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Oxidation of several triterpenic diene and triene systems. Oxidative cleavage to obtain chiral intermediates for drimane and phenanthrene semi-synthesis

Andrés García-Granados, Pilar E. López, Enrique Melguizo, Andrés Parra* and Yolanda Simeó

Departamento de Química Orgánica, Facultad de Ciencias, Universidad de Granada, 18071 Granada, Spain

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Abstract—An exhaustive oxidation study has been made with ozone, MCPBA and/or $NaIO_4/RuCl_3$ of several triterpenic diene and triene compounds from oleanolic and maslinic acids obtained from olive-oil pressing. Through several oxidative cleavages of the opened C-ring of these oleantrienes, different significant decalin-type chiral synthons were achieved. These sesquiterpene and *nor*-sesquiterpene products are of great interest because by means of several simple reactions they could lead to drimane, phenanthrene and tricyclic triterpene compounds.
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1. Introduction

Triterpenes are a large family of pentacyclic compounds obtained biosynthetically by cyclic reactions from squalene.[1] Oleanolic (3β-hydroxy-12-oleanen-28-oic acid)[2] and maslinic (2α,3β-dihydroxy-12-oleanen-28-oic acid)[2] acids belong to these kinds of natural products widely found in nature, which could be useful to semi-synthesize other biologically or chemically significant compounds.[3] The presence of these two oleanene acids in olive-pressing residues has been frequently reported. A method to obtain large amounts of both compounds from these solid wastes has been reported by our group.[4]

Due to their remarkable biological activities and their olfactory and fixative properties, drimane sesquiterpenes or related compounds are being vigorously sought by the scientific community.[5,6] Likewise, some intermediates useful in the synthesis of drimane sesquiterpenes, such as copalol or albicanol, have been produced.[7] These kinds of products can be obtained by degrading of different terpenes such as sclareol, some abietic acids and glycyrrhetinic acid,[8] which are rarer and more expensive than oleanolic and maslinic acids.

Previous works have dealt with reactivity and rearrangement of several derivatives of oleanolic and maslinic acids, reactions which have provided high yields of several interesting A-ring contracted products.[9] In addition, our group reported the isolation and unequivocal structural assignments of a pair of sulphur diastereomeric cyclic sulphites between C-2 and C-3 of maslinic acid.[10] An interesting synthon for the A- and B-rings of the 4-azasteroids was also semi-synthesized. Recently, we have reported the formation of several C-ring derivatives and the cleavage of the triterpenic molecule.[11,12]

In the present paper, we carry out an oxidative study of above-mentioned derivatives in C-ring with the final aim of cleaving the triterpenic molecule and to produce interesting chiral synthons. In this sense, dienes **3** and **4** were ozonized, triggering epoxidations, hydroxylations and lactonizations in one or the two double bonds of the C-ring. Moreover, the treatment of *cis*-triene **5** with some oxidative reagents such as $NaIO_4/RuCl_3$, MCPBA and ozone led to the same type of derivatives. In turn, oxidation of *trans*-triene **11** with $NaIO_4/RuCl_3$ gave rise to the obtention of two sesquiterpene fragments (**45** and **46**) by C-ring cleavage of the triterpene molecule. Similarly, epoxidation of exocyclic triene **16** and subsequent ozonization of the major product yielded two *nor*-sesquiterpene compounds (**53** and **54**) and two C-16 fragments (**55** and **56**). The products formed from A- and B-rings of the original molecule (compounds **45**, **53** and **54**) could be used as a substrate for the semi-synthesis of significant drimane compounds, such as warburganal, polygodial, etc., since it has structure of 3β-hydroxy-drimenal.[8] Also, the fragments derived from D- and E-rings (products **46**, **55** and **56**) could be transformed into several phenanthrenes, which act as estrogen receptor modulators for the treatment or prevention of a variety of conditions related to estrogen functioning, including bone loss,

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* Corresponding author. Tel.: +34-58-240-480; fax: +34-58-243-364; e-mail address: aparra@ugr.es

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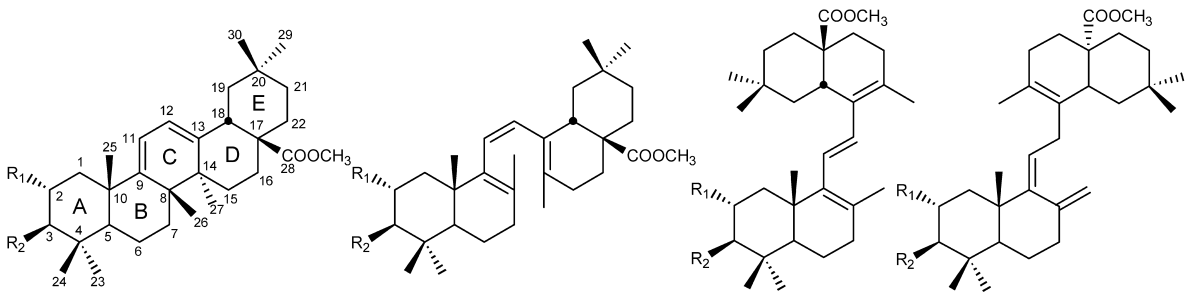


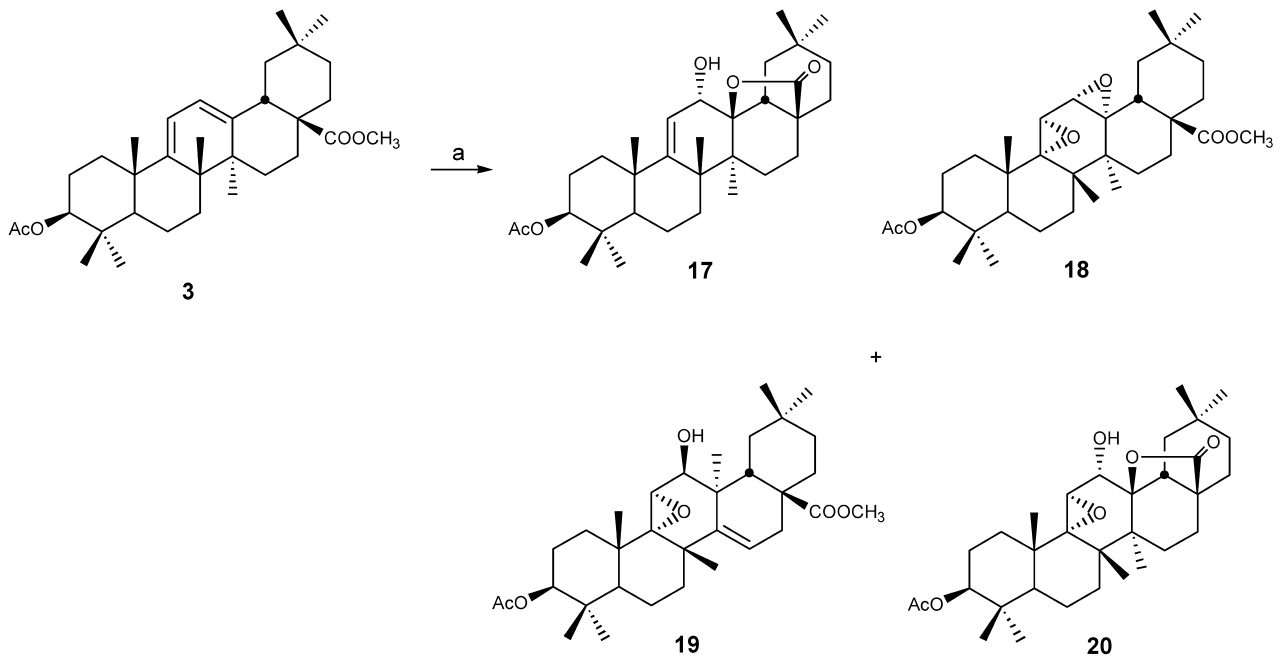
Figure 1. Structures of products **1**–**16**.

osteoporosis, cardiovascular disease, some types of cancer, etc.[13] In addition, these fragments could be used as starting material in the semi-synthesis of natural tricyclic triterpenoids Achilleol B[14] and Camelliol C.[15]

2. Results and discussion

Oleanolic and maslinic acids were isolated from solid wastes resulting from olive-oil production. Dienes **1**–**4** were obtained from the corresponding oleanolic and maslinic esters by a key bromination/dehydrobromination process with NBS (Fig. 1). These products were converted into trienes **5**–**8** by a photochemical reaction with a high-pressure Hg street lamp in a borosilicate flask, whereas trienes **9**–**12** were formed starting from trienes **5**–**8** by chemical isomerization with iodine, and trienes **13**–**16** by photochemical isomerization in a quartz flask. All these processes were described in previous reports.[11,12]

Ozonolysis of diene **3** at a low temperature (−78 °C) for 15 min gave rise to several oxidized products (Scheme 1). The major product, compound **17**, was a lactone formed by the attack of the carboxymethyl group at C-28 on C-13 from the β face and opening of the α-epoxide previously formed between C-12 and C-13 by the ozonolysis process. The C-9/C-11 double bond remained unaltered. This reaction was previously observed in the ozonization[12] and photochemical lactonization[16] of oleanolic acid. In turn, product **18** was produced by epoxidation of the double bonds of the starting material both from the α face, which was the most accessible one. Meanwhile, compound **19** presented a taraxerene structure formed from product **18** by a concerted mechanism. It took place the opening of the epoxide between C-12/C-13, the migration of the methyl group at C-14 to C-13 by the α-face and the formation of a double bond between C-14 and C-15. This way, a β-hydroxyl group was situated at C-12, whereas the α-epoxide between C-9 and C-11 remained unaltered. This change of skeleton was supported by the spectroscopic properties of product **19** and was also observed in the reaction of methyl oleanate with NBS.[12] Finally, compound **20** was formed by the same mechanism as lactone **17** was, but with the epoxidation of the C-9/C-11 double bond also occurring. The structure of

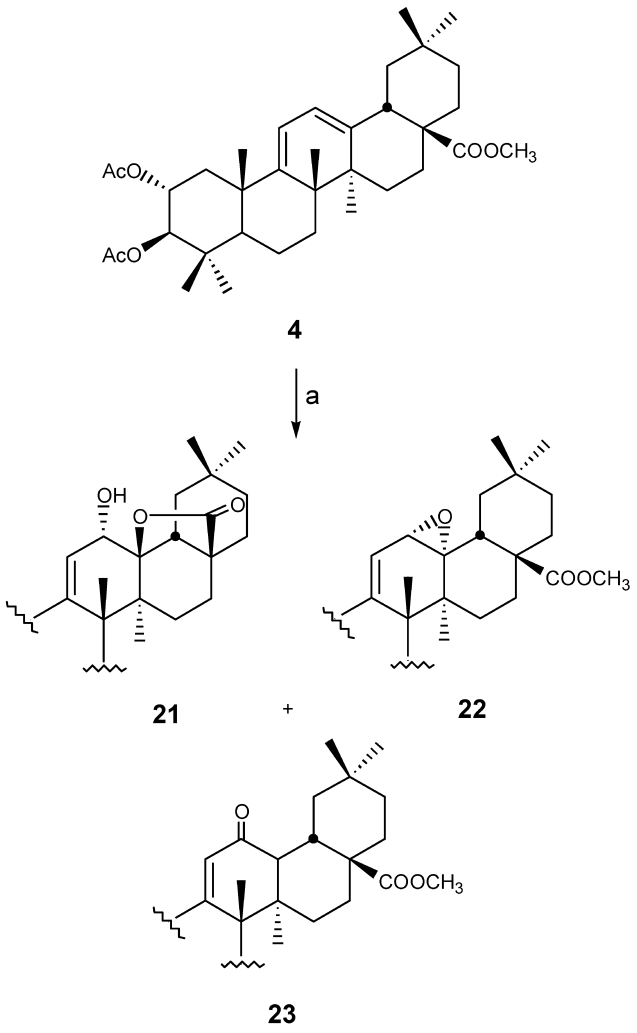


Scheme 1. Reagents and conditions: (a) $O_3/CH_2Cl_2/-78$ °C/15 min/Me_2S/3 h **17** (30%), **18** (20%), **19** (15%) and **20** (7%).

these products suggested that for both double bonds the less hindered face would be the α face.

Likewise, the ozonolysis of diene **4** in MeOH/CH_2Cl_2 4:1 at −78 °C led to several oxidized products, which were similar to those obtained by the ozonization of diene **3** (Scheme 2). Moreover, the major product, lactone **21**, was the equivalent compound to lactone **17**. Oxirane **22** was formed by epoxidation of the double bond between C-12 and C-13 from the less hindered face and the α,β-unsaturated ketone **23** was the result of the evolution of epoxide **22**. According to these structures, we conclude that the C-12/C-13 double bond would be more accessible by the reagent than the C-9/C-11 double bond in the oxidative process. Furthermore, the stereochemistry of all the epoxide and hydroxyl groups of products **17**–**22** was established from their spectroscopic characteristics.

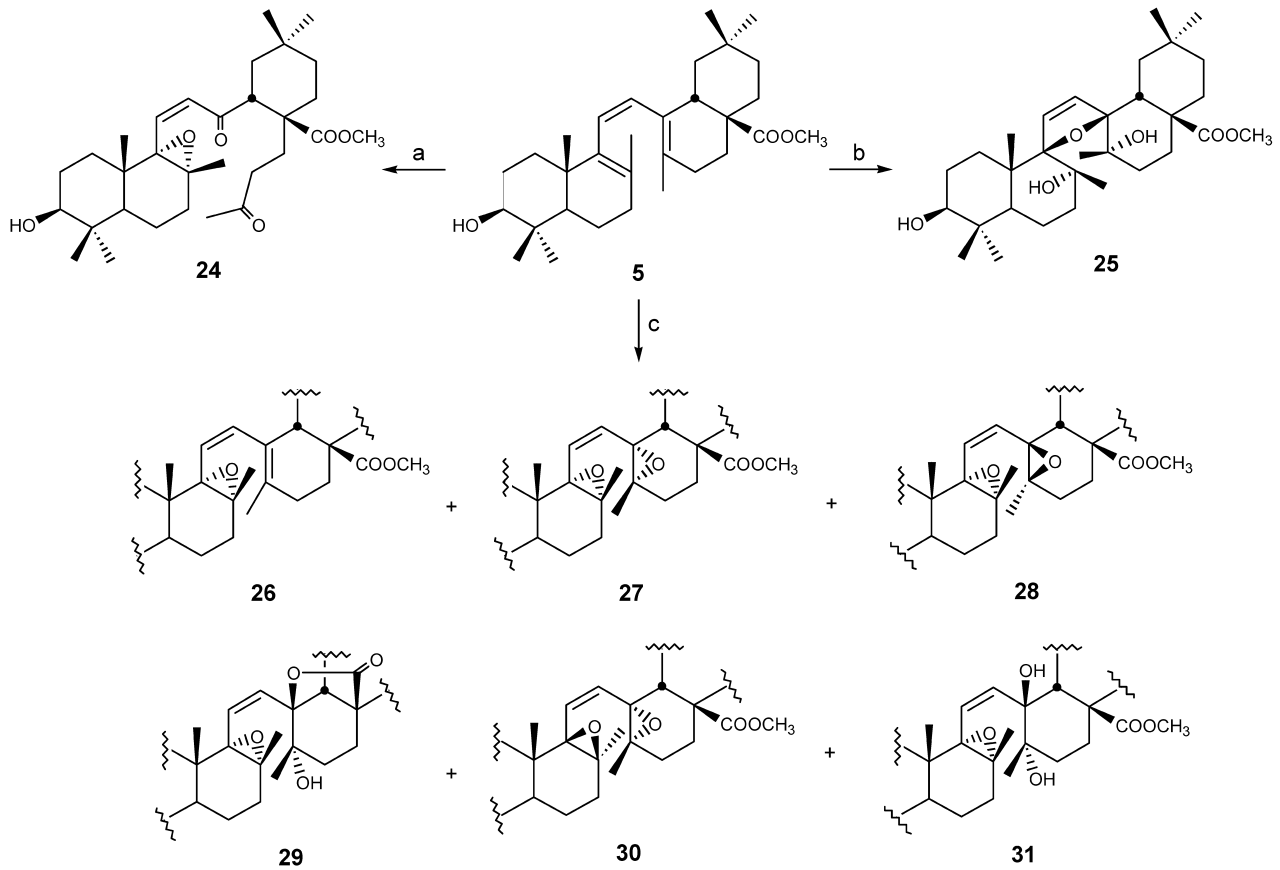
In an attempt to cleave the triterpenic molecule by the C-ring, triene **5**, obtained from diene **1** by a photochemical reaction,[11,12] was treated with ozone under different conditions. In all cases, complex mixtures of products, very difficult to separate chromatographically, resulted. When pyridine was used as the co-solvent, only compound **24** was identified (Scheme 3, path a). This product was formed by epoxidation of the most substituted double bonds of the molecule and hydrolysis of the oxirane group between C-13 and C-14. Subsequent oxidation of the corresponding hydroxyl groups at these positions gave rise to the cleavage of C-13/C-14 double bond, rendering the diketone **24**. Moreover, triene **5** was treated with $NaIO_4/RuCl_3$ at room temperature, giving good yield (80%) in cyclic ether **25** (Scheme 3, path b). The formation of this product could be based on the epoxidation of the C-8/C-9 and C-13/C-14 double bonds of the molecule and the hydrolysis of the epoxide group between C-13 and C-14. The attack of the hydroxyl group at C-13 on C-9 from the β face and opening of the C-8α/C-9α oxirane group yielded product **25**.



Scheme 2. Reagents and conditions: (a) O_3/CH_2Cl_2:MeOH/−78 °C/10 min/thiodipropionic acid/10 min **21** (40%), **22** (20%) and **23** (12%).

The presence of the hydroxyl groups and the cyclic ether in **25** was consistent with the spectroscopic properties of this product. Finally, triene **5** was epoxidized with MCPBA, rendering a mixture of several oxidized products with different yields depending on the reaction conditions (Scheme 3, path c) (Table 1). At low temperature (−78 °C), only product **26** resulted (25%), which had been epoxidized in C-8/C-9 from the α face. When the temperature rose to −40 °C, epoxide **26** was isolated in a good yield (70%). At −20 °C, in addition to compound **26**, whose yield had decreased, products **27**, **28** and **29** were obtained. Compounds **27** and **28** had an epoxide group by the α face in C-8/C-9; however, while **27** had a new oxirane group also by the α face in C-13/C-14, in product **28** this group had the opposite configuration in this position. Product **29** was epoxidized in C-8/C-9 from the α face (as in the latter three compounds) and a lactone system was formed between C-28 and C-13 by the same mechanism as for products **17**, **20** and **21**. When the reaction was maintained at 0 °C for 1 h, two more epoxides were isolated. Product **30** had been epoxidized in C-8/C-9 from the β face, whereas the oxirane group in C-13/C-14 had the opposite configuration. In turn, product **31** has an epoxide group between C-8/C-9 by the α face and two hydroxyl groups at C-13 and C-14. Finally, at room temperature the epoxidation reaction rendered the same products as at 0 °C, but products **26** and **27** were obtained in a slightly better yield.

Moreover, when the reaction with MCPBA was carried out over monoepoxide **26** at −40 °C the major product was **27** and compounds **28** and **31** were also obtained (Scheme 4). At room temperature, the epoxidation of **26** gave rise to the same products as the treatment of triene **5** with MCPBA but with different yields, in addition to two new oxidized products **32** and **33** (Table 2). These compounds had similar structure as cyclic ether **25**, but in **32** the hydroxyl group at C-8 had dehydrated with a H-7 hydrogen and in **33**, the new double bond was formed between C-8 and C-26. As could be observed, product **30** was not isolated from the epoxidation of monoepoxide **26**. This supported the β configuration attributed to the oxirane group between C-8 and C-9. As a mean to protect the hydroxyl group on C-3 of monoepoxide **26**, an acetylation process was carried out with Ac_2O/Py, rendering acetate **34**. This compound was also epoxidized, giving rise to the corresponding acetylated derivatives of products **27**, **28**, **29** and **31**, compounds **35**, **36**, **37** and **38**, respectively. In order to cleave the C-ring of the triterpenic molecule, products **35** and **37** were submitted to several oxidative reactions, yielding complex mixtures of



Scheme 3. Reagents and conditions: (a) O_3/CH_2Cl_2/Py 2:1/−78 °C/30 min **24** (12%); (b) $NaIO_4/RuCl_3/CCl_4/CH_3CN/H_2O$/room temperature/8 h **25** (80%); (c) MCPBA/CH_2Cl_2 **26**, **27**, **28**, **29**, **30** and **31** (Table 1).

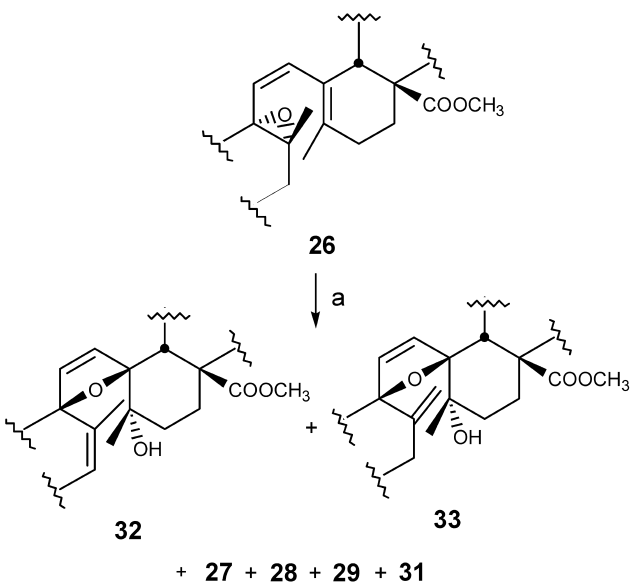
polar compounds very difficult to separate chromatographically.

With the same aim, ozonolysis of monoepoxide **26** was achieved (Scheme 5). When this reaction took place in CH_2Cl_2, only product **31** was obtained in an acceptable yield (60%). As this compound appeared to be suitable for the cleavage of the C-ring, it was ozonized again, rendering ketone **39**. In turn, when the ozonolysis of monoepoxide **26** was carried out in CH_2Cl_2/Py 10:1, ketone **40** was isolated with good yield (80%). The subsequent treatment of this product with ozone did not gave the expected results, since this reaction led to product **39** and lactone **41**. These compounds resulted from the attack of the carboxymethyl group at C-28 on C-13 from the β face and the opening of the α epoxide between C-13 and C-14. In addition, a complex mixture of polar compounds was obtained. It was treated with diazomethane in order to form the corresponding methyl esters, but this reagent did not simplify the mixture.

Table 1. Yields (%) of products obtained by epoxidation of triene **5** at different temperatures (°C) and times (h)

T	Time	**26**	**27**	**28**	**29**	**30**	**31**
−78	24	25	—	—	—	—	—
−40	12	70	—	—	—	—	—
−20	8	40	25	5	5	—	—
0	1	30	30	10	5	5	5
Room temperature	0.5	35	35	10	5	5	5

In an effort to avoid the participation of hydroxyl group at C-3 in the ozonolysis process, acetylated derivative **34** was ozonized. This reaction rendered the already isolated products **37** (acetyl derivative of **29**) and **38** (acetylated derivative of **31**) with different yields depending on reaction conditions. Table 3 shows that at −78 °C the major product

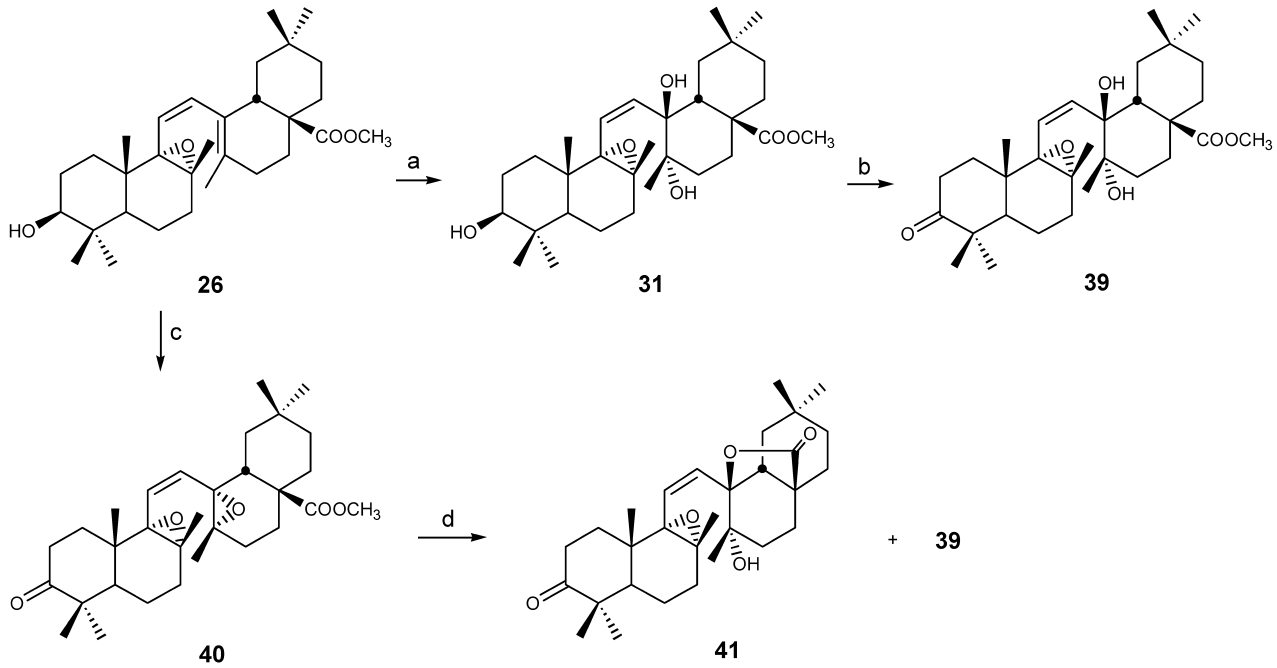


Scheme 4. Reagents and conditions: (a) MCPBA/CH_2Cl_2 **27**, **28**, **29**, **31**, **32** and **33** (Table 2).

Table 2. Yields (%) of products obtained by epoxidation of monoepoxide **26** at different temperatures (°C) and times (h)

T	Time	**27**	**28**	**29**	**31**	**32**	**33**
−40	12	75	15	—	7	—	—
Room temperature	1	15	10	15	30	5	5

In addition, since oxidation reactions carried out using several compounds with the central double bond in *Z*-disposition did not allow the cleavage of the triterpenic molecule, triene **11** was submitted to oxidation processes. This product was obtained by chemical isomerization with iodine of triene **7** and had the central double bond in *E*-disposition.[11,12] In this sense, triene **11** was ozonized in



Scheme 5. Reagents and conditions: (a) $O_3/CH_2Cl_2/-78$ °C/10 min/Me_2S/3 h **31** (60%); (b) O_3/CH_2Cl_2/0 °C/35 min/Me_2S/1 h **39** (45%); (c) O_3/CH_2Cl_2/Py/−78 °C/1 h/Me_2S/3 h **40** (80%); (d) O_3/CH_2Cl_2/Py/room temperature/3 h/Me_2S/5 min **39** (10%) and **41** (10%).

was **38**, whereas at room temperature the proportion of both compounds was equal. These results, along with the absence of deacetylated derivative **29** in the ozonolysis of **26** at −40 °C, suggested that lactonization minimized at low temperature. When ozonolysis of **34** was maintained for 6 h at room temperature, the yield of compounds **37** and **38** decreased considerably due to the formation of complex mixtures of very polar products.

According to above-described oxidation results, the double bond between C-8 and C-9 was the most reactive, epoxidizing preferentially from the α face. At higher temperatures, the opposite configuration could be achieved. The same could be said for the C-13/C-14 double bond, since it was epoxidized mainly from the α face. The oxirane group in this position gave rise more easily to hydroxylation and lactonization reactions. Finally, the double bond between C-11 and C-12 was not oxidized, preventing the cleavage of C-ring by this bond.

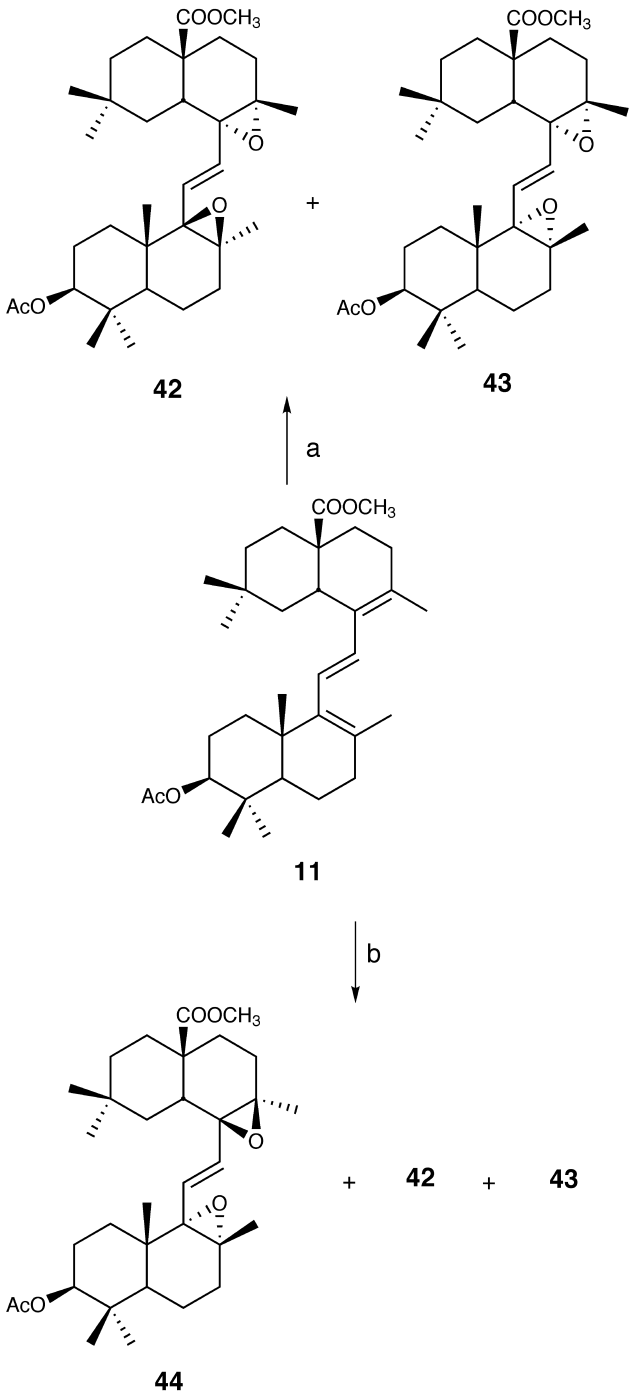
Table 3. Yields (%) of the ozonolysis of product **34** at different times (h) and temperatures (°C)

Temperature	Time	**37**	**38**
−78	0.2	6	55
Room temperature	0.5	30	30
Room temperature	6	15	15

CH_2Cl_2 at low temperature (−78 °C), providing two diepoxides, **42** and **43**, in a low yield as well as complex mixtures of fragmented and oxidized compounds, which were difficult to separate chromatographically (Scheme 6).

Compound **42** was epoxidized in C-8/C-9 from the β face, whereas the oxirane group at C-13/C-14 had the opposite configuration. In turn, product **43** was produced by the epoxidation from the α face of the most substituted double bonds of the starting material. Thus, the treatment of triene **11** with MCPBA yielded compounds **42** and **43**, the latter being the major product of this reaction, together with product **44**. This compound was a diepoxide with opposite configurations in the oxirane groups to those in compound **42**.

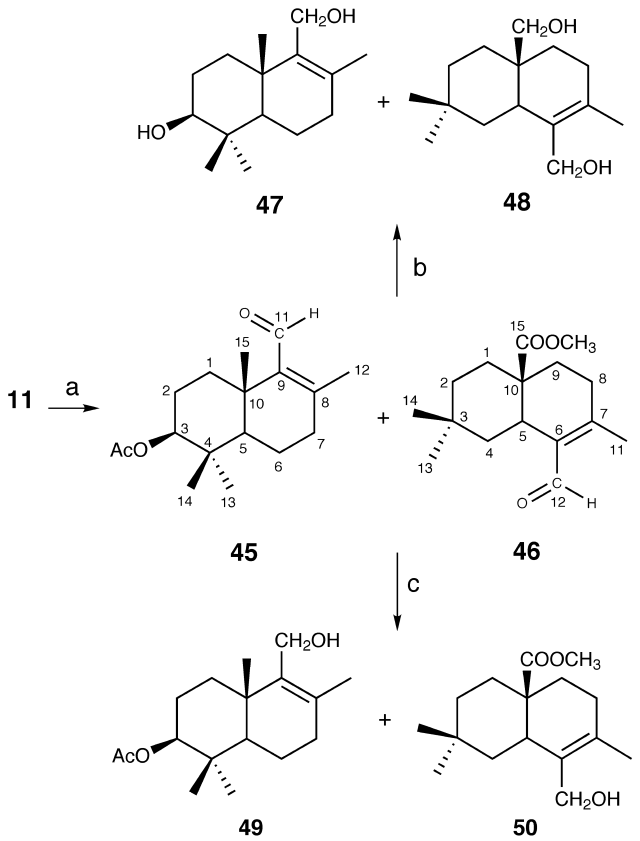
Finally, the oxidation of triene **11** with $NaIO_4/RuCl_3$ in acetone/H_2O (5:1) led to the cleavage of the triterpene by the C-ring, resulting a mixture of two aldehydic sesquiterpenes (**45** and **46**). One of which (**45**) was a promising 3β-acetoxy-8-drimen-11-al (Scheme 7). This reaction was carried out under different conditions, summarized in Table 4. The best results were achieved when 4 equiv. of $NaIO_4$ were added to a solution of product **11** and the process was maintained at room temperature for 30 min. The immediate reduction of these unstable sesquiterpene fragments owing to their aldehydic nature gave rise to the corresponding dihydroxylic sesquiterpenes **47**[17] and **48**. Product **47** had structure of 8-drimenol and



Scheme 6. Reagents and conditions: (a) $O_3/CH_2Cl_2/-78$ °C/1 h/Me_2S/3 h **42** (10%) and **43** (10%); (b) MCPBA/CH_2Cl_2/room temperature/30 min **42** (10%), **43** (50%) and **44** (10%).

therefore could be used as an appropriate synthon to produce other remarkable drimane-related compounds. In turn, product **48** would be a suitable intermediate in the synthesis of phenanthrenes and natural tricyclic triterpenes such as Achilleol B and Camelliol C. The reaction of the aldehydic mixture with $NaBH_4$ provided the partially reduced fragments **49** and **50**. This way, hydroxyl group at C-3 of product **49** was protected as acetate, avoiding the participation in further processes.

Moreover, triene **16**, derived from product **8** by a photochemical isomerization process,[11,12] was ozonized under different conditions, but complex mixtures of products resulted. Therefore, intending to minimize undesirable oxidative cleavages, we protected exocyclic triene **16** at the C-13/C-14 double bond by previous epoxidation (Scheme 8). This process led to a major product, **51**, in which the epoxide group had the opposite configuration to the carboxymethyl group at C-28, and product **52**, whose oxirane group had the opposite disposition as that in compound **51**.

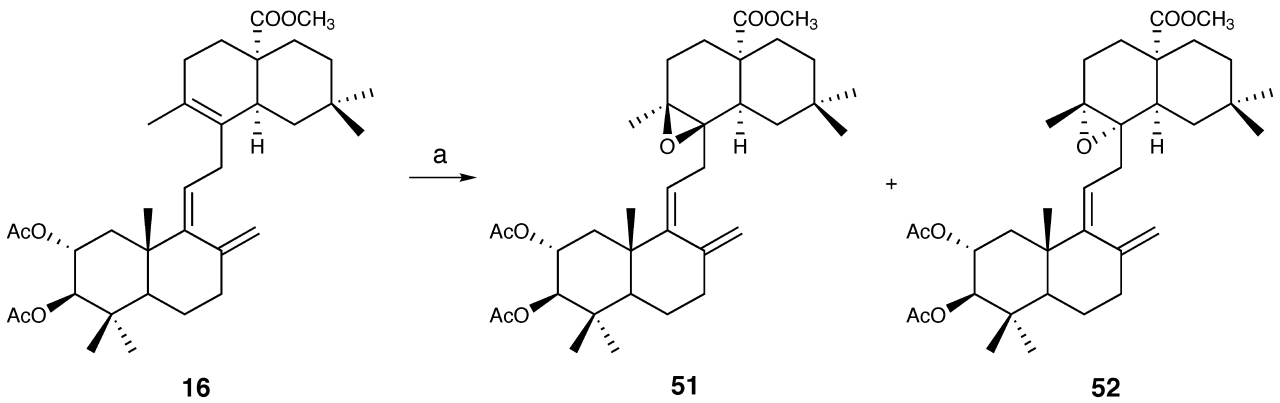


Scheme 7. Reagents and conditions: (a) $NaIO_4/RuCl_3$/acetone/H_2O (5:1) **45** and **46** (Table 4); (b) $LiAlH_4$/THF/reflux/1 h **47** and **48** (95%); (c) $NaBH_4$/DMF/room temperature/1 h **49** and **50** (95%).

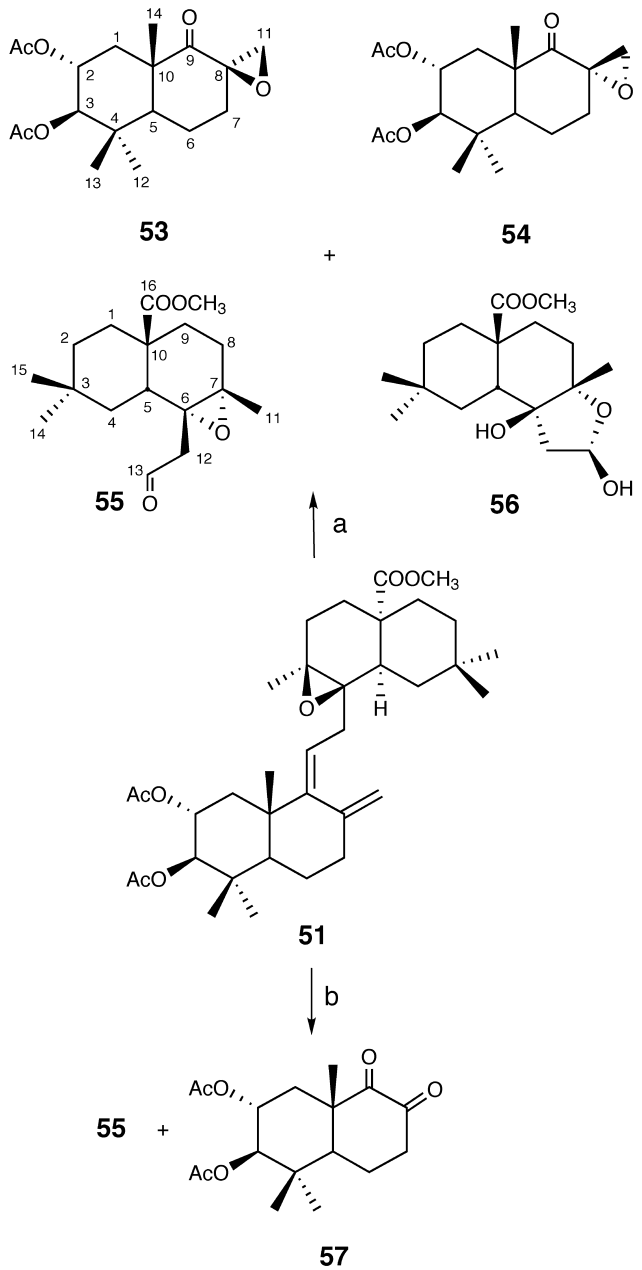
Table 4. Yields (%) of products **45** and **46** obtained by oxidation of triene **11** with $NaIO_4$ and $RuCl_3$ at different temperatures (°C) and times (h)

T	Substrate:reagent	Time	**45**+**46**
−40	1:2	12	30
−30	1:6	10	10
−20	1:4	24	15
0	1:2	1.5	40
Room temperature	1:4	0.5	50

Ozonization in CH_2Cl_2 of the epoxydiene **51** at −80 °C for 5 min rendered four fragments (Scheme 9). Two of these had a 14-carbon skeleton (**53** and **54**) and differed only in the configuration of the epoxide group at C-8/C-11, and the others presented a 16-carbon skeleton (**55** and **56**). These four products were achieved as the result of the C-9/C-11 double-bond rupture of the starting triterpene. It was noteworthy that compounds **53** and **54** were adequate



Scheme 8. Reagents and conditions: (a) MCPBA/CH_2Cl_2/−40 °C/12 h **51** (60%) and **52** (15%).



Scheme 9. Reagents and conditions: (a) O_3/CH_2Cl_2/−80 °C/5 min/Me_2S/36 h **53** (31%), **54** (3%), **55** (10%) and **56** (35%); (b) $NaIO_4$/$RuCl_3$/acetone/H_2O 5:1/room temperature/2 h **55** (30%) and **57** (23%).

ketoepoxy synthons to obtain drimane and ambra oxide related compounds. Thus, product **55** was produced from the D- and E-rings of the triterpenic molecule while hemiacetal **56** was formed from epoxyaldehyde **55** by the attack of a water molecule present in the reaction medium. Ozonization of epoxydiene **51** was tested under different reaction conditions, which affected the yields of the above-mentioned products. The aforementioned conditions (O_3, −80 °C, 5 min) were the optimal ones at the moment Moreover, the treatment of epoxydiene **51** with $NaIO_4$/$RuCl_3$ led to epoxyaldehyde **55** and diketone **57**, recovering 37% of the unreacted starting material. Finally, the ozonolysis of the minor epoxydiene **52** under the same reaction conditions gave rise to ketoepoxides **53** and **54** and epoxyaldehyde **58**, which was the isomer of compound **55** in the epoxide group. In this case, hemiacetal **56** was not obtained. Presumably, the epoxide configuration hindered the entry of the necessary water molecule.

3. Conclusion

Several triterpenic compounds with a diene or triene system were used as starting material in different oxidative processes.

Ozonization of the diene system at low temperature led to oxidized products with epoxide, hydroxyl or lactone groups, showing the different accessibility of the two double bonds of these molecules.

The treatment of a *cis*-triene compound and some derivatives with ozone, $NaIO_4$/$RuCl_3$ and MCPBA gave rise to the same type of oxidized triterpenic products. In all of them the central double bond in *Z*-disposition was not affected by the oxidative reaction.

In turn, the oxidation of a *trans*-triene with $NaIO_4$/$RuCl_3$ at room temperature yielded a mixture of two aldehydic sesquiterpenes by the cleavage of the opened C-ring of the substrate.

Moreover, the protection of the C-13/C-14 double bond of an exocyclic triene by epoxidation and subsequent ozonization rendered 16-carbon fragments and *nor*-sesquiterpene compounds with an epoxydecalone structure. Thus, fragments formed from A- and B-rings of the triterpene

could be used as suitable chiral synthon for the semi-synthesis of products related to drimane and ambra oxide. Finally, the fragments produced from D- and E-rings of the triterpene molecule could be appropriate intermediates for the production of phenanthrenes and natural tricyclic triterpenes as Achilleol B and Camelliol C.

4. Experimental

4.1. General

Measurements of NMR spectra (300.13 MHz ^{1}H and 75.47 MHz ^{13}C) were made in $CDCl_3$ (which also provided the lock signal) using BRUKER AM-300 or ARX-400 spectrometers. The assignments of ^{13}C chemical shifts were made with the aid of distortionless enhancement by polarization transfer (DEPT) using a flip angle of 135°. Bruker's programs were used for COSY (45°) and C/H and C/C correlation. IR spectra were recorded on a MATTSON SATELLITE FTIR spectrometer. High-resolution mass spectra were made in a MICROMASS AUTOSPEC-Q spectrometer (EBE geometry). Mps were determined using a Kofler (Reichter) apparatus and are uncorrected. Optical rotations were measured on a Perkin–Elmer 241 polarimeter at 25 °C. All reaction solvents were dried and distilled immediately prior to use; chromatography solvents were distilled prior to use. Commercially available reagents were used without further purification. Silica gel Scharlau 60 (40–60 μm) was used for flash chromatography. CH_2Cl_2 or $CHCl_3$ containing increasing amounts of Me_2CO were used as eluents. Analytical plates (silica gel, Merck 60 G) were rendered visible by spraying with H_2SO_4–AcOH, followed by heating to 120 °C.

4.2. Isolation of starting material

Oleanolic and maslinic acids[2,4] were isolated from olive-pressing residues, which were extracted in a Soxhlet with hexane and EtOAc successively. Both products were purified from these mixtures by column chromatography over silica gel and transformed into the corresponding methyl esters with ethereal CH_2N_2 or NaOH–MeI and thus, methyl 3β-hydroxy-12-oleanen-28-oate[9] and methyl 2α,3β-dihydroxy-12-oleanen-28-oate[9] were obtained. Acetylation of these esters with Ac_2O/Py at reflux provided the acetylated derivatives.[9] The treatment of the methyl esters independently with NBS/AIBN for 30 min at reflux gave rise to dienes **1**–**4**,[12] which were irradiated for 20 min in a borosilicate flask using a 125 W high-pressure Hg street lamp and yielding trienes **5**–**8**.[12] Isomerization with iodine of these trienes led to products **9**–**12**[12] and a photochemical reaction of compounds **5**–**8** with a 125 W high-pressure Hg street lamp in a quartz flask rendered trienes **13**–**16**.[12]

4.2.1. Ozonolysis of 3. Product **3** (200 mg, 0.4 mmol) was dissolved in 10 mL of CH_2Cl_2, stirred at −78 °C and passed through an O_3 flow of 0.1 L/min (10% O_2–90% O_3). After 15 min, 1.5 mL of Me_2S were added. The mixture was maintained with stirring while being cooled down for 3 h. Then it was evaporated and purified over silica gel, yielding 61 mg (30%) of **17**: white solid; mp 218–220 °C; $[\alpha]_D^{25}=-16$ (*c* 0.7, $CHCl_3$); IR ($CHCl_3$): ν 3401, 2933, 1736, 1244 cm^{-1}; ^{1}H NMR ($CDCl_3$): δ 5.80 (1H, d, J=7.0 Hz, H-11), 4.44 (1H, dd, J_1=5.2 Hz, J_2=10.4 Hz, H-3), 3.45 (1H, d, J=7.0 Hz, H-12), 2.65 (1H, dd, J_1=3.1 Hz, J_2=13.6 Hz, H-18), 2.05 (3H, s, CO*CH*$_3$), 1.32 (3H, s, Me), 1.21 (3H, s, Me), 0.97 (3H, s, Me), 0.93 (3H, s, Me), 0.91 (3H, s, Me), 0.90 (3H, s, Me), 0.83 (3H, s, Me); ^{13}C NMR ($CDCl_3$): δ 16.2 (Me), 19.1 (C-6), 19.1 (Me), 20.7 (C-15), 21.4 (CO*CH*$_3$), 21.9 (C-16), 22.3 (Me), 23.7 (Me), 24.3 (C-2), 24.6 (Me), 26.6 (C-22), 27.9 (Me), 31.0 (C-20), 33.3 (C-7), 33.6 (C-29), 34.5 (C-18), 35.2 (C-21), 36.4 (C-1), 38.0 (C-19), 38.6 and 40.3 (C-4 and C-10), 40.9 (C-8), 41.9 (C-14), 43.4 (C-17), 53.7 (C-5), 72.7 (C-12), 80.3 (C-3), 90.8 (C-13), 118.5 (C-11), 151.9 (C-9), 171.0 (*CO*CH$_3$), 178.8 (C-28); HRLSIMS, *m*/*z*: $[M+Na]^+$ 535.3385 ($C_{32}H_{48}O_5Na$, calcd 535.3399); 45 mg (20%) of **18**: white solid; mp 117–119 °C; $[\alpha]_D^{25}=31$ (*c* 1, $CHCl_3$); IR ($CHCl_3$): ν 2951, 1729, 1251 cm^{-1}; ^{1}H NMR ($CDCl_3$): δ 4.41 (1H, dd, J_1=5.5 Hz, J_2=9.2 Hz, H-3), 3.65 (3H, s, COO*CH*$_3$), 3.61 (1H, d, J=3.3 Hz, H-11 or H-12), 2.96 (1H, d, J=3.3 Hz, H-11 or H-12), 2.02 (3H, s, CO*CH*$_3$), 1.17 (3H, s, 3H-27), 1.08 (3H, s, 3H-25), 1.08 (3H, s, 3H-26), 0.93 (3H, s, 3H-24), 0.91 (3H, s, 3H-29), 0.87 (3H, s, 3H-30), 0.76 (3H, s, 3H-23); ^{13}C NMR ($CDCl_3$): δ 16.5 (C-24), 18.5 (C-26), 20.7 (C-6), 21.3 (C-27), 21.3 (CO*CH*$_3$), 23.5 (C-16), 23.5 (C-30), 24.3 (C-2), 26.3 (C-15), 27.1 (C-25), 27.3 (C-23), 30.7, 32.5 and 32.7 (C-7, C-21 and C-22), 30.8 (C-20), 32.8 (C-29), 34.2 (C-1), 38.7 (C-10), 39.0 (C-4), 39.8 (C-8), 41.1 (C-19), 42.0 (C-14), 43.7 (C-18), 46.2 (C-17), 46.7 (C-5), 51.8 (COO*CH*$_3$), 53.2 and 55.7 (C-11 and C-12), 65.1 (C-13), 65.6 (C-9), 80.9 (C-3), 170.9 (*CO*CH$_3$), 177.6 (C-28); HRLSIMS, *m*/*z*: $[M+Na]^+$ 565.3506 ($C_{33}H_{50}O_6Na$, calcd 565.3505); 32 mg (15%) of **19**: white solid; mp 220–222 °C; $[\alpha]_D^{25}=-21$ (*c* 1, $CHCl_3$); IR ($CHCl_3$): ν 3421, 2946, 1726, 1247 cm^{-1}; ^{1}H NMR ($CDCl_3$): δ 5.55 (1H, dd, J_1=3.7 Hz, J_2=8.2 Hz, H-15), 4.45 (1H, dd, J_1=6.0 Hz, J_2=10.4 Hz, H-3), 3.91 (1H, d, J=4.6 Hz, H-12), 3.57 (3H, s, COO*CH*$_3$), 3.39 (1H, d, J=4.6 Hz, H-11), 3.07 (1H, dd, J_1=3.9 Hz, J_2=13.7 Hz, H-18), 2.39 (1H, dd, J_1=8.2 Hz, J_2=15.0 Hz, H-16), 2.02 (3H, s, CO*CH*$_3$), 1.30 (3H, s, Me), 1.19 (3H, s, Me), 1.07 (3H, s, Me), 0.94 (3H, s, Me), 0.93 (3H, s, Me), 0.85 (3H, s, Me), 0.85 (3H, s, Me); ^{13}C NMR ($CDCl_3$): δ 16.3 (Me), 18.8 (C-6), 21.4 (Me), 21.4 (CO*CH*$_3$), 22.0 (Me), 23.0 (C-2), 27.4 (Me), 29.3 (C-20), 29.5 (Me), 30.0, 31.2 and 32.8 (C-7, C-21 and C-22), 30.1 (Me), 32.9 (C-29), 33.8 and 35.6 (C-1 and C-16), 34.5 (C-18), 38.0 (C-10), 38.1 (C-19), 38.5 (C-4), 41.0 (C-8), 42.0 (C-13), 49.8 (C-17), 49.9 (C-5), 52.0 (COO*CH*$_3$), 56.2 (C-11), 68.3 (C-9), 71.5 (C-12), 80.0 (C-3), 120.0 (C-15), 158.2 (C-14), 170.9 (*CO*CH$_3$), 178.9 (C-28); HRLSIMS, *m*/*z*: $[M+Na]^+$ 565.3500 ($C_{33}H_{50}O_6Na$, calcd 565.3505) and 15 mg (7%) of **20**: white solid; mp 126–128 °C; $[\alpha]_D^{25}=0$ (*c* 1, $CHCl_3$); IR ($CHCl_3$): ν 3421, 2943, 1735, 1248 cm^{-1}; ^{1}H NMR ($CDCl_3$): δ 4.46 (1H, dd, J_1=5.3 Hz, J_2=10.9 Hz, H-3), 3.94 (1H, d, J=6.3 Hz, H-11), 3.41 (1H, d, J=6.3 Hz, H-12), 2.47 (1H, dd, J_1=5.8 Hz, J_2=11.9 Hz, H-18), 2.04 (3H, s, CO*CH*$_3$), 1.30 (3H, s, Me), 1.17 (3H, s, Me), 0.96 (3H, s, Me), 0.94 (3H, s, Me), 0.92 (3H, s, Me), 0.88 (3H, s, Me), 0.88 (3H, s, Me); ^{13}C NMR ($CDCl_3$): δ 16.7 (Me), 18.2 (C-6), 18.8 (Me), 19.1 (Me), 20.9 (C-15), 21.2 (Me), 21.3 (CO*CH*$_3$), 21.7 (C-16), 23.6 (C-2), 24.8 (Me), 26.3 (C-22), 28.0 (C-23), 31.1 (C-20), 33.2 (C-7), 33.5 (C-29), 34.1 (C-21), 34.3 (C-18), 34.7 (C-1), 36.4 (C-19), 38.4 and 39.7 (C-4 and C-10), 40.0

(C-8), 41.8 (C-14), 41.8 (C-17), 51.8 (C-5), 60.8 (C-11), 71.8 (C-12), 72.4 (C-9), 80.2 (C-3), 88.6 (C-13), 171.1 (*CO*CH_3), 178.2 (C-28); HRLSIMS, *m/z*: $[M+Na]^+$ 551.3351 ($C_{32}H_{48}O_6Na$, calcd 551.3348).

4.2.2. Ozonolysis of 4. 250 mg (0.4 mmol) of product **4** were dissolved in 10 mL of MeOH/CH_2Cl_2 4:1 and stirred at −78 °C. Then an O_3 flow of 0.1 L/min (10% O_2−90% O_3) was passed through the solution for 10 min. After that, 90 mg (0.5 mmol) of thiodipropionic acid were added. The mixture was maintained with stirring for 10 min, evaporated to dryness and chromatographed over silica gel to give 101 mg (40%) of **21**: white solid; mp 240–242 °C; $[\alpha]_D^{25}$=−47 (*c* 1, $CHCl_3$); IR ($CHCl_3$): ν 3441, 2939, 1742, 1252 cm^{-1}; ^1H NMR ($CDCl_3$): δ 5.73 (1H, d, *J*=7.0 Hz, H-11), 5.18 (1H, ddd, J_1=3.8 Hz, J_2=J_3=11.0 Hz, H-2), 4.67 (1H, d, *J*=11.0 Hz, H-3), 3.41 (1H, d, *J*=7.0 Hz, H-12), 2.61 (1H, dd, J_1=3.6 Hz, J_2=13.1 Hz, H-18), 2.03 (3H, s, CO*CH*$_3$), 1.98 (3H, s, CO*CH*$_3$), 1.30 (3H, s, Me), 1.29 (3H, s, Me), 0.94 (3H, s, Me), 0.92 (3H, s, Me), 0.90 (3H, s, Me), 0.88 (3H, s, Me), 0.83 (3H, s, Me); ^{13}C NMR ($CDCl_3$): δ 17.1 (Me), 19.0 (C-6), 19.0 (Me), 20.6 (C-15), 20.9 (CO*CH*$_3$), 21.1 (CO*CH*$_3$), 21.8 (C-16), 23.2 (Me), 23.6 (Me), 24.5 (Me), 26.5 (C-22), 28.1 (Me), 31.0 (C-20), 33.2 (C-7), 33.5 (C-29), 34.4 (C-18), 34.9 (C-21), 36.3 (C-19), 39.7 (C-10), 40.2 (C-4), 41.8 (C-8), 41.9 (C-14), 43.3 (C-17), 43.8 (C-1), 53.4 (C-5), 70.6 (C-2), 72.5 (C-12), 80.0 (C-3), 90.5 (C-13), 118.6 (C-11), 150.7 (C-9), 170.4 (*CO*CH_3), 170.6 (*CO*CH_3), 178.6 (C-28); HRLSIMS, *m/z*: $[M+Na]^+$ 593.3460 ($C_{34}H_{50}O_7Na$, calcd 593.3454); 52 mg (20%) of **22**: white solid; mp 137–139 °C; $[\alpha]_D^{25}$=56 (*c* 1, $CHCl_3$); IR ($CHCl_3$): ν 2928, 1742, 1248 cm^{-1}; ^1H NMR ($CDCl_3$): δ 5.56 (1H, d, *J*=4.6 Hz, H-11), 5.12 (1H, ddd, J_1=4.6 Hz, J_2=J_3=11.0 Hz, H-2), 4.70 (1H, d, *J*=11.0 Hz, H-3), 3.61 (3H, s, COO*CH*$_3$), 2.97 (1H, d, *J*=4.6 Hz, H-12), 2.31 (1H, dd, J_1=4.6 Hz, J_2=12.4 Hz, H-1), 2.05 (3H, s, CO*CH*$_3$), 1.99 (3H, s, CO*CH*$_3$), 1.25 (3H, s, Me), 1.23 (3H, s, Me), 0.94 (3H, s, Me), 0.92 (3H, s, Me), 0.89 (3H, s, Me), 0.89 (3H, s, Me), 0.89 (3H, s, Me); ^{13}C NMR ($CDCl_3$): δ 17.6 (Me), 17.7 (C-6), 21.0 (CO*CH*$_3$), 21.2 (CO*CH*$_3$), 22.5 (Me), 23.5 (Me), 23.7 and 25.7 (C-15 and C-16), 26.0 (Me), 28.5 (Me), 29.9 (Me), 30.8 (C-20), 32.6 (C-7), 33.0 (C-29), 34.1 and 35.3 (C-21 and C-22), 38.7, 39.3 and 40.5 (C-4, C-8 and C-10), 41.0 (C-19), 42.5 (C-1), 42.9 (C-18), 45.1 (C-14), 46.1 (C-17), 50.9 (C-5), 51.8 (COO*CH*$_3$), 52.8 (C-12), 69.4 (C-13), 70.3 (C-2), 80.2 (C-3), 114.5 (C-11), 160.3 (C-9), 170.6 (*CO*CH_3), 170.9 (*CO*CH_3), 177.9 (C-28); HRLSIMS, *m/z*: $[M+Na]^+$ 607.3607 ($C_{35}H_{52}O_7Na$, calcd 607.3611); and 31 mg (12%) of **23**: white solid; mp 167–169 °C; $[\alpha]_D^{25}$=18 (*c* 1, $CHCl_3$); IR ($CHCl_3$): ν 2950, 1739, 1249 cm^{-1}; ^1H NMR ($CDCl_3$): δ 5.74 (1H, s, H-11), 5.16 (1H, ddd, J_1=4.6 Hz, J_2=J_3=11.2 Hz, H-2), 4.72 (1H, d, *J*=11.2 Hz, H-3), 3.69 (3H, s, COO*CH*$_3$), 2.34 (1H, dd, J_1=4.6 Hz, J_2=12.4 Hz, H-1), 2.05 (3H, s, CO*CH*$_3$), 2.00 (3H, s, CO*CH*$_3$), 1.44 (3H, s, Me), 1.37 (3H, s, Me), 1.06 (3H, s, Me), 1.00 (3H, s, Me), 0.93 (3H, s, Me), 0.91 (3H, s, Me), 0.82 (3H, s, Me); ^{13}C NMR ($CDCl_3$): δ 17.5 (C-6), 17.8 (Me), 20.9 (CO*CH*$_3$), 21.2 (CO*CH*$_3$), 25.7 (Me), 26.6 (C-16), 27.2 (Me), 28.4 (Me), 28.4 (Me), 28.9 (C-15), 29.8 (C-22), 30.1 (Me), 32.0 (C-20), 33.8 (C-29), 33.9 (C-7), 35.3 (C-18), 36.6 and 37.1 (C-19 and C-21), 39.4 and 40.6 (C-4 and C-10), 42.0 (C-1), 42.4 (C-8), 43.6 (C-14), 48.0 (C-17), 50.5 (C-5), 52.1 (COO*CH*$_3$), 53.2 (C-13), 69.7 (C-2), 79.8 (C-3), 123.5 (C-11), 170.5 (*CO*CH_3), 170.8 (*CO*CH_3), 176.2 (C-9), 178.2 (C-28), 201.5 (C-12); HRLSIMS, *m/z*: $[M+Na]^+$ 607.3615 ($C_{35}H_{52}O_7Na$, calcd 607.3611).

4.2.3. Ozonolysis of 5. Product **5** (235 mg, 0.5 mmol) was dissolved in 15 mL of CH_2Cl_2/Py 2:1, stirred at −78 °C and passed through an O_3 flow lower than 0.1 L/min (50% O_2−50% O_3). After 30 min, 1.5 mL of Me_2S were added. The mixture was maintained with stirring while being cooled down for 3 h. Then it was evaporated and purified over silica gel, yielding 32 mg (12%) of **24**: syrup; $[\alpha]_D^{25}$=91 (*c* 1, $CHCl_3$); IR ($CHCl_3$): ν 3511, 2948, 1724, 1252 cm^{-1}; ^1H NMR ($CDCl_3$): δ 7.02 (1H, d, *J*=15.1 Hz, H-12), 6.68 (1H, d, *J*=15.1 Hz, H-11), 3.69 (3H, s, COO*CH*$_3$), 3.32 (1H, dd, J_1=5.1 Hz, J_2=10.2 Hz, H-3), 2.03 (3H, s, Me), 1.21 (3H, s, Me), 1.08 (3H, s, Me), 1.02 (3H, s, Me), 0.91 (3H, s, Me), 0.89 (3H, s, Me), 0.85 (3H, s, Me); ^{13}C NMR ($CDCl_3$): δ 15.7 (Me), 16.7 (Me), 19.6 (Me), 21.6 and 22.8 (C-6 and C-16), 24.1 (Me), 26.5 (C-7), 28.3 (Me), 29.6 (C-2), 29.8 (C-20), 29.9 (Me), 31.0 (C-15), 32.8 (C-29), 33.9 and 34.0 (C-1 and C-22), 34.3 (C-18), 35.6 (C-21), 40.4 and 44.5 (C-4 and C-10), 45.5 (C-19), 47.6 (C-5), 51.5 (C-17), 52.0 (COO*CH*$_3$), 65.0 (C-8), 68.4 (C-9), 78.2 (C-3), 125.6 (C-11), 146.1 (C-12), 177.8 (C-28), 204.0 and 208.6 (C-13 and C-14); HRLSIMS, *m/z*: $[M+Na]^+$ 539.3344 ($C_{31}H_{48}O_6Na$, calcd 539.3349).

4.2.4. Oxidation of 5 with $NaIO_4$/$RuCl_3$. $NaIO_4$ (110 mg, 0.5 mmol) and $RuCl_3.3H_2O$ (approximately 5 mg) in water (2 mL) were added to a solution of product **5** (95 mg, 0.2 mmol) in CCl_4 (5 mL) and CH_3CN (5 mL). The reaction mixture was stirred at room temperature for 8 h and then diluted with CH_2Cl_2, washed with water and dried over anhydrous Na_2SO_4. The solvent was evaporated at reduced pressure and the residue was chromatographed to obtain 84 mg (80%) of **25**: white solid; mp 232–234 °C; $[\alpha]_D^{25}$=27 (*c* 0.4, $CHCl_3$); IR ($CHCl_3$): ν 3416, 2946, 1722 cm^{-1}; ^1H NMR ($CDCl_3$): δ 5.70 (1H, d, *J*=6.4 Hz, H-12), 5.52 (1H, d, *J*=6.4 Hz, H-11), 3.67 (3H, s, COO*CH*$_3$), 3.23 (1H, dd, J_1=4.7 Hz, J_2=10.4 Hz, H-3), 2.86 (1H, dd, J_1=4.4 Hz, J_2=13.6 Hz, H-18), 1.29 (3H, s, Me), 1.21 (3H, s, Me), 1.01 (3H, s, Me), 1.00 (3H, s, Me), 0.97 (3H, s, Me), 0.92 (3H, s, Me), 0.79 (3H, s, Me); ^{13}C NMR ($CDCl_3$): δ 15.6 (Me), 19.6 (C-6), 19.8 (Me), 23.1 (C-16), 24.2 (Me), 26.8 (Me), 27.1 (C-2), 28.4 (Me), 29.2 (Me), 30.4 (C-20), 33.0, 34.1, 34.3, 36.0, 38.6 and 39.6 (C-1, C-19, C-21, C-22, C-15 and C-7), 33.5 (C-29), 39.4 and 42.3 (C-4 and C-10), 42.9 (C-18), 46.3 (C-5), 46.9 (C-17), 52.0 (COO*CH*$_3$), 74.0 and 74.5 (C-8 and C-14), 78.6 (C-3), 95.6 and 103.1 (C-9 and C-13), 124.5 (C-11), 134.8 (C-12), 178.5 (C-28); HRLSIMS, *m/z*: $[M+Na]^+$ 541.3503 ($C_{31}H_{50}O_6Na$, calcd 541.3505).

4.2.5. Epoxidation of 5. Product **5** (236 mg, 0.5 mmol) was dissolved in 10 mL of CH_2Cl_2 and 130 mg (0.75 mmol) of MCPBA were added. The resulting mixture was stirred at different temperatures (Table 1). When the reaction finished, the mixture was diluted with CH_2Cl_2, extracted with a solution of $FeSO_4$, neutralized with $NaHCO_3$, dried over anhydrous Na_2SO_4 and evaporated to dryness. Depending on the reaction conditions (Table 1), chromatography over silica gel yielded different amounts of **26**, **27**, **28**, **29**, **30** and **31**. Product **26**: syrup; $[\alpha]_D^{25}$=5 (*c* 1, $CHCl_3$);

IR ($CHCl_3$): ν 3482, 2926, 1728 cm^{-1}; ^1H NMR ($CDCl_3$): δ 6.13 (1H, d, J=13.3 Hz, H-12), 5.60 (1H, d, J=13.3 Hz, H-11), 3.66 (3H, s, COOCH_3), 3.50 (1H, dd, J_1=3.6 Hz, J_2=12.7 Hz, H-18), 3.19 (1H, dd, J_1=4.2 Hz, J_2=10.7 Hz, H-3), 1.51 (3H, s, 3H-27), 1.18 (3H, s, 3H-26), 1.07 (3H, s, 3H-25), 0.92 (3H, s, 3H-23), 0.87 and 0.83 (3H each, s, 3H-29 and 3H-30), 0.75 (3H, s, 3H-24); ^{13}C NMR ($CDCl_3$): δ 15.3 (C-24), 17.0 (C-6), 18.2 (C-25), 20.8 (C-27), 22.3 (C-26), 23.6 (C-16), 25.0 (C-30), 27.4 (C-7), 28.4 (C-2), 28.6 (C-23), 29.5 (C-15), 30.7 (C-20), 31.9 (C-22), 32.5 (C-29), 33.2 (C-1), 34.4 (C-21), 36.1 (C-18), 38.4 (C-10), 38.6 (C-4), 41.5 (C-5), 42.8 (C-19), 45.1 (C-17), 51.8 (COOCH_3), 60.9 (C-8), 71.9 (C-9), 78.6 (C-3), 126.2 (C-11), 127.6 (C-14), 132.7 (C-13), 134.7 (C-12), 178.4 (C-28); HRLSIMS, *m/z*: $[M+Na]^+$ 507.3452 ($C_{31}H_{48}O_4Na$, calcd 507.3450). Product **27**: syrup; $[\alpha]_D^{25}$=72 (*c* 1, $CHCl_3$); IR ($CHCl_3$): ν 3484, 2948, 1728 cm^{-1}; ^1H NMR ($CDCl_3$) δ 5.90 (1H, d, J=13.6 Hz, H-12), 5.65 (1H, d, J=13.6 Hz, H-11), 3.66 (3H, s, COOCH_3), 3.23 (1H, dd, J_1=4.4 Hz, J_2=11.2 Hz, H-3), 2.49 (1H, dd, J_1=3.6 Hz, J_2=12.7 Hz, H-18), 1.12 (3H, s, 3H-26), 1.10 (3H, s, 3H-25), 1.10 (3H, s, 3H-27), 0.93 (3H, s, 3H-23), 0.93 (3H, s, 3H-29), 0.85 (3H, s, 3H-30), 0.78 (3H, s, 3H-24); ^{13}C NMR ($CDCl_3$): δ 15.1 (C-24), 16.9 (C-6), 18.6 (C-25), 20.3 (C-26), 20.8 (C-27), 22.5 (C-16), 24.2 (C-30), 27.0 (C-7), 28.3 (C-2), 28.4 (C-23), 29.5 (C-15), 30.0 (C-20), 31.4 (C-22), 33.2 (C-29), 34.0 (C-1), 35.0 (C-21), 35.2 (C-19), 35.9 (C-18), 37.2 (C-10), 38.7 (C-4), 41.1 (C-5), 45.5 (C-17), 51.7 (COOCH_3), 61.4 (C-14), 62.4 (C-8), 65.6 (C-13), 71.7 (C-9), 78.8 (C-3), 125.4 (C-11), 133.3 (C-12), 178.4 (C-28); HRLSIMS, *m/z*: $[M+Na]^+$ 523.3340 ($C_{31}H_{48}O_5Na$, calcd 523.3399). Product **28**: syrup; $[\alpha]_D^{25}$=−7 (*c* 1, $CHCl_3$); IR ($CHCl_3$): ν 3488, 2947, 1715 cm^{-1}; ^1H NMR ($CDCl_3$): δ 5.84 (1H, d, J=12.5 Hz, H-12), 5.70 (1H, d, J=12.5 Hz, H-11), 3.74 (3H, s, COOCH_3), 3.24 (1H, dd, J_1=3.9 Hz, J_2=14.3 Hz, H-18), 3.21 (1H, dd, J_1=4.3 Hz, J_2=11.6 Hz, H-3), 1.17 (3H, s, 3H-26), 1.11 (3H, s, 3H-27), 1.06 (3H, s, 3H-25), 0.90 (3H, s, 3H-23), 0.90 (3H, s, 3H-29), 0.87 (3H, s, 3H-30), 0.76 (3H, s, 3H-24); ^{13}C NMR ($CDCl_3$): δ 15.2 (C-24), 17.1 (C-6), 18.5 (C-25), 19.8 (C-16), 21.7 (C-26), 21.7 (C-27), 24.9 (C-30), 25.6 (C-15), 27.4 (C-7), 28.7 (C-23), 28.8 (C-2), 30.5 (C-20), 31.9 (C-22), 33.1 (C-29), 33.5 (C-21), 34.7 (C-1), 36.7 (C-18), 37.7 (C-10), 38.2 (C-19), 38.6 (C-4), 41.5 (C-5), 42.5 (C-17), 51.4 (COOCH_3), 57.4 (C-14), 60.0 (C-8), 66.3 (C-13), 72.3 (C-9), 78.4 (C-3), 129.8 (C-12), 130.8 (C-11), 178.6 (C-28); HRLSIMS, *m/z*: $[M+Na]^+$ 523.3340 ($C_{31}H_{48}O_5Na$, calcd 523.3399). Product **29**: white solid; mp 197–199 °C; $[\alpha]_D^{25}$=42 (*c* 1, $CHCl_3$); IR ($CHCl_3$): ν 3282, 2936, 1746, 1079 cm^{-1}; ^1H NMR ($CDCl_3$): δ 5.81 (1H, d, J=14.1 Hz, H-12), 5.60 (1H, d, J=14.1 Hz, H-11), 3.21 (1H, dd, J_1=2.4 Hz, J_2=9.7 Hz, H-3), 1.27 (3H, s, Me), 1.25 (3H, s, Me), 1.12 (3H, s, Me), 0.99 (3H, s, Me), 0.96 (3H, s, Me), 0.82 (3H, s, Me), 0.80 (3H, s, Me); ^{13}C NMR ($CDCl_3$): δ 15.3 (C-24), 16.6 (C-6), 18.5 (C-25), 20.4 (C-16), 20.6 and 20.9 (C-26 and C-27), 24.3 (C-30), 27.0, 27.1, 27.7 and 28.3 (C-2, C-7, C-15 and C-22), 28.5 (C-23), 30.5 (C-20), 33.5 (C-1), 33.5 (C-21), 33.5 (C-29), 35.4 (C-19), 37.2 (C-10), 38.7 (C-4), 40.6 (C-17), 41.4 and 42.2 (C-5 and C-18), 67.2 (C-8), 74.2 (C-9), 74.8 (C-14), 78.5 (C-3), 84.7 (C-13), 120.8 (C-11), 138.3 (C-12), 179.0 (C-28); HRLSIMS, *m/z*: $[M+Na]^+$ 509.3243 ($C_{30}H_{46}O_5Na$, calcd 509.3243). Product **30**: white solid; mp 152–154 °C; $[\alpha]_D^{25}$=37 (*c* 0.5, $CHCl_3$); IR ($CHCl_3$): ν 3476, 2947, 1727 cm^{-1}; ^1H NMR ($CDCl_3$): δ 5.90 (1H, d, J=15.4 Hz, H-12), 5.78 (1H, d, J=15.4 Hz, H-11), 3.68 (3H, s, COOCH_3), 3.21 (1H, dd, J_1=4.4 Hz, J_2=11.1 Hz, H-3), 2.48 (1H, dd, J_1=4.2 Hz, J_2=13.0 Hz, H-18), 1.14 (3H, s, Me), 1.12 (3H, s, Me), 1.12 (3H, s, Me), 0.94 (3H, s, Me), 0.89 (3H, s, Me), 0.80 (3H, s, Me), 0.78 (3H, s, Me); ^{13}C NMR ($CDCl_3$): δ 15.3 (Me), 17.0 (C-6), 17.9 (Me), 19.9 (Me), 20.8 (Me), 23.1 (C-16), 24.0 (Me), 27.3 (C-7), 28.4 (Me), 28.8 (C-2), 29.7 (C-15), 29.8 (C-20), 31.1, 34.1, 34.5 and 35.4 (C-1, C-19, C-21 and C-22), 32.8 (C-29), 34.8 (C-18), 37.0 (C-10), 38.7 (C-4), 41.9 (C-5), 44.8 (C-17), 51.9 (COOCH_3), 64.3 and 64.4 (C-13 and C-14), 68.6 (C-8), 73.2 (C-9), 78.4 (C-3), 126.4 (C-11), 133.1 (C-12), 178.1 (C-28); HRLSIMS, *m/z*: $[M+Na]^+$ 523.3397 ($C_{31}H_{48}O_5Na$, calcd 523.3399). Product **31**: white solid; mp 268–270 °C; $[\alpha]_D^{25}$=−19 (*c* 1, $CHCl_3$); IR ($CHCl_3$): ν 3449, 2948, 1713 cm^{-1}; ^1H NMR ($CDCl_3$): δ 6.09 (1H, d, J=13.7 Hz, H-12), 5.71 (1H, d, J=13.7 Hz, H-11), 3.71 (3H, s, COOCH_3), 3.21 (1H, dd, J_1=4.6 Hz, J_2=11.1 Hz, H-3), 2.57 (1H, dd, J_1=3.6 Hz, J_2=13.7 Hz, H-18), 1.24 (3H, s, 3H-26), 1.11 (3H, s, 3H-25), 1.11 (3H, s, 3H-27), 0.92 (3H, s, 3H-23), 0.86 (3H, s, 3H-29), 0.78 (3H, s, 3H-30), 0.77 (3H, s, 3H-24); ^{13}C NMR ($CDCl_3$): δ 15.3 (C-24), 16.8 (C-6), 18.7 (C-25), 21.7 (C-27), 22.2 (C-16), 23.5 (C-26), 27.3 (C-2), 27.4 (C-30), 28.3 (C-7), 28.6 (C-23), 30.7 (C-20), 33.3 (C-29), 33.4, 33.7, 34.0 and 34.2 (C-15, C-21, C-22 and C-1), 37.5 (C-10), 37.9 (C-19), 38.6 (C-4), 41.2 (C-5), 44.1 (C-17), 45.2 (C-18), 51.5 (COOCH_3), 65.4 (C-8), 73.7 (C-9), 74.2 (C-14), 77.7 (C-13), 78.2 (C-3), 123.0 (C-11), 137.2 (C-12), 179.8 (C-28); HRLSIMS, *m/z*: $[M+Na]^+$ 541.3509 ($C_{31}H_{50}O_6Na$, calcd 541.3505).

4.2.6. Epoxidation of 26. 240 mg (0.5 mmol) of product **26** were dissolved in 10 mL of CH_2Cl_2 and 130 mg (0.75 mmol) of MCPBA were added. The resulting mixture was stirred at different temperatures (−40 °C and room temperature). When the reaction finished, the mixture was diluted with CH_2Cl_2, extracted with a solution of $FeSO_4$, neutralized with $NaHCO_3$, dried over anhydrous Na_2SO_4 and evaporated to dryness. Depending on the reaction conditions (Table 2), chromatography over silica gel yielded different amounts of **27**, **28**, **29**, **31**, **32** and **33**. Product **32**: syrup; $[\alpha]_D^{25}$=78 (*c* 1, $CHCl_3$); IR ($CHCl_3$): ν 3536, 2927, 1728, 1285 cm^{-1}; ^1H NMR ($CDCl_3$): δ 6.13 (1H, d, J=6.3 Hz, H-12), 5.89 (1H, d, J=6.3 Hz, H-11), 5.57 (1H, dd, J_1=3.5 Hz, J_2=5.0 Hz, H-7), 3.50 (3H, s, COOCH_3), 3.17 (1H, dd, J_1=5.5 Hz, J_2=10.3 Hz, H-3), 2.67 (1H, dd, J_1=3.7 Hz, J_2=14.5 Hz, H-18), 2.25 (1H, ddd, J_1=3.5 Hz, J_2=13.6 Hz, J_3=17.6 Hz, H-6), 1.67 (3H, s, Me), 1.15 (3H, s, Me), 0.95 (3H, s, Me), 0.88 (3H, s, Me), 0.86 (3H, s, Me), 0.84 (3H, s, Me), 0.84 (3H, s, Me); ^{13}C NMR ($CDCl_3$): δ 14.9 (Me), 18.8 (Me), 22.6 (C-16), 23.3 (Me), 23.7 (Me), 24.8 (C-6), 27.2 (C-2), 27.3 (Me), 30.8 (C-20), 31.3 (Me), 31.5 (C-15), 33.4 (C-29), 34.1 and 34.2 (C-21 and C-22), 34.9 (C-1), 38.4 (C-19), 39.1 (C-4), 40.5 (C-18), 40.7 (C-10), 44.2 (C-5), 45.0 (C-17), 51.6 (COOCH_3), 74.8 (C-14), 79.1 (C-3), 93.8 (C-13), 96.8 (C-9), 126.9 (C-7), 131.1 (C-11), 132.9 (C-12), 133.8 (C-8), 179.0 (C-28); HRLSIMS, *m/z*: $[M+Na]^+$ 523.3397 ($C_{31}H_{48}O_5Na$, calcd 523.3399). Product **33**: syrup; $[\alpha]_D^{25}$=6 (*c* 0.7, $CHCl_3$); IR ($CHCl_3$): ν 3471, 2945, 1724 cm^{-1}; ^1H NMR ($CDCl_3$): δ 6.14 (1H, d, J=6.4 Hz, H-12), 5.96 (1H, d, J=6.4 Hz,

H-11), 4.83 (1H, d, J=2.0 Hz, H-26a), 4.55 (1H, d, J=2.0 Hz, H-26b), 3.66 (3H, s, COOCH_3), 3.17 (1H, dd, J_1=4.5 Hz, J_2=11.2 Hz, H-3), 2.67 (1H, dd, J_1=4.3 Hz, J_2=13.9 Hz, H-18), 1.16 (3H, s, Me), 0.98 (3H, s, Me), 0.89 (3H, s, Me), 0.84 (3H, s, Me), 0.78 (3H, s, Me), 0.76 (3H, s, Me); ^{13}C NMR ($CDCl_3$): δ 15.8 (Me), 18.7 (Me), 22.5 and 23.0 (C-6 and C-16), 23.7 (Me), 27.4 (C-2), 28.5 (Me), 30.6 (C-20), 30.9 (Me), 32.6 (C-15), 32.6 (C-7), 33.0 (C-29), 34.0, 35.1 and 35.2 (C-1, C-21 and C-22), 38.9 (C-19), 39.1 and 42.2 (C-4 and C-10), 44.3 (C-17), 44.3 and 45.2 (C-5 and C-18), 51.8 (COOCH_3), 74.6 (C-14), 79.1 (C-3), 95.2 (C-13), 98.3 (C-9), 110.8 (C-26), 130.6 (C-11), 133.3 (C-12), 152.7 (C-8), 179.6 (C-28); HRLSIMS, m/z: $[M+Na]^+$ 523.3395 ($C_{31}H_{48}O_5Na$, calcd 523.3399).

4.2.7. Acetylation of 26. Product **26** (100 mg, 0.2 mmol) was dissolved in 4 mL of pyridine and 2 mL of Ac_2O and stirred for 1 h at reflux. The reaction mixture was diluted with water, extracted with CH_2Cl_2, washed with saturated aqueous $KHSO_4$ solution and dried with anhydrous Na_2SO_4. The solvent was evaporated at reduced pressure and the residue was chromatographed on a silica gel column to give 103 mg (95%) of **34**: white solid; mp 99–101 °C; $[\alpha]_D^{25}$=65 (c 0.8, $CHCl_3$); IR ($CHCl_3$): ν 2949, 1732, 1246 cm^{-1}; ^{1}H NMR ($CDCl_3$): δ 6.14 (1H, d, J=13.3 Hz, H-12), 5.58 (1H, d, J=13.3 Hz, H-11), 4.47 (1H, dd, J_1=4.4 Hz, J_2=10.6 Hz, H-3), 3.72 (3H, s, COOCH_3), 3.55 (1H, dd, J_1=3.9 Hz, J_2=12.7 Hz, H-18), 2.01 (3H, s, COCH_3), 1.50 (3H, s, Me), 1.18 (3H, s, Me), 1.09 (3H, s, Me), 0.88 (3H, s, Me), 0.83 (3H, s, Me), 0.83 (3H, s, Me), 0.81 (3H, s, Me); ^{13}C NMR ($CDCl_3$): δ 16.4 (C-24), 16.9 (C-6), 18.3 (C-25), 20.8 (C-27), 21.4 (C-26), 21.4 (COCH_3), 22.3 (C-30), 23.8 (C-16), 23.8 (C-2), 28.2 (C-7), 28.6 (C-23), 29.6 (C-15), 30.7 (C-20), 32.0 (C-22), 32.5 (C-29), 32.8 (C-1), 34.5 (C-21), 35.9 (C-18), 37.5 (C-10), 38.3 (C-4), 41.6 (C-5), 42.8 (C-19), 45.2 (C-17), 52.0 (COOCH_3), 61.0 (C-8), 71.6 (C-9), 80.6 (C-3), 126.0 (C-11), 128.0 (C-14), 132.8 (C-13), 134.9 (C-12), 170.9 (COCH$_3$), 178.4 (C-28); HRLSIMS, m/z: $[M+Na]^+$ 549.3559 ($C_{33}H_{50}O_5Na$, calcd 549.3556).

4.2.8. Epoxidation of 34. Product **34** (160 mg, 0.3 mmol) was dissolved in 10 mL of CH_2Cl_2 and 78 mg (0.45 mmol) of MCPBA were added. The resulting mixture was stirred at −20 °C for 3.5 h. When the reaction finished, the mixture was diluted with CH_2Cl_2, extracted with a solution of $FeSO_4$, neutralized with $NaHCO_3$, dried over anhydrous Na_2SO_4, evaporated to dryness and purified over silica gel, yielding 66 mg (40%) of **35**: syrup; $[\alpha]_D^{25}$=50 (c 0.5, $CHCl_3$); IR ($CHCl_3$): ν 2949, 1731, 1246 cm^{-1}; ^{1}H NMR ($CDCl_3$): δ 5.91 (1H, d, J=13.5 Hz, H-12), 5.66 (1H, d, J=13.5 Hz, H-11), 4.48 (1H, dd, J_1=4.1 Hz, J_2=11.4 Hz, H-3), 3.68 (3H, s, COOCH_3), 2.52 (1H, dd, J_1=3.0 Hz, J_2=13.1 Hz, H-18), 2.02 (1H, s, COCH_3), 1.13 (3H, s, Me), 1.13 (3H, s, Me), 1.10 (3H, s, Me), 0.98 (3H, s, Me), 0.90 (3H, s, Me), 0.86 (3H, s, Me), 0.82 (3H, s, Me); ^{13}C NMR ($CDCl_3$): δ 16.2 (C-24), 16.8 (C-6), 18.7 (C-25), 20.4 (C-26), 20.7 (C-27), 21.3 (COCH_3), 22.6 (C-16), 23.5 (C-7), 24.0 (C-30), 28.1 (C-2), 28.3 (C-23), 29.5 (C-15), 30.0 (C-20), 31.5 (C-22), 33.2 (C-29), 34.2 (C-1), 35.0 (C-21), 35.0 (C-19), 35.9 (C-18), 37.1 and 37.6 (C-4 and C-10), 41.4 (C-5), 45.5 (C-17), 51.7 (COOCH_3), 61.3 (C-14), 62.5 (C-8), 65.6 (C-13), 71.7 (C-9), 80.7 (C-3), 125.2 (C-11), 133.4 (C-12), 170.8 (COCH$_3$), 178.5 (C-28); HRLSIMS, m/z: $[M+Na]^+$ 565.3515 ($C_{33}H_{50}O_6Na$, calcd 565.3505); 17 mg (10%) of **36**: syrup; $[\alpha]_D^{25}$=−10 (c 1, $CHCl_3$); IR ($CHCl_3$): ν 2948, 1729, 1247 cm^{-1}; ^{1}H NMR ($CDCl_3$): δ 5.82 (1H, d, J=12.5 Hz, H-12), 5.69 (1H, d, J=12.5 Hz, H-11), 4.43 (1H, dd, J_1=4.4 Hz, J_2=11.7 Hz, H-3), 3.73 (3H, s, COOCH_3), 3.21 (1H, dd, J_1=4.2 Hz, J_2=13.5 Hz, H-18), 1.99 (1H, s, COCH_3), 1.16 (3H, s, Me), 1.08 (3H, s, Me), 1.07 (3H, s, Me), 0.88 (3H, s, Me), 0.85 (3H, s, Me), 0.81 (3H, s, Me), 0.78 (3H, s, Me); ^{13}C NMR ($CDCl_3$): δ 16.4 (C-24), 17.0 (C-6), 18.4 (C-25), 19.8 (C-16), 21.3 (COCH_3), 21.7 (C-26), 21.7 (C-27), 23.8 (C-15), 24.8 (C-30), 25.6 (C-7), 28.7 (C-2), 28.7 (C-23), 30.4 (C-20), 31.9 (C-22), 33.1 (C-29), 33.5 (C-21), 34.4 (C-1), 36.6 (C-18), 37.5 and 37.6 (C-4 and C-10), 38.2 (C-19), 41.7 (C-5), 42.4 (C-17), 51.4 (COOCH_3), 57.3 (C-14), 59.9 (C-8), 66.0 (C-13), 72.0 (C-9), 80.5 (C-3), 129.5 (C-11), 131.1 (C-12), 170.6 (COCH$_3$), 178.3 (C-28); HRLSIMS, m/z: $[M+Na]^+$ 565.3505 ($C_{33}H_{50}O_6Na$, calcd 565.3505); 16 mg (10%) of **37**: white solid; mp 183–185 °C; $[\alpha]_D^{25}$=46 (c 1, $CHCl_3$); IR ($CHCl_3$): ν 3288, 2948, 1737, 1244 cm^{-1}; ^{1}H NMR ($CDCl_3$): δ 5.82 (1H, d, J=14.1 Hz, H-12), 5.60 (1H, d, J=14.1 Hz, H-11), 4.47 (1H, dd, J_1=3.0 Hz, J_2=11.3 Hz, H-3), 2.03 (3H, s, COCH_3), 1.27 (3H, s, Me), 1.24 (3H, s, Me), 1.14 (3H, s, Me), 1.02 (3H, s, Me), 0.86 (3H, s, Me), 0.84 (3H, s, Me), 0.83 (3H, s, Me); ^{13}C NMR ($CDCl_3$): δ 16.4 (C-24), 16.5 (C-6), 18.5 (C-25), 20.4 (C-16), 20.7 and 20.9 (C-26 and C-27), 21.3 (COCH_3), 23.4 (C-2), 24.2 (C-30), 27.1, 27.7 and 28.1 (C-7, C-15 and C-22), 28.4 (C-23), 30.5 (C-20), 33.5, 33.5 and 35.1 (C-1, C-19 and C-21), 33.5 (C-29), 37.1 and 37.6 (C-4 and C-10), 40.6 (C-17), 41.6 and 42.2 (C-5 and C-18), 67.1 (C-8), 74.0 (C-9), 74.8 (C-14), 80.1 (C-3), 84.8 (C-13), 120.7 (C-11), 138.5 (C-12), 170.8 (COCH$_3$), 179.1 (C-28); HRLSIMS, m/z: $[M+Na]^+$ 551.3348 ($C_{32}H_{48}O_6Na$, calcd 551.3349); and 52 mg (30%) of **38**: white solid; mp 198–200 °C; $[\alpha]_D^{25}$=4 (c 0.7, $CHCl_3$); IR ($CHCl_3$): ν 3458, 2948, 1730, 1248 cm^{-1}; ^{1}H NMR ($CDCl_3$): δ 6.10 (1H, d, J=13.7 Hz, H-12), 5.70 (1H, d, J=13.7 Hz, H-11), 4.44 (1H, dd, J_1=4.6 Hz, J_2=11.5 Hz, H-3), 3.73 (3H, s, COOCH_3), 2.57 (1H, dd, J_1=3.7 Hz, J_2=13.6 Hz, H-18), 2.01 (3H, s, COCH_3), 1.24 (3H, s, Me), 1.13 (3H, s, Me), 1.09 (3H, s, Me), 0.86 (3H, s, Me), 0.84 (3H, s, Me), 0.81 (3H, s, Me), 0.78 (3H, s, Me); ^{13}C NMR ($CDCl_3$): δ 16.5 (C-24), 16.7 (C-6), 18.6 (C-25), 21.4 (COCH_3), 21.8 (C-27), 22.1 (C-16), 23.5 (C-26), 23.8 (C-2), 27.4 (C-30), 28.1 (C-7), 28.5 (C-23), 30.7 (C-20), 33.4 (C-29), 33.5, 33.8, 33.9 and 34.0 (C-1, C-15, C-21 and C-22), 37.4 (C-10), 37.5 (C-4), 37.9 (C-19), 41.4 (C-5), 44.2 (C-17), 45.2 (C-18), 51.7 (COOCH_3), 65.2 (C-8), 73.4 (C-9), 74.3 (C-14), 77.1 (C-13), 80.4 (C-3), 122.8 (C-11), 137.6 (C-12), 170.8 (COCH$_3$), 179.7 (C-28); HRLSIMS, m/z: $[M+Na]^+$ 583.3613 ($C_{33}H_{52}O_7Na$, calcd 583.3611).

4.2.9. Ozonolysis of 26 in CH_2Cl_2. Product **26** (95 mg, 0.2 mmol) was dissolved in 10 mL of CH_2Cl_2, stirred at −78 °C and passed through an O_3 flow of 0.1 L/min (10% O_2–90% O_3). After 10 min, 1 mL of Me_2S was added. The mixture was maintained with stirring while being cooled down for 3 h. Then it was evaporated and purified over silica gel, yielding 34 mg (36%) of **26** and 61 mg (60%) of **31**.

4.2.10. Ozonolysis of 31. 50 mg (0.1 mmol) of product **31** were dissolved in 5 mL of CH_2Cl_2 and stirred at 0 °C. Then

an O_3 flow of 0.1 L/min (10% O_2–90% O_3) was passed through the solution for 35 min. After that, 0.5 mL of Me_2S were added. The mixture was maintained with stirring while being cooled down for 1 h, evaporated to dryness and chromatographed on a silica gel column, rendering 23 mg (45%) of **39**: white solid; mp 189–191 °C; $[\alpha]_D^{25}=-31$ (*c* 1, $CHCl_3$); IR ($CHCl_3$): ν 3461, 2949, 1707 cm^{-1}; ^1H NMR ($CDCl_3$): δ 6.15 (1H, d, *J*=13.7 Hz, H-12), 5.73 (1H, d, *J*=13.7 Hz, H-11), 3.69 (3H, s, COOCH_3), 2.57 (1H, dd, J_1=3.5 Hz, J_2=13.5 Hz, H-18), 1.28 (3H, s, Me), 1.26 (3H, s, Me), 1.09 (3H, s, Me), 1.01 (3H, s, Me), 1.00 (3H, s, Me), 0.86 (3H, s, Me), 0.78 (3H, s, Me); ^{13}C NMR ($CDCl_3$): δ 18.0 (C-6), 18.2 (Me), 21.6 (Me), 21.8 (Me), 22.1 (C-16), 23.5 (Me), 26.5 (Me), 27.4 (C-30), 28.3 (C-7), 30.7 (C-20), 33.3 (C-29), 33.4 (C-1), 33.7, 34.0, 34.2 and 34.5 (C-2, C-15, C-21 and C-22), 37.3 (C-10), 37.9 (C-19), 42.6 (C-5), 44.2 (C-17), 45.1 (C-18), 47.0 (C-4), 51.6 (COOCH_3), 65.5 (C-8), 73.0 (C-9), 74.2 (C-14), 77.7 (C-13), 122.6 (C-11), 138.0 (C-12), 179.7 (C-28), 216.2 (C-3); HRLSIMS, *m/z*: $[M+Na]^+$ 539.3346 ($C_{31}H_{48}O_6Na$, calcd 539.3349).

4.2.11. Ozonolysis of 26 in CH_2Cl_2/Py. Product **26** (95 mg, 0.2 mmol) was dissolved in 11 mL of CH_2Cl_2/Py 10:1, stirred at −78 °C and passed through an O_3 flow of 0.1 L/min (10% O_2–90% O_3). After 1 h, 1 mL of Me_2S was added. The mixture was maintained with stirring while being cooled down for 3 h. Then it was evaporated and purified over silica gel, yielding 78 mg (80%) of **40**: syrup; $[\alpha]_D^{25}=42$ (*c* 1, $CHCl_3$); IR ($CHCl_3$): ν 2948, 1727 cm^{-1}; ^1H NMR ($CDCl_3$): δ 5.95 (1H, d, *J*=13.6 Hz, H-12), 5.68 (1H, d, *J*=13.6 Hz, H-11), 3.67 (3H, s, COOCH_3), 1.27 (3H, s, Me), 1.17 (3H, s, Me), 1.12 (3H, s, Me), 1.02 (3H, s, Me), 1.02 (3H, s, Me), 0.90 (3H, s, Me), 0.83 (3H, s, Me); ^{13}C NMR ($CDCl_3$): δ 18.1 (C-6), 18.2 (Me), 20.2 (Me), 21.0 (Me), 21.5 (Me), 22.4 (C-16), 24.2 (Me), 26.3 (Me), 28.5 (C-7), 29.6 (C-15), 29.9 (C-20), 31.4 (C-22), 33.1 (C-29), 33.9, 34.2, 35.3 and 35.3 (C-1, C-2, C-19 and C-21), 35.9 (C-18), 37.2 (C-10), 42.8 (C-5), 45.5 (C-4), 47.2 (C-17), 51.8 (COOCH_3), 61.9 (C-14), 62.5 (C-8), 65.9 (C-13), 71.2 (C-9), 125.1 (C-11), 134.2 (C-12), 178.4 (C-28), 216.4 (C-3); HRLSIMS, *m/z*: $[M+Na]^+$ 521.3235 ($C_{31}H_{46}O_5Na$, calcd 521.3243).

4.2.12. Ozonolysis of 40. 100 mg (0.2 mmol) of product **40** were dissolved in 11 mL of CH_2Cl_2/Py 10:1 and an O_3 flow of 0.1 L/min (10% O_2–90% O_3) was passed through the solution for 3 h at room temperature. After that, 1 mL of Me_2S was added and the mixture maintained 5 min with stirring, evaporated to dryness and purified over silica gel to give 11 mg (10%) of **39** and 10 mg (10%) of **41**: syrup; $[\alpha]_D^{25}=-35$ (*c* 0.8, $CHCl_3$); IR ($CHCl_3$): ν 3266, 2948, 1694, 1185 cm^{-1}; ^1H NMR ($CDCl_3$): δ 5.90 (1H, d, *J*=13.5 Hz, H-12), 5.83 (1H, d, *J*=13.5 Hz, H-11), 1.24 (3H, s, Me), 1.21 (3H, s, Me), 1.17 (3H, s, Me), 1.03 (3H, s, Me), 0.99 (3H, s, Me), 0.94 (3H, s, Me), 0.80 (3H, s, Me); ^{13}C NMR ($CDCl_3$): δ 18.2 (C-6), 18.3 (Me), 20.0 (C-16), 22.0 (Me), 22.2 (Me), 25.2 (Me), 26.5 (Me), 26.8 and 28.2 (C-7 and C-15), 27.3 (Me), 31.5 (C-20), 33.1 (C-29), 33.9, 34.1, 34.8, 34.9 and 34.9 (C-1, C-2, C-19, C-21 and C-22), 37.4 (C-10), 42.5 (C-18), 44.1 (C-4), 46.4 (C-5), 47.1 (C-17), 60.8 (C-8), 71.5 (C-9), 71.6 (C-14), 87.8 (C-13), 127.3 (C-11), 129.7 (C-12), 179.5 (C-28), 216.9 (C-3); HRLSIMS, *m/z*: $[M+Na]^+$ 507.3083 ($C_{30}H_{44}O_5Na$, calcd 507.3086).

4.2.13. Ozonolysis of 34. Product **34** (105 mg, 0.2 mmol) was dissolved in 10 mL of CH_2Cl_2 and passed through an O_3 flow of 0.1 L/min (10% O_2–90% O_3) at different temperatures. When the reaction was complete, 1 mL of Me_2S was added and the mixture maintained with stirring while being cooled down. Then it was evaporated and chromatographed on a silica gel column to give different amounts of **37** and **38** depending on the reaction conditions (Table 3).

4.2.14. Ozonolysis of 11. Product **11** (100 mg, 0.2 mmol) was dissolved in 10 mL of CH_2Cl_2, stirred at −78 °C and passed through an O_3 flow lower than 0.1 L/min (10% O_2–90% O_3). After 1 h, 1 mL of Me_2S was added. The mixture was maintained with stirring while being cooled down for 3 h. Then it was evaporated and purified over silica gel, yielding 11 mg (10%) of **42**: syrup; $[\alpha]_D^{25}=104$ (*c* 0.5, $CHCl_3$); IR ($CHCl_3$): ν 2949, 1647, 1246 cm^{-1}; ^1H NMR ($CDCl_3$): δ 5.94 (1H, d, *J*=15.5 Hz, H-12), 5.78 (1H, d, *J*=15.5 Hz, H-11), 4.49 (1H, dd, J_1=5.3 Hz, J_2=10.6 Hz, H-3), 3.68 (3H, s, COOCH_3), 2.54 (1H, dd, J_1=4.7 Hz, J_2=12.8 Hz, H-18), 2.04 (3H, s, COCH_3), 1.13 (3H, s, Me), 1.10 (3H, s, Me), 1.01 (3H, s, Me), 0.90 (3H, s, Me), 0.84 (3H, s, Me), 0.83 (3H, s, Me), 0.82 (3H, s, Me); ^{13}C NMR ($CDCl_3$): δ 16.1 (Me), 16.6 (C-6), 17.0 (Me), 20.1 (Me), 20.3 (Me), 21.3 (COCH_3), 23.2 (C-16), 24.1 (C-30), 24.7 (C-2), 28.0 (C-23), 29.7 (C-7), 29.8 (C-20), 31.2 (C-15), 32.8 (C-23), 34.1 and 34.9 (C-21 and C-22), 35.3 (C-18), 35.9 (C-1), 36.4 (C-19), 38.1 and 38.3 (C-4 and C-10), 44.9 (C-17), 51.9 (COOCH_3), 52.4 (C-5), 64.2 (C-14), 65.6 (C-8), 68.3 (C-13), 72.8 (C-9), 80.3 (C-3), 128.5 (C-11), 133.0 (C-12), 171.0 (*CO*CH_3), 178.0 (C-28); HRLSIMS, *m/z*: $[M+Na]^+$ 565.3510 ($C_{33}H_{50}O_6Na$, calcd 565.3505); and 10 mg (10%) of **43**: syrup; $[\alpha]_D^{25}=47$ (*c* 0.4, $CHCl_3$); IR ($CHCl_3$): ν 2949, 1732, 1247 cm^{-1}; ^1H NMR ($CDCl_3$): δ 5.90 (1H, d, *J*=15.4 Hz, H-12), 5.80 (1H, d, *J*=15.4 Hz, H-11), 4.45 (1H, dd, J_1=4.4 Hz, J_2=11.0 Hz, H-3), 3.68 (3H, s, COOCH_3), 2.47 (1H, dd, J_1=3.3 Hz, J_2=13.2 Hz, H-18), 2.02 (3H, s, COCH_3), 1.14 (3H, s, Me), 1.14 (3H, s, Me), 1.10 (3H, s, Me), 0.89 (3H, s, Me), 0.85 (3H, s, Me), 0.83 (3H, s, Me), 0.79 (3H, s, Me); ^{13}C NMR ($CDCl_3$): δ 16.4 (Me), 16.9 (C-6), 18.0 (Me), 19.9 (Me), 20.8 (Me), 21.4 (COCH_3), 23.1 (C-16), 23.7 (C-2), 24.0 (C-30), 28.3 (C-23), 28.6 (C-7), 29.7 (C-15), 29.8 (C-20), 31.1 (C-22), 32.8 (C-29), 34.1, 34.3 and 35.4 (C-1, C-19 and C-21), 34.9 (C-18), 36.9 and 37.6 (C-4 and C-10), 42.0 (C-5), 44.8 (C-17), 51.9 (COOCH_3), 64.2 and 64.3 (C-8 and C-14), 68.7 (C-13), 73.0 (C-9), 80.4 (C-3), 126.2 (C-11), 133.3 (C-12), 170.9 (*CO*CH_3), 178.0 (C-28); HRLSIMS, *m/z*: $[M+Na]^+$ 565.3502 ($C_{33}H_{50}O_6Na$, calcd 565.3505).

4.2.15. Epoxidation of 11. 255 mg (0.5 mmol) of product **11** were dissolved in 10 mL of CH_2Cl_2 and 169 mg (1 mmol) of MCPBA were added. The resulting mixture was stirred at room temperature for 30 min and then diluted with CH_2Cl_2, extracted with a solution of $FeSO_4$, neutralized with $NaHCO_3$, dried over anhydrous Na_2SO_4, evaporated at reduced pressure and chromatographed on a silica gel column to obtain 27 mg (10%) of **42**, 135 mg (50%) of **43** and 28 mg (10%) of **44**: syrup; $[\alpha]_D^{25}=$(*c* 1, $CHCl_3$); IR ($CHCl_3$): ν 2949, 1732, 1246 cm^{-1}; ^1H NMR ($CDCl_3$): δ 5.94 (1H, d, *J*=3.5 Hz, H-11), 5.94 (1H, d, *J*=3.5 Hz, H-12), 4.49 (1H, dd, J_1=4.3 Hz, J_2=10.9 Hz, H-3), 3.68 (3H, s, COOCH_3), 2.71 (1H, dd, J_1=3.8 Hz,

J_2=13.3 Hz, H-18), 2.03 (3H, s, COCH_3), 1.13 (3H, s, Me), 1.09 (3H, s, Me), 1.07 (3H, s, Me), 0.94 (3H, s, Me), 0.91 (3H, s, Me), 0.86 (3H, s, Me), 0.83 (3H, s, Me); ^{13}C NMR ($CDCl_3$): δ 16.2 (Me), 16.7 (C-6), 17.9 (Me), 19.8 (C-16), 21.2 (COCH_3), 21.2 (Me), 21.2 (Me), 23.8 (C-2), 24.6 (C-30), 26.1 (C-15), 28.4 (C-23), 28.7 (C-7), 30.4 (C-20), 32.4 (C-22), 33.0 (C-29), 33.4 (C-21), 34.1 (C-1), 36.9 and 37.8 (C-4 and C-10), 37.6 (C-19), 39.2 (C-18), 42.1 (C-5), 43.0 (C-17), 51.5 (COOCH_3), 61.8 (C-14), 64.5 (C-8), 68.5 (C-13), 73.2 (C-9), 80.4 (C-3), 128.0 (C-11), 130.9 (C-12), 170.8 (*CO*CH_3), 178.1 (C-28); HRLSIMS, *m/z*: $[M+Na]^+$ 565.3495 ($C_{33}H_{50}O_6Na$, calcd 565.3505).

4.2.16. Oxidation of 11 with $NaIO_4/RuCl_3$. Product **11** (102 mg, 0.2 mmol) was dissolved in 10 mL of acetone, and a solution in water (2 mL) of approximately 5 mg of $RuCl_3.3H_2O$ and different amounts of $NaIO_4$ depending on the reaction conditions was added (Table 4). The reaction mixture was stirred at several temperatures and then diluted with CH_2Cl_2, washed with water and dried over anhydrous Na_2SO_4. The solvent was evaporated at reduced pressure and the residue was chromatographed to give variable amounts of **45** and **46** (Table 4). Product **45**: white solid; mp 79–81 °C; $[\alpha]_D^{25}$=5 (*c* 0.4, $CHCl_3$); IR ($CHCl_3$): ν 2948, 1734, 1245 cm^{-1}; ^{1}H NMR ($CDCl_3$): δ 10.03 (1H, s, C-11), 4.50 (1H, dd, J_1=5.5 Hz, J_2=10.9 Hz, H-3), 2.66 (1H, ddd, J_1=J_2=3.7 Hz, J_3=13.5 Hz, H-1α), 2.04 (3H, s, COCH_3), 2.04 (3H, s, 3H-12), 1.18 (3H, s, 3H-15), 0.89 (3H, s, 3H-13), 0.89 (3H, s, 3H-14); ^{13}C NMR ($CDCl_3$): δ 16.7 (C-14), 18.0 (C-6), 19.0 (C-12), 20.0 (C-15), 21.3 (COCH_3), 24.1 (C-2), 28.3 (C-13), 34.0 (C-7), 36.7 (C-1), 37.3 (C-10), 37.9 (C-4), 51.2 (C-5), 80.5 (C-3), 143.0 (C-8), 154.6 (C-9), 171.0 (COCH_3), 192.1 (C-11); HRLSIMS, *m/z*: $[M+Na]^+$ 301.1779 ($C_{17}H_{26}O_3Na$, calcd 301.1780). Product **46**: syrup; $[\alpha]_D^{25}$=51 (*c* 1, $CHCl_3$); IR ($CHCl_3$): ν 2949, 1727, 1668 cm^{-1}; ^{1}H NMR ($CDCl_3$): δ 10.03 (1H, s, C-12), 3.59 (3H, s, COOCH_3), 3.32 (1H, dd, J_1=2.8 Hz, J_2=12.2 Hz, H-5), 2.04 (3H, s, 3H-11), 1.03 (3H, s, 3H-13), 0.86 (3H, s, 3H-14); ^{13}C NMR ($CDCl_3$): δ 18.0 (C-11), 22.2 (C-9), 24.0 (C-13), 30.8 (C-5), 30.9 (C-3), 31.7 (C-8), 32.3 (C-1), 32.8 (C-14), 33.9 (C-2), 42.0 (C-4), 44.8 (C-10), 51.9 (COOCH_3), 137.4 (C-7), 154.6 (C-6), 177.7 (C-15), 190.2 (C-12); HRLSIMS, *m/z*: $[M+Na]^+$ 287.1617 ($C_{16}H_{24}O_3Na$, calcd 287.1623).

4.2.17. Obtention of 47 and 48. The oxidation reaction of product **11** with $NaIO_4/RuCl_3{\cdot}3H_2O$ was worked-up and the residue dissolved in 10 mL of THF without further purification. Then, 2 mL of a solution 1 M of $LiAlH_4$ in THF were added. The reaction was maintained 1 h at reflux, diluted with aqueous ether, extracted with CH_2Cl_2, dried over anhydrous Na_2SO_4 and evaporated to dryness. Chromatography over silica gel rendered 95% of the reduced products **47**[17] and **48**: syrup; $[\alpha]_D^{25}$=29 (*c* 0.8, $CHCl_3$); IR ($CHCl_3$): ν 3328, 2916, 1464, 1022 cm^{-1}; ^{1}H NMR ($CDCl_3$): δ 4.22 (1H, d, J=11.2 Hz, H-12a), 3.90 (1H, d, J=11.2 Hz, H-12b), 3.42 (1H, d, J=10.8 Hz, H-15a), 3.28 (1H, d, J=10.8 Hz, H-15b), 1.66 (3H, s, 3H-11), 0.91 and 0.89 (3H each, s, 3H-13 and 3H-14); ^{13}C NMR ($CDCl_3$): δ 18.5 (C-11), 22.4 (C-9), 24.2 (C-13), 29.1 (C-1), 30.1 (C-8), 30.9 (C-3), 33.1 (C-14), 34.1 (C-2), 35.3 (C-5), 36.1 (C-10), 42.5 (C-4), 61.6 (C-12), 68.7 (C-15), 130.5 (C-7), 133.1 (C-6); HRLSIMS, *m/z*: $[M+Na]^+$ 261.1834 ($C_{15}H_{26}O_2Na$, calcd 261.1830).

4.2.18. Obtention of 49 and 50. Product **11** (102 mg, 0.2 mmol) was dissolved in 10 mL of acetone and a solution in water (2 mL) of approximately 5 mg of $RuCl_3{\cdot}3H_2O$ and 171 mg (0.8 mmol) of $NaIO_4$ was added. The reaction mixture was stirred 30 min at room temperature and then diluted with CH_2Cl_2, washed with water, dried over anhydrous Na_2SO_4 and the solvent evaporated to dryness. Without further purification, the residue was dissolved in 5 mL of DMF and 10 mg (0.3 mmol) of $NaBH_4$ were added. The reaction was maintained 1 h at room temperature and then suspension was evaporated adding 60 mL of toluene/ethyl ether (3:1). The residue was extracted with CH_2Cl_2, washed with water, dried over anhydrous Na_2SO_4 and finally evaporated at reduced pressure. Chromatography over silica gel yielded 95% of products **49** and **50**. Product **49**: syrup; $[\alpha]_D^{25}$=54 (*c* 1, $CHCl_3$); IR ($CHCl_3$): ν 3447, 2946, 1733, 1246 cm^{-1}; ^{1}H NMR ($CDCl_3$): δ 4.48 (1H, dd, J_1=4.8 Hz, J_2=11.4 Hz, H-3), 4.16 (1H, d, J=11.6 Hz, H-11a), 4.00 (1H, d, J=11.6 Hz, H-11b), 2.02 (3H, s, COCH_3), 1.89 (1H, ddd, J_1=J_2=3.5 Hz, J_3=12.9 Hz, H-1α), 1.69 (3H, s, 3H-12), 0.97 (3H, s, 3H-15), 0.86 (3H, s, 3H-13), 0.85 (3H, s, 3H-14); ^{13}C NMR ($CDCl_3$): δ 16.6 (C-14), 18.6 (C-6), 19.3 (C-12), 20.8 (C-15), 21.4 (COCH_3), 24.1 (C-2), 28.2 (C-13), 33.8 (C-7), 34.6 (C-1), 37.8 (C-10), 37.8 (C-4), 51.0 (C-5), 58.3 (C-11), 80.8 (C-3), 132.7 (C-8), 140.1 (C-9), 171.1 (*CO*CH_3); HRLSIMS, *m/z*: $[M+Na]^+$ 303.1935 ($C_{17}H_{28}O_3Na$, calcd 303.1936). Product **50**: syrup; $[\alpha]_D^{25}$=47 (*c* 1, $CHCl_3$); IR ($CHCl_3$): ν 3463, 2947, 1725, 1253 cm^{-1}; ^{1}H NMR ($CDCl_3$): δ 4.17 (1H, d, J=11.1 Hz, H-12a), 3.88 (1H, d, J=11.1 Hz, H-12b), 3.61 (3H, s, COOCH_3), 2.71 (1H, dd, J_1=3.9 Hz, J_2=12.8 Hz, H-5), 1.60 (3H, s, 3H-11), 0.91 (3H, s, 3H-13), 0.87 (3H, s, 3H-14); ^{13}C NMR ($CDCl_3$): δ 18.6 (C-11), 22.9 (C-9), 24.3 (C-13), 30.0 (C-8), 30.7 (C-3), 31.7 (C-1), 32.9 (C-14), 34.0 (C-2), 35.6 (C-5), 42.0 (C-4), 45.7 (C-10), 51.9 (COOCH_3), 61.5 (C-12), 130.6 (C-7), 133.8 (C-6), 178.6 (C-15); HRLSIMS, *m/z*: $[M+Na]^+$ 289.1775 ($C_{16}H_{26}O_3Na$, calcd 289.1780).

4.2.19. Epoxidation of 16. Product **16** (500 mg, 0.9 mmol) was dissolved in 50 mL of CH_2Cl_2 and 228 mg (1.3 mmol) of MCPBA were added. The resulting mixture was stirred at −40 °C for 12 h and then diluted with CH_2Cl_2, extracted with a solution of $FeSO_4$, neutralized with $NaHCO_3$, dried over anhydrous Na_2SO_4 and evaporated at reduced pressure to give 310 mg (60%) of **51**: white solid; mp 133–135 °C; $[\alpha]_D^{25}$=−36 (*c* 1, $CHCl_3$); IR ($CHCl_3$): ν 3459, 2946, 1743, 1368, 1251 cm^{-1}; ^{1}H NMR ($CDCl_3$): δ 5.18 (1H, ddd, J_1=4.6 Hz, J_2=J_3=10.3 Hz, H-2), 5.18 (1H, dd, J_1=4.9 Hz, J_2=9.3 Hz, H-11), 5.02 (1H, d, J=2.2 Hz, H-26a), 4.76 (1H, d, J=10.3 Hz, H-3), 4.59 (1H, d, J=2.2 Hz, H-26b), 3.66 (3H, s, COOCH_3), 2.72 (1H, dd, J_1=9.3 Hz, J_2=15.1 Hz, H-12a), 2.11 (1H, dd, J_1=4.9 Hz, J_2=15.1 Hz, H-12b), 2.04 (3H, s, COCH_3), 2.00 (3H, s, COCH_3), 1.24 (3H, s, Me), 1.07 (3H, s, Me), 0.91 (3H, s, Me), 0.89 (3H, s, Me), 0.86 (3H, s, Me), 0.83 (3H, s, Me); ^{13}C NMR ($CDCl_3$): δ 17.5 (Me), 19.9 (Me), 21.0 (Me), 21.3 (COCH_3), 21.4 (COCH_3), 22.9 (C-6), 24.3 (Me), 28.6 (Me), 29.8 and 30.3 (C-15 and C-16), 29.9 (C-20), 31.6, 34.1 and 33.5 (C-12, C-21 and C-22), 32.8 (Me), 33.7 (C-18), 36.1 (C-19), 36.8 (C-7), 39.7

(C-4), 40.3 (C-1), 41.6 (C-10), 45.1 (C-17), 51.7 and 52.3 (C-5 and COO*CH*$_3$), 62.5 and 67.8 (C-13 and C-14), 70.7 (C-2), 80.5 (C-3), 112.7 (C-26), 115.0 (C-11), 144.5 (C-8), 150.7 (C-9), 170.6 (*CO*CH$_3$), 170.8 (*CO*CH$_3$), 177.5 (C-28); HRLSIMS, *m/z*: [M+Na]$^+$ 607.3611 ($C_{35}H_{52}O_7Na$, calcd 607.3611); and 78 mg (15%) of **52**: syrup; $[\alpha]_D^{25}=-31$ (*c* 1, $CHCl_3$); IR ($CHCl_3$): ν 2946, 2857, 1743, 1250, 1035 cm^{-1}; ^{1}H NMR ($CDCl_3$): δ 5.22 (1H, dd, J_1=4.3 Hz, J_2=10.0 Hz, H-11), 5.19 (1H, ddd, J_1=3.6 Hz, J_2=J_3=10.3 Hz, H-2), 5.03 (1H, d, *J*=2.2 Hz, H-26a), 4.75 (1H, d, *J*=10.3 Hz, H-3), 4.59 (1H, d, *J*=2.2 Hz, H-26b), 3.67 (3H, s, COO*CH*$_3$), 2.78 (1H, dd, J_1=4.3 Hz, J_2=14.6 Hz, H-12a), 2.76 (1H, dd, J_1=10.0 Hz, J_2=14.6 Hz, H-12b), 2.06 (3H, s, CO*CH*$_3$), 1.99 (3H, s, CO*CH*$_3$), 1.20 (3H, s, Me), 1.07 (3H, s, Me), 0.93 (3H, s, Me), 0.92 (3H, s, Me), 0.91 (3H, s, Me), 0.88 (3H, s, Me); ^{13}C NMR ($CDCl_3$): δ 17.6 (Me), 19.5 (C-6), 20.7 (Me), 21.0 (CO*CH*$_3$), 21.2 (CO*CH*$_3$), 21.6 (Me), 22.8 and 26.5 (C-15 and C-16), 25.2 (Me), 28.8 (Me), 29.8, 32.0 and 33.5 (C-12, C-21 and C-22), 30.6 (C-20), 33.2 (Me), 35.1 (C-18), 36.6 (C-19), 37.2 (C-7), 39.8, 41.5 and 42.9 (C-4, C-10 and C-17), 41.1 (C-1), 51.3 and 52.4 (C-5 and COO*CH*$_3$), 61.2 and 68.4 (C-13 and C-14), 70.4 (C-2), 80.6 (C-3), 113.7 (C-26), 114.5 (C-11), 143.8 (C-8), 151.3 (C-9), 170.5 (*CO*CH$_3$), 170.8 (*CO*CH$_3$), 178.2 (C-28); HRLSIMS, *m/z*: [M+Na]$^+$ 607.3612 ($C_{35}H_{52}O_7Na$, calcd 607.3611).

4.2.20. Ozonolysis of 51. 250 mg (0.4 mmol) of product **51** were dissolved in 12 mL of CH_2Cl_2 and an O_3 flow of 0.1 L/min (10% O_2–90% O_3) was passed through the solution for 5 min at −80 °C. After that, 1 mL of Me_2S was added and the mixture maintained 36 h with stirring. Evaporation to dryness and purification over silica gel gave 90 mg (31%) of **53**: white solid; mp 154–156 °C; $[\alpha]_D^{25}=-12$ (*c* 1, $CHCl_3$); IR ($CHCl_3$): ν 2933, 1742, 1371, 1245 cm^{-1}; ^{1}H NMR ($CDCl_3$): δ 5.13 (1H, ddd, J_1=4.5 Hz, J_2=10.3 Hz, J_3=12.1 Hz, H-2), 4.73 (1H, d, *J*=10.3 Hz, H-3), 3.25 (1H, d, *J*=5.2 Hz, H-11a), 2.59 (1H, d, *J*=5.2 Hz, H-11b), 2.18 (1H, dd, J_1=4.5 Hz, J_2=13.5 Hz, H-1β), 2.06 (3H, s, CO*CH*$_3$), 1.99 (3H, s, CO*CH*$_3$), 1.36 (3H, s, 3H-12), 1.05 (3H, s, 3H-13), 0.95 (3H, s, 3H-14); ^{13}C NMR ($CDCl_3$): δ 18.0 (C-14), 18.3 (C-12), 18.6 (C-6), 20.9 (CO*CH*$_3$), 21.1 (CO*CH*$_3$), 28.3 (C-13), 31.5 (C-7), 37.3 (C-1), 40.2 (C-4), 49.8 (C-5), 49.9 (C-10), 50.1 (C-11), 57.7 (C-8), 69.0 (C-2), 79.5 (C-3), 170.4 (*CO*CH$_3$), 170.7 (*CO*CH$_3$), 207.9 (C-9); HRLSIMS, *m/z*: [M+Na]$^+$ 361.1626 ($C_{18}H_{26}O_6Na$, calcd 361.1627); 10 mg (3%) of **54**: white solid; mp 172–174 °C; $[\alpha]_D^{25}=-104$ (*c* 1, $CHCl_3$); IR ($CHCl_3$): ν 2951, 1740, 1370, 1246 cm^{-1}; ^{1}H NMR ($CDCl_3$): δ 5.10 (1H, ddd, J_1=4.5 Hz, J_2=10.3 Hz, J_3=12.1 Hz, H-2), 4.73 (1H, d, *J*=10.3 Hz, H-3), 2.84 (1H, d, *J*=6.2 Hz, H-11a), 2.73 (1H, d, *J*=6.2 Hz, H-11b), 2.15 (1H, dd, J_1=4.5 Hz, J_2=13.5 Hz, H-1), 2.04 (3H, s, CO*CH*$_3$), 1.98 (3H, s, CO*CH*$_3$), 1.28 (3H, s, 3H-12), 1.02 (3H, s, 3H-13), 0.95 (3H, s, 3H-14); ^{13}C NMR ($CDCl_3$): δ 18.0 (C-13), 18.3 (C-12), 19.9 (C-6), 20.8 (CO*CH*$_3$), 21.0 (CO*CH*$_3$), 28.3 (C-14), 32.3 (C-7), 36.9 (C-1), 40.0 (C-4), 49.9 (C-10), 50.0 (C-5), 56.1 (C-11), 58.5 (C-8), 69.0 (C-2), 79.2 (C-3), 170.4 (*CO*CH$_3$), 170.5 (*CO*CH$_3$), 207.5 (C-9); HRLSIMS, *m/z*: [M+Na]$^+$ 361.1624 ($C_{18}H_{26}O_6Na$, calcd 361.1627); 25 mg (10%) of **55**: syrup; $[\alpha]_D^{25}=51$ (*c* 1, $CHCl_3$); IR ($CHCl_3$): ν 2949, 2865, 1727, 1464, 1254, 1200, 1042 cm^{-1}; ^{1}H NMR ($CDCl_3$): δ 9.87 (1H, dd, J_1=2.7 Hz, J_2=3.6 Hz, H-13), 3.65 (3H, s, COO*CH*$_3$), 2.79 (1H, dd, J_1=3.6 Hz, J_2=15.4 Hz, H-12a), 2.44 (1H, dd, J_1=2.7 Hz, J_2=15.4 Hz, H-12b), 2.37 (1H, dd, J_1=5.8 Hz, J_2=11.0 Hz, H-5), 1.91 (1H, ddd, J_1=0.0 Hz, J_2=4.8 Hz, J_3=12.7 Hz, H-8a), 1.76 (1H, ddd, J_1=0.0 Hz, J_2=4.8 Hz, J_3=12.7 Hz, H-8b), 1.29 (3H, s, 3H-11), 0.92 and 0.86 (3H each, s, 3H-14 and 3H-15); ^{13}C NMR ($CDCl_3$): δ 20.1 (C-11), 22.9 (C-9), 24.0 (C-14), 29.8 (C-3), 29.8 (C-8), 30.9 (C-1), 32.7 (C-15), 33.9 (C-2), 35.4 (C-4), 35.7 (C-5), 45.2 (C-10), 49.6 (C-12), 51.9 (COO*CH*$_3$), 62.3 (C-6), 64.1 (C-7), 177.8 (C-16), 200.6 (C-13); HRLSIMS, *m/z*: [M+Na]$^+$ 317.1732 ($C_{17}H_{26}O_4Na$, calcd 317.1729); and 95 mg (35%) of **56**: syrup; $[\alpha]_D^{25}=-24$ (*c* 1, $CHCl_3$); IR ($CHCl_3$): ν 3450, 2950, 1726, 1257, 1036, 977 cm^{-1}; ^{1}H NMR ($CDCl_3$): δ 5.20 (1H, dd, J_1=J_2=5.8 Hz, H-13), 3.71 (3H, s, COO*CH*$_3$), 2.51 (1H, dd, J_1=5.8 Hz, J_2=14.0 Hz, H-12a), 2.43 (1H, dd, J_1=J_2=8.9 Hz, H-5), 2.13 (1H, dd, J_1=5.8 Hz, J_2=14.0 Hz, H-12b), 1.31 (3H, s, 3H-11), 0.91 (3H, s, 3H-14), 0.91 (3H, s, H-15); ^{13}C NMR ($CDCl_3$): δ 22.0 (C-9), 23.9 (C-14), 26.0 (C-11), 30.7 (C-3), 31.4 (C-1), 33.2 (C-15), 33.4 (C-8), 33.5 (C-2), 38.3 (C-4), 41.8 (C-5), 45.7 (C-12), 47.1 (C-10), 52.5 (COO*CH*$_3$), 81.7 (C-7), 82.0 (C-6), 95.9 (C-13), 181.2 (C-16); HRLSIMS, *m/z*: [M+Na]$^+$ 335.1828 ($C_{17}H_{28}O_5Na$, calcd 335.1834).

4.2.21. Oxidation of 51 with $NaIO_4$/$RuCl_3$. $NaIO_4$ (171 mg, 0.8 mmol) and $RuCl_3{\cdot}3H_2O$ (approximately 5 mg) in water (2 mL) were added to a solution of product **51** (100 mg, 0.2 mmol) in acetone (10 mL). The reaction mixture was stirred at room temperature for 3 h and then diluted with CH_2Cl_2, washed with water and dried over anhydrous Na_2SO_4. The solvent was evaporated at reduced pressure and the residue was chromatographed to obtain 37 mg (37%) of **51**, 30 mg (30%) of **55** and 25 mg (23%) of **57**: syrup; $[\alpha]_D^{25}=-11$ (*c* 1, $CHCl_3$); IR ($CHCl_3$): ν 3460, 2937, 2857, 1742, 1678, 1370, 1321, 1052 cm^{-1}; ^{1}H NMR ($CDCl_3$): δ 6.11 (1H, dd, J_1=3.8 Hz, J_2=5.6 Hz, H-7), 5.14 (1H, ddd, J_1=4.6 Hz, J_2=10.4 Hz, J_3=12.0 Hz, H-2), 4.74 (1H, d, *J*=10.4 Hz, H-3), 2.06 (3H, s, CO*CH*$_3$), 2.00 (3H, s, CO*CH*$_3$), 1.23 (3H, s, 3H-12), 1.07 (3H, s, 3H-13), 0.93 (3H, s, 3H-14); ^{13}C NMR ($CDCl_3$): δ 18.1 (C-13), 18.3 (C-12), 20.9 (CO*CH*$_3$), 21.1 (CO*CH*$_3$), 21.5 (C-6), 27.6 (C-14), 36.9 (C-1), 39.7 (C-4), 44.9 (C-10), 48.6 (C-5), 69.0 (C-2), 79.5 (C-3), 116.5 (C-7), 144.6 (C-8), 170.4 (*CO*CH$_3$), 170.6 (*CO*CH$_3$), 199.4 (C-9); HRLSIMS, *m/z*: [M+Na]$^+$ 347.1467 ($C_{17}H_{24}O_6Na$, calcd 347.1471).

4.2.22. Ozonolysis of 52. 250 mg (0.4 mmol) of product **52** were dissolved in 12 mL of CH_2Cl_2 and an O_3 flow of 0.1 L/min (10% O_2–90% O_3) was passed through the solution for 5 min at −80 °C. After that, 1 mL of Me_2S was added and the mixture maintained 36 h with stirring. Evaporation to dryness and purification over silica gel yielded 89 mg (31%) of **53**, 9 mg (3%) of **54** and 115 mg (46%) of **58**: syrup; $[\alpha]_D^{25}=19$ (*c* 1, $CHCl_3$); IR ($CHCl_3$): ν 2949, 2865, 1718, 1463, 1260, 1173, 1045 cm^{-1}; ^{1}H NMR ($CDCl_3$): δ 9.76 (1H, dd, J_1=2.0 Hz, J_2=2.7 Hz, H-13), 3.67 (3H, s, COO*CH*$_3$), 2.76 (1H, dd, J_1=4.0 Hz, J_2=13.4 Hz, H-5), 2.72 (1H, dd, J_1=2.7 Hz, J_2=16.9 Hz, H-12a), 2.56 (1H, dd, J_1=2.0 Hz, J_2=16.9 Hz, H-12b), 1.21 (3H, s, 3H-11), 0.93 (3H, s, 3H-14), 0.93 (3H, s, 3H-15); ^{13}C NMR ($CDCl_3$): δ 19.0 (C-9), 21.1 (C-11), 24.5 (C-14), 26.1 (C-8), 30.5 (C-3), 32.1 (C-1), 33.0 (C-15), 33.2 (C-2), 37.5

(C-4), 38.4 (C-5), 43.1 (C-10), 46.5 (C-12), 51.6 ($COOCH_3$), 60.2 (C-6), 64.9 (C-7), 178.0 (C-16), 200.1 (C-13); HRLSIMS, *m/z*: $[M+Na]^+$ 317.1729 ($C_{17}H_{26}O_4Na$, calcd 317.1729).

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