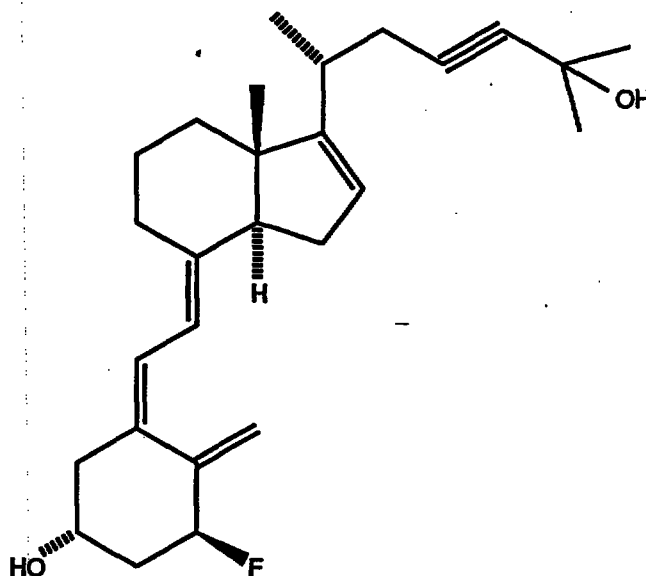


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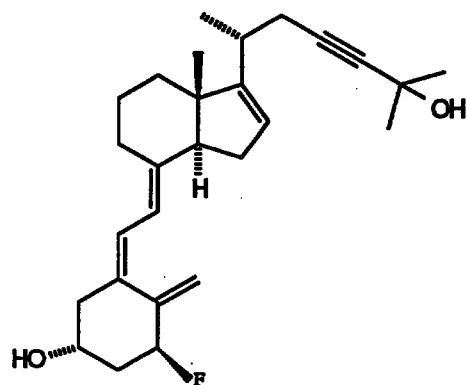
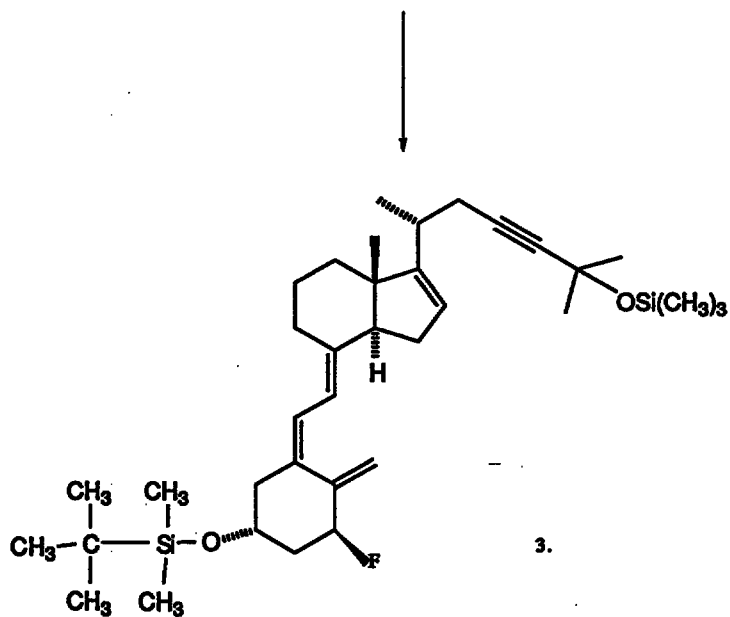
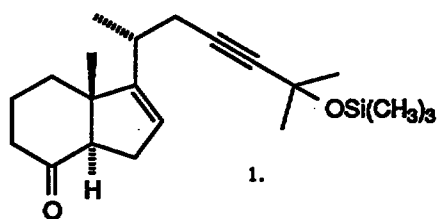
The invention relates to the compound 1 α -fluoro-25-hydroxy-16-ene-23-yne-cholecalciferol, which can be further characterized by
5 the formula:



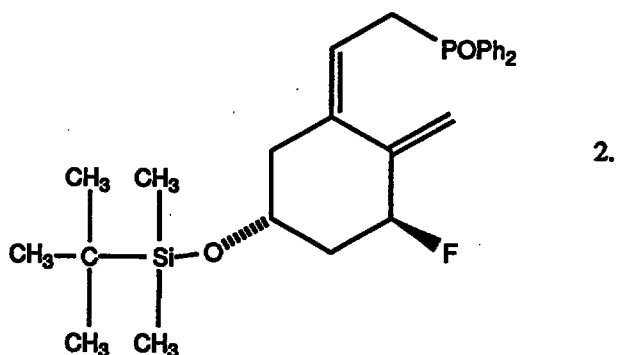
and which is useful as an agent for the treatment of sebaceous gland
10 diseases, such as acne or seborrheic dermatitis.

In still another aspect, the invention relates to pharmaceutical
compositions comprising the compound of formula I and to the use of
this compound for the manufacture of medicaments for the treatment
15 of the above diseases.

1 α -fluoro-25-hydroxy-16-ene-23-yne-cholecalciferol can be
prepared by the following reaction Scheme



In the above reaction scheme, the compound of formula 1 is converted to a compound of formula 3 by reaction with a corresponding compound of formula:



The reaction is carried out at -60°C - 90°C , preferably -75°C , in a polar, aprotic organic solvent, such as dry ether or more preferably dry tetrahydrofuran, in the presence of a strong base such as an alkyl lithium like butyl lithium. The compound of formula 2 is known (J. Org. Chem. 1990, 55, 243) or can be prepared in accordance with known methods.

The protecting groups of a compound of formula 3 is removed by reaction with a fluorine salt, such as tetrabutyl-ammonium fluoride in a polar, organic solvent such as ether, or more preferably tetrahydrofuran, to yield a corresponding compound of formula I.

1α -fluoro-25-hydroxy-16-ene-23-yne-cholecalciferol is useful as an agent for the treatment of sebaceous gland diseases such as acne or seborrheic dermatitis.

1α -fluoro-25-hydroxy-16-ene-23-yne-cholecalciferol can be administered topically, for the treatment of sebaceous gland diseases such as acne or seborrheic dermatitis, to hosts which need such treatment. More specifically, 1α -fluoro-25-hydroxy-16-ene-23-yne-cholecalciferol can be administered topically to a human in dosages that are in the range of 0.01 to 100 μg per gram of topical formulation

per day for the treatment of sebaceous gland diseases such as acne or sebhorreic dermatitis.

10 1 α -fluoro-25-hydroxy-16-ene-23-yne-cholecalciferol can be
5 administered orally, for the treatment of sebaceous gland diseases
such as acne or sebhorreic dermatitis to hosts which need such
treatment. More specifically, 1 α -fluoro-25-hydroxy-16-ene-23-yne-
cholecalciferol can be administered orally in dosages that are in the
range of about 0.01 to 10 μ g per day for the treatment of sebaceous
gland diseases such as acne or seborrheic dermatitis.

15 The useful activity of 1 α -fluoro-25-hydroxy-16-ene-23-yne-
cholecalciferol as an agent for the treatment of sebaceous gland
diseases such as acne or sebhorreic dermatitis can be demonstrated
by the following test procedures which are known in the art.

Methods

1. In Vitro 20

Sebaceous cells were isolated from adult human sebaceous
glands as in J. Invest. Dermatol. 96:341-348 (1991) and cultured on a
layer of growth-arrested 3T3 mouse fibroblasts.

25 The cells were cultured in Iscove's medium containing 10% fetal
calf serum and 4 μ g/ml dexamethasone.

Cells were plated in medium without 1 α -fluoro-25-hydroxy-16-
ene-23-yne-cholecalciferol. 24-48 hours after the initial plating, the
30 cultures were given fresh medium containing the compound of the
invention. Every 48 hours, the cultures were given fresh medium
containing the compound of the invention. On the day of harvesting,
the cultures were rinsed with a 0.03% EDTA in PBS, to remove only
the 3T3 fibroblasts. The remaining sebocyte colonies were incubated
35 in 0.05% trypsin/0.03% EDTA to create a single cell suspension of

sebocytes. The cells were diluted, mixed vigorously to maintain a single cell suspension, and counted in a hemocytometer.

The compounds tested were handled in the following manner.
5 Stock solutions were made up as 10^{-2} M solutions in degassed 100% ethanol and stored at -20°C in the dark. Solutions were never used after storage of more than one month. During experimental use the solutions, which were aliquoted, were thawed once and used by diluting directly into complete medium to the appropriate
10 concentration, at 10^{-6} , 10^{-7} , 10^{-8} M and 10^{-9} . The compounds tested were

- (1) 1,25-dihydroxycholecalciferol; and
- (2) 1α -fluoro-25-hydroxy-16-ene-23-yne-cholecalciferol.

15 Results

The compounds were tested for the inhibition of proliferation of sebaceous cells in vitro at the following concentrations: 10^{-6} , 10^{-7} , 10^{-8} and 10^{-9} M. 1,25-dihydroxycholecalciferol is an agent
20 reducing the size of sebaceous glands in ears of the male Syrian hamster.

The results are summarized in table 1 as the amount of compound necessary to inhibit the proliferation of the sebaceous cells
25 by 50% as compared to a control (ED₅₀). The control was a culture treated with diluent only.

Table 1

30 INHIBITION OF HUMAN SEBOCYTE PROLIFERATION IN VITRO

Compound	ED ₅₀ (μM)
1,25-dihydroxycholecalciferol	0.05
1 α -fluoro-25-hydroxy-16-ene-23-yne cholecalciferol	0.001

The results demonstrate that the inventive compound inhibits human sebocyte proliferation in vitro. Therefore, the inventive compound is useful as an agent for the treatment of acne.

5

2. In Vivo Hamster Ear Model

a. Topical Study

10 The compound was evaluated for topical anti-acne activity in the hamster ear sebaceous gland model. For these studies, the compound was dissolved in acetone. Fifty (50) μ l of the drug-containing solution was applied daily (5 days per week) to the dorsal side of the right ear of the hamster. Control hamsters received 50 μ l of
15 acetone. The animals were sacrificed after 4 weeks. The ears were removed and processed for histological evaluation. The ventral surface was separated from the rest of the ear. A 2 mm punch was removed 5 mm from the tip of the ear and stained in 0.1% Sudan Black B dissolved in 100% propylene glycol overnight. After
20 destaining, the areas of the sebaceous glands were determined from the cross sections by image analysis using a Donsato Image Analysis System. The data was expressed as a percentage change from control animals for 80-120 sebaceous glands per dose. The results are summarized in table 2.

Table 2

EFFECT OF 4 WEEKS TOPICAL DOSING ON HAMSTER FOR SEBACEOUS
GLAND SIZE

5

	<u>Compound</u>	<u>Dose ug/animal</u>	<u>Change in Hamster Ear Sebaceous Gland Size Cross Section Analysis</u>
10	1 α -fluoro-25-hydroxy- 16-ene-23-yne- cholecalciferol	0.001	-3 ns
		0.01	-18 ns
		0.1	-28 ns
15		1.0	-40

ns = not statistically significant from controls -

20

b. Oral Study

The purpose of the test was to evaluate the effect of the
inventive compound on the sebaceous glands of the hamster ear after
25 oral administration of the compound. 200 μ l of the compound of the
invention dissolved in Tween 20/water/ethanol (50/40/100)
administered daily (5 days per week) by gavage to male Golden
Syrian hamsters. The animals were sacrificed at 4 weeks and the ears
were processed for histological evaluation. One ear was fixed with 10%
30 buffered formalin, processed for paraffin embedding, sectioned, and
stained with hematoxyline and eosin. The area of the sebaceous
glands was measured on histologically prepared cross-sections of the
ear by image analysis using a Leitz TAS Plus system. The data
obtained from this study is presented below. Data is given as the
35 average areas of 48 sebaceous glands per dose.

Table 3

EFFECT OF 4 WEEKS ORAL DOSING ON HAMSTER FOR SEBACEOUS
GLAND SIZE

5

<u>Compound</u>		<u>Dose</u> <u>ug/kg</u>	<u>% Change in Hamster Ear</u> <u>Sebaceous Gland Size</u> <u>Cross Section Analysis</u>
10	1 α -fluoro-25-hydroxy- 16-ene-23-yne- cholecalciferol	0.05	-28
		0.5	-28
		5.0	-34
15		50.0	-35

The above data demonstrates that the inventive compound is
useful as an agent in the treatment of sebaceous gland diseases such
20 as acne or seborrheic dermatitis.

Oral dosage forms comprising 1 α -fluoro-25-hydroxy-16-ene-
23-yne-cholecalciferol may be incorporated in capsules, tablets and
the like with pharmaceutically acceptable carrier materials.

25

Illustrative of the pharmaceutically acceptable carrier materials
which may be incorporated into capsules, and the like are the
following: a binder such as gum traganth, acacia, corn starch, or
gelatin; an excipient such as dicalcium phosphate; a disintegrating
30 agent such as corn starch, potato starch, algenic acid, and the like; a
lubricant such as magnesium stearate, a sweetening agent such as
sucrose, lactose, or saccharin; a flavoring agent such as peppermint, oil
of wintergreen or cherry. Various other materials may be present as
coating or to otherwise modify the physical form of the dosage unit.
35 For instance, tablets may be coated with shellac, sugar, or both. A
syrup or elixir may contain the active compound, sucrose as a

sweetening agent, methyl and propyl parabens as preservatives, a dye, and a flavoring such as cherry or orange flavor.

Topical dosage forms comprising 1 α -fluoro-25-hydroxy-16-ene-
5 23-yne-cholecalciferol include: ointments and creams encompassing formulations having oleaginous, absorbable, water-soluble and emulsion-type bases such as petrolatum, lanolin, polyethylene glycols and the like.

10 Lotions are liquid preparations and vary from simple solutions to aqueous or hydroalcohol preparations containing finely divided substances. Lotions can contain suspending or dispersing agents, for example, cellulose derivatives such as ethyl cellulose, methyl
15 cellulose, and the like; gelatin or gums, which incorporate the active ingredient in a vehicle made up water, alcohol, glycerin and the like.

Gels are semi-solid preparations made by gelling a solution or suspension of the active ingredient in a carrier vehicle. The vehicles, which can be hydrous or anhydrous, are gelled using a gelling agent,
20 such as, carboxy polymethylene, and neutralized to a proper gel consistency with the use of alkalies, such as, sodium hydroxide and amines, such as polyethylenecocoamine.

As used herein, the term "topical" denotes the use of the active
25 ingredient, incorporated in a suitable pharmaceutical carrier, and applied at the site of the inflammation for the exertion of local action. Accordingly, the topical compositions include those pharmaceutical forms in which the compound is applied externally by direct contact with the skin. The topical dosage forms comprise gels, creams, lotions,
30 ointments, powders, aerosols and other conventional forms for applying medication to the skin obtained by admixing a compound of formula I with known pharmaceutical topical carrier materials. In addition to application to the skin, the topical compositions of this invention can also be employed in the treatment of inflammations of
35 mucous membranes, where such membranes are accessible to topical

application of medication. For example, the topical composition can be applied to the mucous lining of the mouth or lower colon.

EXAMPLE 1

5

(1 α ,3 β ,5Z,7E)-1-fluoro-3[[[(1,1-dimethyl-ethyl)dimethylsilyl]oxy]-25-
[(trimethylsilyl)oxy]-9,10-secocholesta-5,7,10(19),16-tetraen-23-yne

To a solution of 217 mg (0.461 mmol) of [3S-(1Z,3 α ,5 β)]-[2-[3-
10 fluoro-5-[[[(1,1-dimethylethyl)dimethylsilyl]oxy]-2-methylenecyclo-
hexylidene]ethyl]diphenylphosphine oxide in 6 ml of dry
tetrahydrofuran was added dropwise at -75°C, 0.27 ml (0.43 mmol)
of a 1.6 M solution of n-butyl lithium in hexane. After the mixture
was stirred for 6 minutes, a solution of 120 mg (0.346 mmol) of
15 [1(R*),3aR*-3a β , 7a α)]-3,3a,5,6,7,7a-hexahydro-1-(1,5-dimethyl-5-
[(trimethylsilyl)oxy]-3-hexynyl)-7a-methyl-4H-indene-4-one in 5 ml
of dry tetrahydrofuran was added dropwise. The mixture was stirred
at -75°C for 1.50 hours and quenched by addition of 1:1 mixture of
1M aqueous potassium sodium tartrate and 2M aqueous potassium
20 bicarbonate. The mixture was extracted with ethyl acetate, and the
organic phase was washed with brine, dried (Na₂SO₄), filtered, and
evaporated to dryness. The residue was purified by column
chromatography on silica gel using ethyl acetate-hexane (1:15) to give
136 mg (66%) of (1 α ,3 β ,5Z,7E)-1-fluoro-3[[[(1,1-dimethyl-ethyl)-
25 dimethylsilyl]oxy]-25-[(trimethylsilyl)oxy]-9,10-secocholesta-
5,7,10(19),16-tetraen-23-yne as a glass: IR (CHCl₃) 2230, 840 cm⁻¹;
¹H NMR (CDCl₃) δ 0.08 (s, 6H), 0.17 (s, 9H), 0.72 (s, 3H), 0.88 (s, 9H),
1.13 (d, J = 8 Hz, 3H), 1.44 (s, 6H), 2.51 (m, 1H), 2.82 (m, 1H), 4.17 (br
s, 1H), 5.11 (s, 1 H), 5.12 (dm, J = 48 Hz, 1 H), 5.37 (s, 2H), 6.10 (d, J =
30 12 Hz, 1 H), 6.34 (d, J = 12 Hz, 1 H) mass spectrum, m/e 578 (M⁺-HF).

EXAMPLE 2

1 α -fluoro-25-hydroxy-16-ene-23-yne-cholecalciferol

35

To a solution of 132 mg (0.220 mmol) of (1 α ,3 β ,5Z,7E)-1-fluoro-3[[[(1,1-dimethyl-ethyl)dimethylsilyl]oxy]-25-[(trimethylsilyl)oxy]-9,10-secocholesta-5,7,10(19),16-tetraen-23-yne in 8 ml of dry tetrahydrofuran was added 1.38 ml (1.38 mmol) of 1M tetrabutylammonium fluoride in tetrahydrofuran. The mixture was stirred at room temperature for 16 hrs. After dilution with water, the mixture was extracted with ethyl acetate. The organic phase was washed with water, brine, dried (Na₂SO₄) and evaporated to dryness. The residue was purified by column chromatography on silica gel using ethyl acetate-hexane (1:1:3) as the effluent to afford 81 mg (89%) of 1 α -fluoro-25-hydroxy-16-ene-23-yne-cholecalciferol as a glass: $[\alpha]_D^{20} + 74.7$ (C 0.15, MeOH): IR (CHCl₃) 3600, 2230, 1649 cm⁻¹: UV_{max} (EtOH) 242, 267 nm: ¹H NMR (CDCl₃) δ 0.72 (s, 3 H), 1.13 (d, J = 8Hz, 3H), 1.48 (s, 6H) 2.63 (m, 1H), 2.83 (m, 1H), 4.24 (br s, 1H), 5.12 (s, 1H), 5.14 (dm, J= 48 Hz, 1 H), 5.38 (s, 1 H), 5.40 (s, 1 H), 6.12 (d, J= 12 Hz, 1 H), 6.41 (d, J= 12 Hz, 1 H); mass spectrum m/e 392 (M⁺-HF).

EXAMPLE 3

Oral Dosage Form Soft Gelatin Capsules A and B

20

A	mg/capsule
1 α -fluoro-25-hydroxy-16-ene-23-yne-cholecalciferol	0.00001-0.010
25 Butylated Hydroxytoluene (BHT)	0.016
Butylated Hydroxyanisole (BHA)	0.016
Myglyol®-812 or Polyethylene Glycol 400 qs	160

B	mg/capsule
1 α -fluoro-25-hydroxy-16-ene-	
23-yne-cholecalciferol	0.00001-0.010
5 α -Tocopherol	0.016
Myglyol®-812 or Polyethylene Glycol 400 qs	160



Claims

1. The compound, 1α -fluoro-25-hydroxy-16-ene-23-yne-cholecalciferol.
- 5 2. The compound of claim 1, for use as therapeutically active compound, particularly for the treatment of sebaceous gland diseases, specially acne or seborrheic dermatitis.
- 10 3. A process for the manufacture of the compound of claim 1, which comprises removing the silyl protecting groups from a corresponding compound with silyl protected hydroxy groups.
- 15 4. A pharmaceutical composition, particularly for treating sebaceous gland diseases, like acne or seborrheic dermatitis, comprising an effective amount of 1α -fluoro-25-hydroxy-16-ene-23-yne-cholecalciferol and a carrier material.
- 20 5. The use of the compound of claim 1, for the manufacture of a pharmaceutical composition for the treatment of sebaceous gland diseases, specially of acne or seborrheic dermatitis.



6. The compound, compositions, uses and processes as herein-
before described with particular reference to the examples.
