2.06 (s, 3H), 2.0 (s, 3H),1.23 (m, 3H); ^{13}C-NMR (125 MHz, $CDCl_3$) δ 170.3, 170.2, 170.1, 169.9, 92.5, 91.9, 71.1, 70.5, 70.3, 68.8, 66.2, 29.6, 20.8, 20.7,

20.6, 17.3; IR(KBr) 3430.7, 2925.6, 1747.3, 1723.1, 1376.5, 1263.8, 1226.7, 1057.7, 978.4 cm^{-1}; HRMS (ESI) *m/z* [M + Na]-calc for $C_{12}H_{18}O_8Na$ = 313.0893 found 313.0887.

2,3,4-tri-O-acetate - α - L - rhamnosyl trichloro acetimidate (13):

2,3,4 – tri - *O*-acetate – L -rhamnopyranose hemiacetal **(12)** (2.8 g, 9.65 mmol) was treated with trichloroacetonitrile (9.68 mL, 86.2 mmol) and DBU (0.29 mL, 3.44 mmol) in anhydrous DCM (30 mL) and stirred for 2 h at RT. Later the reaction mixture was concentrated under reduced pressure and purified by silica gel column chromatography. The required product was eluted in solvent mixture (20: 80, EtOAc: hexane, v/v) with yield (80%, 3.35 g). ^{1}H-NMR (500 MHz, $CDCl_3$) δ 8.73 (s, 1H), 6.18 (d, *J* = 1.83 Hz, 1H), 5.44-5.45 (m, 1H), 5.35 (dd, *J* = 3.35, 10.07 Hz, 1H), 5.16 (t, *J* = 10.07 Hz, 1H), 4.05-4.11 (m, 1H), 2.18 (s, 3H), 2.06 (s, 3H), 1.99 (s, 3H), 1.26 (d, 3H); ^{13}C-NMR (125 MHz, $CDCl_3$) δ 169.9, 169.87, 169.8, 159.9, 94.5, 70.2, 69.2, 68.7, 68, 20.7, 20.5, 17.4.

General procedure for the synthesis of N-alkyl-2-(4-(α-L-rhamnopyranosyl) phenyl) acetamide:

Imidate (**13**) (1 mmol), N-alkyl-2-(4-hydroxyphenyl) acetamides (**2-10**) (1.2 mmol) and molecular sieves (4 Å) were taken in freshly distilled DCM (10 mL) at 0 °C and stirred for 30 min under nitrogen atmosphere. To this reaction mixture TMSOTf (0.3 eq.) was added dropwise at 0 °C and slowly allowed the reaction mixture to RT and stirred for overnight. After completion of all the starting materials, the reaction mixture was filtered and dissolved in $CHCl_3$ (30 mL). The organic layer was extracted with aq. $NaHCO_3$ solution, dried over anhydrous Na_2SO_4 and concentrated under reduced pressure. This crude mixture was dissolved in dry methanol that contained a catalytic amount of sodium methoxide.

The reaction mixture was allowed to stir at ambient temperature for 30 min under nitrogen. After total consumption of starting material, the reaction mixture was neutralized by the addition of Amberlite IR-120 (H^+) resin. Then the reaction mixture was filtered and concentrated under reduced pressure to obtain a crude product. This crude product was purified by silica gel chromatography using a gradient of chloroform: methanol (95: 5, v/v) to give title compounds (**14-22**) as white solids with 65 – 74% yields.

N-butyl-2-(4-(α-L-rhamnopyranosyl) phenyl) acetamide (14):

The title compound was obtained in chloroform: methanol (95: 5, v/v) solvent system as white solid with 74% yield (0.3 g). mp: 122-126 °C, ^{1}H-NMR (500 MHz, $CDCl_3$) δ 7.09 (d, *J* = 7.78 Hz, 2H), 6.96 (d, *J* = 7.62 Hz, 2H), 5.93 (br s, 1H), 5.46 (s, 1H), 4.11 (m, 1H), 3.97 (m, 1H), 3.71-3.74 (m, 1H), 3.55-3.58 (m, 1H), 3.43 (s, 2H), 3.19 (q, *J* = 6.86, 13.27 Hz, 2H), 1.84 (br s, 3H), 1.38-1.44 (m, 2H), 1.24-1.26 (m, overlap, 5H), 0.86 (t, *J* = 7.32 Hz, 3H); ^{13}C-NMR (75 MHz, $CDCl_3$+DMSO-d_6) δ 170, 154.1, 128.9, 128.3, 115.3, 97.4, 71.4, 70.1, 69.4, 68.03, 41.1, 37.9, 30.3, 18.8, 16.7, 12.6; IR(KBr) 3421.8, 2926.2, 1627.8, 1551.6, 1510.1, 1442.4, 1236.9, 1062.7, 1013.6, 837.6, 810.4 cm^{-1}; HRMS (ESI) *m/z* [M + Na]-calc for $C_{18}H_{27}O_6NNa$ = 376.173 found 376.171.

N-hexyl - 2-(4-(α-L-rhamnopyranosyl) phenyl) acetamide (15):

The title compound was obtained in chloroform: methanol (95: 5, v/v) solvent system as semisolid (hygroscopic) with 72% yield (0.316 g). ^{1}H-NMR (300 MHz, $CDCl_3$) δ 7.0 (d, *J* = 7.78 Hz, 2H), 6.88 (d, *J* = 7.62 Hz, 2H), 6.67 (br s, 1H), 5.41 (s, 1H), 4.98 (br s, 3H), 3.98-4.11 (m, 2H), 3.6-3.66 (m, 2H), 3.36 (s, 2H), 3.15 (m, 2H), 1.43 (m, 2H), 1.22 (m, overlap, 9H), 0.83 (t, *J* = 7.32 Hz, 3H); ^{13}C-NMR (100 MHz, $CDCl_3$) δ 171.8, 155, 130.1, 128.7, 116.4, 97.8, 72.5, 71.3, 70.6, 68.9, 42.3, 39.7, 31.3, 29.2, 26.4, 22.3, 17.5, 13.8; IR(KBr) 3421.8, 2926.2, 1627.8, 1551.6, 1510.1, 1442.4, 1236.9, 1062.7, 1013.6, 837.6, 810.4 cm^{-1}; HRMS (ESI) *m/z* [M + H]-calc for $C_{20}H_{32}O_6N$ = 382.222 found 382.221.

N-octyl - 2- (4-(α-L-rhamnopyranosyl) phenyl) acetamide (16):

The title compound was obtained in chloroform: methanol (95: 5, v/v) solvent system as white solid with 71% yield (0.334 g). mp: 108-113 °C, ^{1}H-NMR (300 MHz, $CDCl_3$) δ 6.98 (d, *J* = 7.93 Hz, 2H), 6.86 (d, *J* = 7.74 Hz, 2H), 6.67 (br s, 1H), 5.41 (s, 1H), 4.99 (br s, 3H), 3.97-4.1 (m, 2H), 3.58-3.67

(m, 2H), 3.34 (s, 2H), 3.16 (m, 2H), 1.44 (m, 2H), 1.23 (m, overlap, 13H), 0.85 (t, *J* = 6.23 Hz, 3H); ^{13}C-NMR (100 MHz, $CDCl_3$) δ 171.7, 155.1, 130.2, 128.7, 116.6, 97.9, 72.6, 71.4, 70.7, 68.9, 42.4, 39.8, 31.7, 29.6, 29.3, 29.2, 29.1, 26.8, 22.5, 17.5, 14; IR(KBr) 3415.8, 2925.7, 2856.4, 1645.2, 1554.7, 1512.4, 1235.3, 1124.1, 838.2 cm^{-1}; HRMS (ESI) *m/z* [M + H]-calc for $C_{22}H_{36}O_6N$ = 410.253 found 410.252.

N-decyl - 2 - (4-(α-L-rhamnopyranosyl) phenyl) acetamide (17):

The title compound was obtained in chloroform: methanol (95: 5, v/v) solvent system as white solid with 69% yield (0.346 g). mp: 120-124 °C, ^{1}H-NMR (500 MHz, $CDCl_3$) δ 7.02 (d, *J* = 8.54 Hz, 2H), 6.9 (d, *J* = 8.4 Hz, 2H), 6.34 (br s, 1H), 5.42 (s, 1H), 4.61 (br s, 3H), 4.1 (m, 1H), 3.98 (d, *J* = 7.93 Hz, 1H), 3.7 (m, 1H), 3.58 (t, *J* = 9.15 Hz, 1H), 3.38 (s, 2H), 3.16 (q, J = 6.56, 13.42 Hz, 2H), 1.43-1.45 (m, 2H), 1.23 (m, overlap, 17H), 0.86 (t, *J* = 6.86 Hz, 3H); ^{13}C-NMR (100 MHz, $CDCl_3$) δ 171.7, 155.2, 130.2, 128.7, 116.6, 97.9, 72.7, 71.4, 70.7, 68.9, 42.5, 39.8, 31.8, 29.5, 29.4, 29.2, 26.9, 22.6, 17.5, 14; IR(KBr) 3300.5, 2923.9, 2853.4, 1643.5, 1552.3, 1511.4, 1235.7, 1062.3, 983.3, 838, 811.4 cm^{-1}; HRMS (ESI) *m/z* [M + H]-calc for $C_{24}H_{40}O_6N$ = 438.285 found 438.283.

N-dodecyl-2- (4-(α-L-rhamnopyranosyl) phenyl) acetamide (18):

The title compound was obtained in chloroform: methanol (95: 5, v/v) solvent system as white solid with 66% yield (0.353 g). mp: 125-127 °C, ^{1}H-NMR (500 MHz, $CDCl_3$+DMSO-d_6) δ 7.18 (d, *J* = 8.54 Hz, 2H), 7.0 (d, *J* = 8.54 Hz, 2H), 6.49 (br s, 1H), 5.44 (d, *J* = 1.37 Hz, 1H), 4.4 (d, *J* = 3.5 Hz, 1H), 4.29 (d, *J* = 4.12 Hz, 1H), 4.26 (d, *J* = 5.95 Hz, 1H), 4.05 (m, 1H), 3.86-3.9 (m, 1H), 3.66-3.72 (m, 1H), 3.48-3.53 (m, 1H), 3.45 (s, 2H), 3.16 (q, *J* = 7.01, 14.03 Hz, 2H), 1.42-1.45 (m, 2H), 1.24 (m, overlap, 21H), 0.87 (t, *J* = 6.86 Hz, 3H); ^{13}C-NMR (75 MHz, $CDCl_3$+DMSO-d_6) δ 170.6, 154.8, 129.6, 128.3, 115.9, 97.6, 72.2, 70.8, 69.9, 68.3, 41.9, 38.9, 31.2, 28.9, 28.6, 26.2, 21.2, 17.1, 13.5; IR(KBr) 3452.5, 3343.3, 2955.2, 2920.2, 1624.9, 1546.7, 1510.8, 1239.7, 1086.5, 1007.2, 984.4, 837.1, 813 cm^{-1}; HRMS (ESI) *m/z* [M + Na]-calc for $C_{26}H_{43}O_6NNa$ = 488.298 found 488.297.

N-tetradecyl - 2 - (4-(α-L-rhamnopyranosyl) phenyl) acetamide (19):

The title compound was obtained in chloroform: methanol (95: 5, v/v) solvent system as white solid with 67% yield (0.38 g). mp: 127-129.5 °C, ^{1}H-NMR (500 MHz, $CDCl_3$+DMSO-d_6) δ 7.18 (d, *J* = 8.54 Hz, 2H), 7.02 (d, *J* = 8.54 Hz, 2H), 5.97 (br s, 1H), 5.46 (s, 1H), 4.07-4.19 (m, 3H), 3.89-3.94 (m, 1H), 3.69-3.74 (m, 1H), 3.5-3.54 (m, 1H), 3.47 (s, 2H), 3.18 (q, *J* = 6.86, 13.58 Hz, 2H), 1.43-1.44 (m, 2H), 1.25 (m, overlap, 25H), 0.87 (t, *J* = 6.86 Hz, 3H); ^{13}C-NMR (75 MHz, $CDCl_3$+DMSO-d_6) δ 170.5, 154.8, 129.5, 128.3, 115.9, 97.7, 72.1, 70.8, 69.9, 68.3, 41.9, 38.9, 31.1, 28.9, 28.6, 26.2, 21.9, 17.1, 13.5; IR(KBr) 3451.7, 3342.9, 2920.3, 2850.7, 1625, 1546.6, 1510.6, 1240.5, 1086.8, 1007.4, 984.4, 836.3, 812.6 cm^{-1}; ESI-MS *m/z* at 516 [M + Na].

N-hexadecyl – 2 - (4-(α-L-rhamnopyranosyl) phenyl) acetamide (20):

The title compound was obtained in chloroform: methanol (95: 5, v/v) solvent system as white solid with 66% yield (0.395 g). mp: 110-115 °C, ^{1}H-NMR (500 MHz, $CDCl_3$+DMSO-d_6) δ 7.18 (d, *J* = 8.08 Hz, 2H), 6.97 (d, *J* = 8.54 Hz, 2H), 5.39 (br s, 1H), 4.72 (m, 1H), 4.57 (m, 1H), 4.32 (m, 1H), 3.99 (m, 1H), 3.81 (m, 1H), 3.62-3.67 (m, 1H), 3.43-3.46 (m, 1H), 3.41 (s, 2H), 3.13 (q, *J* = 7.01, 13.58 Hz, 2H), 1.43 (m, 2H), 1.25 (m, overlap, 29H), 0.87 (t, *J* = 6.41 Hz, 3H); ^{13}C-NMR (100 MHz, $CDCl_3$+DMSO-d_6) δ 170, 154.2, 129, 128.3, 115.4, 97.4, 71.5, 70.2, 69.4, 68, 41.3, 38.3, 30.7, 28.4, 28.1, 25.8, 21.5, 16.7, 13.1; IR(KBr) 3300.3, 2919.6, 2850.3, 1642.9, 1552.2, 1511.2, 1234.7, 1062.6, 1024.3, 983.4, 836.8, 810.7 cm^{-1}; HRMS (ESI) *m/z* [M + Na]-calc for $C_{30}H_{51}O_6NNa$ = 544.360 found 544.360.

N-octadecyl – 2 - (4-(α-L-rhamnopyranosyl) phenyl)acetamide (21):

The title compound was obtained in chloroform: methanol (95: 5, v/v) solvent system as white solid with 65% yield (0.41 g). mp: 112-115 °C, ^{1}H-NMR (500 MHz, $CDCl_3$+DMSO-d_6) δ 7.12 (d, *J* = 7.93 Hz, 2H), 6.88 (d, *J* = 7.78 Hz, 2H), 5.31 (d, *J* = 8.08 Hz, 1H), 3.88 (m, 1H), 3.69-3.71 (m, 2H), 3.57 (m, 1H), 3.49-3.55 (m, 2H), 3.34-3.36 (m, 1H), 3.31 (s, 2H), 3.03 (q, *J* = 5.34, 11.6 Hz, 2H), 1.37 (m, 2H), 1.18 (s, 30H), 1.13 (d, *J* = 5.95 Hz,

3H), 0.81 (t, *J* = 6.25 Hz, 3H); ^{13}C-NMR (125 MHz, $CDCl_3$+DMSO-d_6) δ 169.7, 154, 128.7, 128.2, 115.1, 97.3, 71.3, 69.9, 69.2, 67.9, 50.5, 41, 38, 30.4, 28.2, 27.9, 25.5, 21.2, 16.6, 12.9; IR(KBr) 3305.2, 2919.4, 2850.3, 1643.2, 1552.3, 1511.5, 1234.6, 1063, 1024.9, 983.4, 836.6, 811.3 cm^{-1}; HRMS (ESI) *m/z* [M + H]-calc for $C_{32}H_{56}O_6N$ = 550.410 found 550.409.

N-((Z)-octadec - 9 - en-1-yl) – 2 - (4-(α-L-rhamnopyranosyl)phenyl)acetamide (22):

The title compound was obtained in chloroform: methanol (95: 5, v/v) solvent as white solid with 67% yield (0.454 g). mp: 106-109 °C, ^{1}H-NMR (300 MHz, $CDCl_3$) δ 7.01 (d, *J* = 7.93 Hz, 2H), 6.89 (d, *J* = 7.93 Hz, 2H), 6.41 (br s, 1H), 5.42 (s, 1H), 5.29-5.36 (m, 2H), 4.54-5.01 (m, 3H), 4.11 (m, 1H), 3.99 (m, 1H), 3.67-3.69 (m, 1H), 3.58-3.61 (m, 1H), 3.36 (s, 2H), 3.16 (q, *J* = 6.04, 13.58 Hz, 2H), 1.98-2.0 (m, 4H), 1.45 (m, 2H), 1.25 (s, 23H), 0.87 (t, *J* = 6.23 Hz, 3H); ^{13}C-NMR (100 MHz, $CDCl_3$) δ 171.6, 155.1, 130.2, 129.9, 129.6, 128.7, 116.6, 97.9, 72.7, 71.4, 70.7, 68.9, 42.5, 39.8, 32.5, 31.8, 29.7, 29.6, 29.4, 29.2, 27.1, 26.9, 22.6, 17.6, 14.0; IR(KBr) 3453, 3340, 2924.2, 2852.1, 1626.3, 1550.2, 1511.2, 1240.5, 1130.3, 1065, 1008.5, 984, 837, 812.8 cm^{-1}; HRMS (ESI) *m/z* [M + H]-calc for $C_{32}H_{54}O_6N$ = 548.410 found 548.409.

Marumoside A (23):

Imidate (**13**) (0.5 g, 1.15 mmol), 4-hydroxyphenylacetamide (**1**) (0.208 g, 1.37 mmol) and molecular sieves (4 Å) were taken in freshly distilled DCM (10 mL) at 0 °C and stirred for 30 min under nitrogen atmosphere. To this reaction mixture, TMSOTf (0.3 eq.) was added dropwise at 0 °C and slowly allowed the reaction mixture to RT and stirred for overnight. After completion of all the starting materials, the reaction mixture was filtered and dissolved in $CHCl_3$ (30 mL). The organic layer was extracted with aq. $NaHCO_3$ solution, dried over anhydrous Na_2SO_4 and concentrated under reduced pressure. This crude mixture was dissolved in dry methanol that contained a catalytic amount of sodium methoxide. The reaction mixture was allowed to stir at ambient temperature for 30 min under nitrogen. After total consumption of starting material, the reaction mixture was neutralized by the addition of Amberlite IR-120 (H^+) resin. Then the reaction mixture was filtered and concentrated under reduced pressure to obtain a crude product. This crude product was purified by silica gel chromatography using a gradient of chloroform: methanol (92: 8, v/v) to obtain the title compound (**23**) as semisolid (0.211 g, 62%). ^{1}H-NMR (500 MHz, DMSO-d_6) δ 7.12 (d, *J* = 8.85 Hz, 2H), 6.95 (br s, 1H), 6.89 (d, *J* = 8.85 Hz, 2H), 6.38 (br s, 1H), 5.3 (s, 1H), 4.77 (m, 1H), 4.61 (m, 1H), 4.41 (m, 1H), 3.92(br s, 1H), 3.72 (br d, *J* = 8.39 Hz, 1H), 3.52-3.59 (m, 2H), 3.34 (s, 2H), 1.13 (d, *J* = 7.17, 3H); ^{13}C-NMR (75 MHz, $CDCl_3$+DMSO-d_6) δ 172.4, 154, 128.9, 128, 115.1, 97.3, 71.2, 69.9, 69.2, 67.9, 40.6, 28.2, 16.6; IR(KBr) 3356.4, 2924.5, 2853.7, 1663.3, 1511.3, 1461.3, 1232.8, 1065.1, 912, 835.6, 722.9 cm^{-1}; HRMS (ESI) *m/z* [M + Na]-calc for $C_{14}H_{19}O_6NNa$ = 320.110 found 320.109.

Antiinflammatory activity:

U937 cells were maintained in RPMI1640, 2mM L-glutathione, 10% FBS, 100U/ml Pen Strep and incubated at 37°C, 5% CO_2, 95% O_2. These cells were grown in T25/T75 flasks. Approximately, 1X10^5 cells/mL were seeded in 24-well culture plate and stimulated with PMA (Phorbol 12-myristate 13-acetate) (10ng/mL) for 24 h to convert the U937 cells in to macrophages. In this stage, the cells will adhere to the wells. After 24h incubation, media was replaced with fresh media. Standard (Prednisolone, 10µM, 1µM, 0.1µM) or test compounds (10µM) were incubated for 1h with the cells in each well. After 1h pre-incubation with compounds, adhered cells were with stimulated with LPS (1µg/mL) for next 24h. After 24h of LPS stimulation, the plates were centrifuged and the supernatant was collected and estimated for various pro inflammatory cytokines employing commercial kits (Ebiosciences, USA.) employing sandwitch ELISA method[23].

DPPH radical scavenging activity:

Antioxidant activity of Marumoside A and its lipid derivatives was assessed on the basis of the free radical scavenging effect on the stable 1, 1-diphenyl-2-picrylhydrazyl (DPPH) by a modified method [24] and the DPPH radical scavenging activity was calculated using the formula [25]

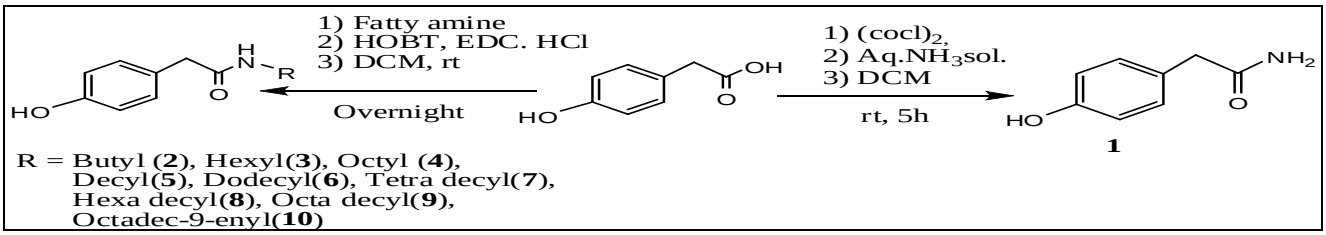
DPPH radical scavenging activity (%) =

[(Absorbance of control – Absorbance of test sample) / (Absorbance of control)] × 100.

The radical scavenging potential was expressed as EC_{50} value, which represents the test compound concentration at which 50% of the DPPH radicals were scavenged. All tests were performed in triplicate and values are represented as mean.

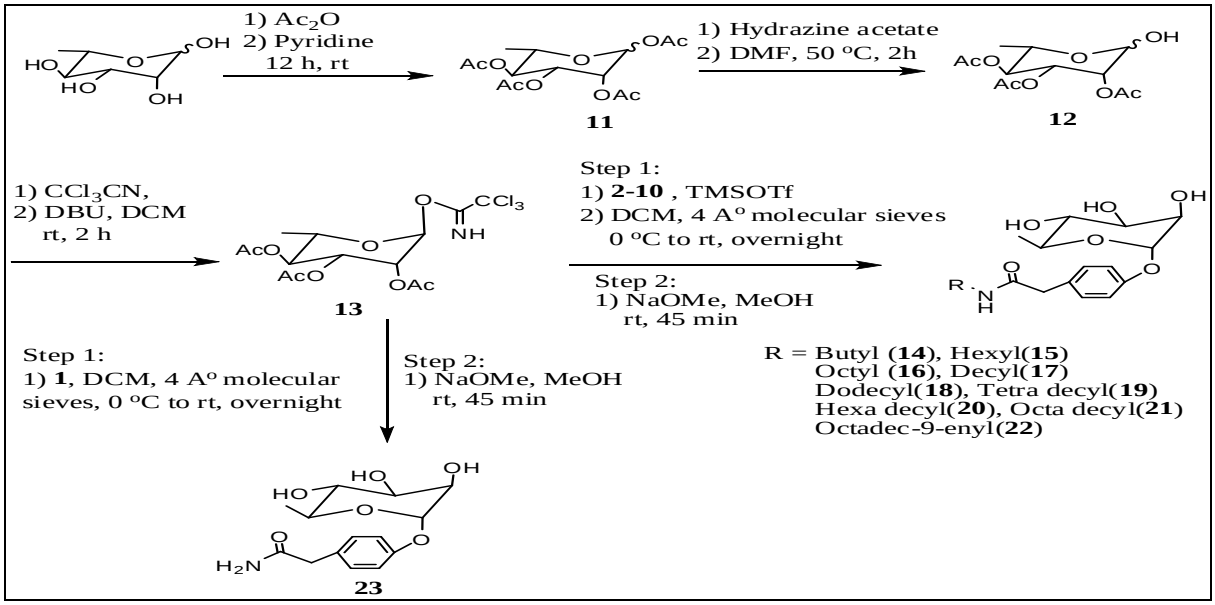
RESULTS AND DISCUSSION:

Chemistry:



SCHEME 1: SYNTHESIS OF 4-HYDROXY PHENYLACETAMIDE AND ITS LIPID DERIVATIVES

As shown in **scheme 1**, the synthesis of Marumoside A starts with the preparation of 4-hydroxy phenylacetamide (**1**) from the 4-hydroxy phenylacetic acid by using oxallyl chloride, aq. ammonia with 70% yield. This was confirmed by ^{1}H-NMR signals which appeared at 6.47, 6.21 ppm for NH_2 group as broad singlet. The coupling of rhamnose unit with 4-hydroxyphenyl acetamide was a key step in the synthesis of Marumoside A. According to **scheme 2**, this was achieved by acetylation of rhamnose with acetic anhydride in pyridine with 98% yield. The chemoselective removal of anomeric acetate group from rhamnose tetra acetate (**11**) was achieved by hydrazine hydrate [26] in DMF by heating at 50 °C for 2 h gave (**12)** with 92% yield. Subsequently, hemiacetal (**12)** was reacted with trichloroacetonitrile in the presence of DBU at RT which exclusively gave α-trichloroacetimidate **13** due to anomeric effect. The coupling of Imidate (**13)** with 4-hydroxy phenylacetamide (**1**) in presence of trimethylsilyl trifluoromethanesulfonate [27, 28] (TMSOTf) at RT, overnight, led to the formation of acetylated Marumoside A. This crude acetylated Marumoside A was used directly for the next deacetylation step of sugar acetate groups in presence of sodium methoxide in MeOH to give Marumoside A (**23**) with 62% yield. The formation of glycosidic bond between 4-hydroxy phenylacetamide and rhamnose was confirmed by ^{1}H-NMR and ^{13}C-NMR, the signals related to anomeric carbon appeared at δ 5.30 ppm (br s) in ^{1}H-NMR and C^{13}-NMR signals at 97.3 ppm.



SCHEME 2: SYNTHESIS OF MARUMOSIDE A AND ITS LIPID DERIVATIVES

NH_2 group signals appeared at 6.95, 6.38 ppm. As per **Table 1**, the ^{1}H- NMR and ^{13}C-NMR signals of compound **23** exactly matched with the isolated molecule [18]. Further the compound **23** was confirmed by IR and HRMS, IR spectrum exhibited characteristic absorption bands at 3356.4 and 2924.5 cm^{-1} for hydroxyl groups and primary amide, respectively, and HRMS peak appeared at *m/z* [M + Na]-calc for $C_{14}H_{19}O_6NNa$ = 320.110 found at 320.109. All the spectral data matches with the isolated compound data [18].

TABLE 1: NMR SPECTROSCOPIC DATA OF COMPOUNDS 23 AND ISOLATED COMPOUND IN REF.18

Position	Compound 23		Isolated compound in Ref. 18	
	^{1}H-NMR	^{13}C-NMR	^{1}H-NMR	^{13}C-NMR
Aglycone				
1	-	172.4	-	172.8
2	3.34 (s, 2H)	40.6	3.30 (s, 2H)	41.5
1'	-	128	-	129.9
2', 6'	7.12 (d, *J* = 8.85 Hz, 2H)	128.9	7.17 (d, *J* = 8.85 Hz, 2H)	130.2
3', 5'	6.89 (d, *J* = 8.85 Hz, 2H)	115.1	6.94 (d, *J* = 8.85 Hz, 2H)	116.3
4'	-	154	-	154.8
NH_2	6.95 (br s, 1H)	-	7.46 (br s, 1H)	-
	6.38 (br s, 1H)	-	6.86 (br s, 1H)	-
Sugar moiety				
1"	5.30 (br s, 1H)	97.3	5.32 (br s, 1H)	98.9
2"	3.91 (br s, 1H)	67.9	3.82 (br s, 1H)	69.3
3"	3.72 (br d, *J* = 8.39 Hz, 1H)	71.2	3.63 (dd, *J* = 9.0, 3.2 Hz, 1H)	81.4
4"	3.38 (m, 1H)	69.9	3.28 (dd, *J* = 9.4, 9.0 Hz, 1H)	71.1
5"	3.55 (m, 1H)	69.2	3.45 (m, 1H)	69.8
6"	1.13 (d, *J* = 7.17, 3H)	16.6	1.09 (d, *J* = 6.0, 3H)	18.2

Subsequently the Marumoside A lipid derivatives were prepared according to **Schemes 1** and **2**. First the coupling of fatty amines with 4-hydroxy phenylacetic acid in presence of HOBt and EDC. HCl gave *N*-alkyl-2-(4-hydroxyphenyl) acetamides (**2-10**) with 80-90% yields. These N-alkyl-2-(4-hydroxyphenyl) acetamides (**2-10**) were coupled with imidate (**13**) in presence TMSOTf to give acylated glycosylated products. These crude acylated glycosylated products underwent deacetylation in presence of sodium methoxide in MeOH to afford *N*-alkyl-2-(4-(α-L-rhamnopyranosyl) phenyl) acetamides (**14-22**) with 65-74% yield.

Biology:

Antiinflammatory Activity:

Moringa oleifera constituents have been recognized for different medicinal uses related to pain and inflammation in folklore medicine and the recent studies also suggest that some of constituents from different parts of *Moringa oleifera* plant also exhibited potential anti-inflammatory activity. In Marumoside A, the aglycone moiety is structurally related to potential antiinflammatory active Capsaicin and hydroxyphenylacetamides, the bioactivity of these compounds strictly depend on the fatty amine moiety. In the present study, the antiinflammatory activities of all the synthesized compounds (**14-23**) were tested and the inhibition of TNF-α and IL-1β secretion as a measure of anti-inflammatory activity was monitored. The data to this regard are presented in **Tables 2** and **3**.

TABLE 2: INHIBITION PERCENTAGE AT 10 µM CONCENTRATION OF MARUMOSIDE A AND ITS LIPID DERIVATIVES

Compound	CONC. (µM)	% Inhibition @10µm	
		TNF-α	IL-1β
Prednisolone	0.5	55.53	42.67
Prednisolone	1	83.70	52.50
23	10	1.67	1.70
14	10	1.24	0.06
15	10	1.60	4.89
16	10	2.84	2.99
17	10	1.24	3.68
18	10	9.75	1.43
19	10	6.19	4.16
20	10	1.67	5.63
21	10	0.15	0.36
22	10	40.32	6.68

From these Tables, the inhibition percentage is very low for Marumoside A and its saturated lipid derivatives (**23**, **14-21)** and these compounds did not show any bioactivity. However, unsaturated analogue (**22)** (oleyl amine) exhibited good anti-

inflammatory activity with significant inhibition of TNF-α and IL-1β secretion with IC_{50} value of 16.7 µM and 23.4 µM, respectively, when compared to Marumoside A and its saturated analogues.

TABLE 3: IC_{50} VALUES OF MARUMOSIDE A AND ITS LIPID DERIVATIVES

Compound	IC_{50} in µM	
	TNF-α	IL-1β
Prednisolone	0.46	0.69
23	ND	ND
14	ND	ND
15	ND	ND
16	ND	ND
17	ND	ND
18	ND	ND
19	ND	ND
20	ND	ND
21	ND	ND
22	16.7	23.4

Antioxidant activity:

Marumoside A and its synthesized derivatives were tested for the DPPH free radical scavenging activity (see **Table 4**). The screened compounds exhibited EC_{50} values ranging between 155 – 915 µg ml^{-1}.

TABLE 4: DPPH RADICAL SCAVENGING ACTIVITY OF MARUMOSIDE A AND ITS LIPID DERIVATIVES

Test compound	EC_{50} (µg ml^{-1}) (Mean ± S.D.)
23	781.6 ± 0.38
14	155.2 ± 0.42
15	183.9 ± 0.54
16	536.7 ± 0.28
17	915.7 ± 0.22
18	761.6 ± 0.28
19	795.9 ± 0.36
20	384.4 ± 0.52
21	769.1 ± 0.48
22	572.2 ± 0.46
BHT	28.5 ± 0.44
α-Tocopherol	10.4 ± 0.22

CONCLUSIONS: In conclusion, for the first time we have synthesized Marumoside A isolated from *Moringa oleifera* and its lipid derivatives using trichloroacetimidate methodology. The aglycone 4-hydroxy phenylacetamide was prepared from 4-hydroxyphenyl acetic acid using oxallyl chloride and aq. ammonia. The lipid derivatives of Marumoside A were synthesized using different fatty amines. The *in vitro* anti-inflammatory activity of the Marumoside A and its lipid derivatives was evaluated and the inhibition of TNF-α and IL-1β secretion was monitored. Among all the synthesized molecules, the unsaturated oleyl amine lipid derivative of Marumoside A exhibited significant inhibitory activity of TNF-α and IL-1β secretion with IC_{50} values of 16.7 and 23.4 µM, respectively.

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