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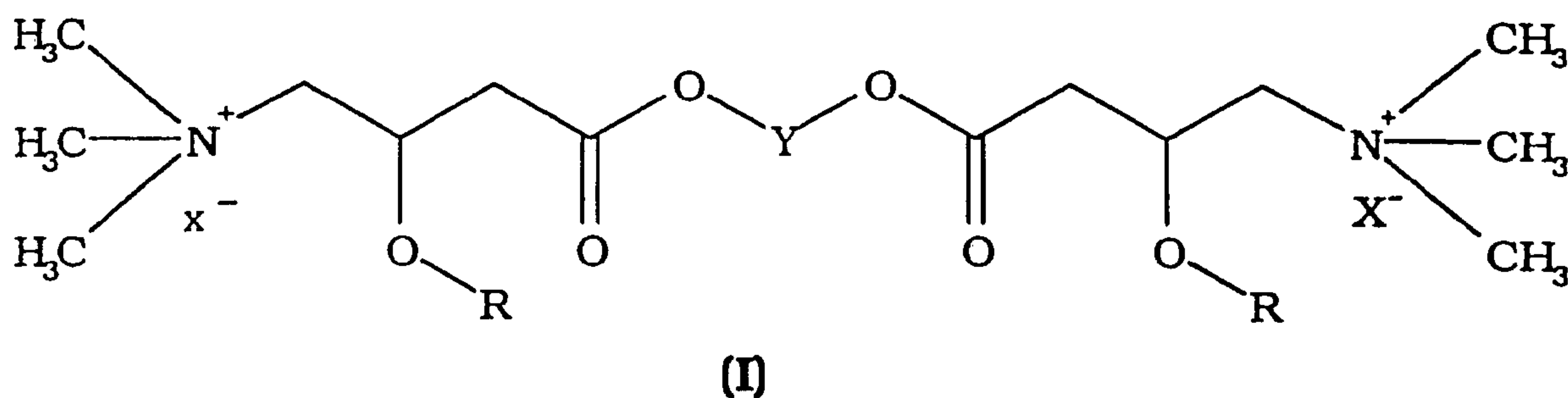
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(54) Titre : ESTERS BIS(ALCANOYLIQUES) DE CARNITINE, POSSEDANT UNE ACTIVITE BACTERICIDE, FONGICIDE ET ANTIPROTOZAIRE

(54) Title: BIS ALKANOYL ESTERS OF CARNITINE HAVING BACTERICIDAL, FUNGICIDAL AND ANTIPROTOZOAL ACTIVITY

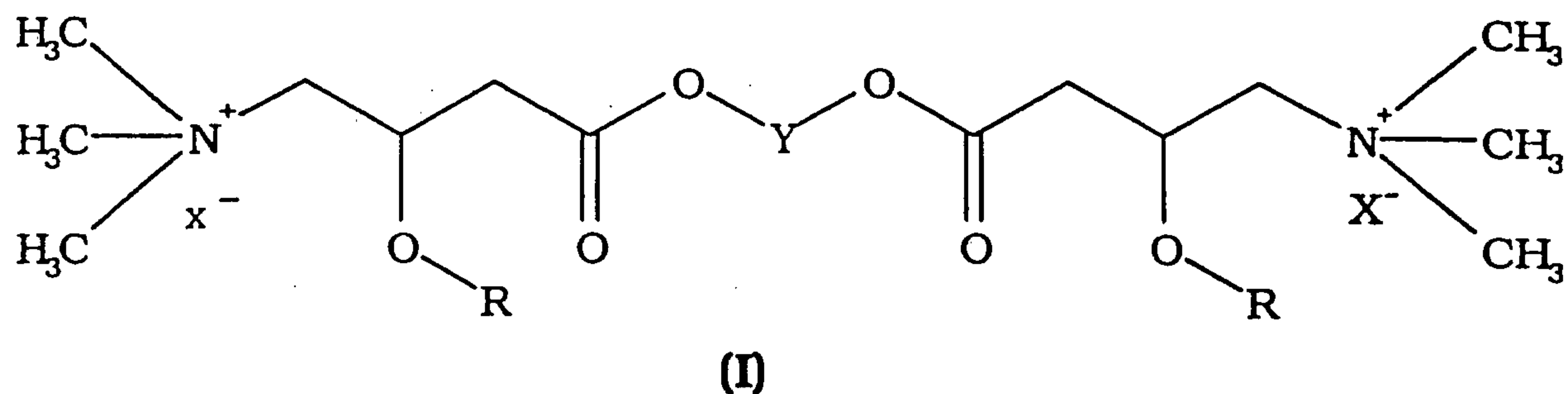


(57) Abrégé/Abstract:

DL-, D- or L-carnitine esters of formula (see formula I) wherein R, Y and X⁻ have the meaning shown in the specification which possess potent bactericidal, fungicidal and antiprozoal activity, processes for their preparation and composition topically applicable for treating infections of the skin, outer ear and mucosa, are disclosed.

ABSTRACT

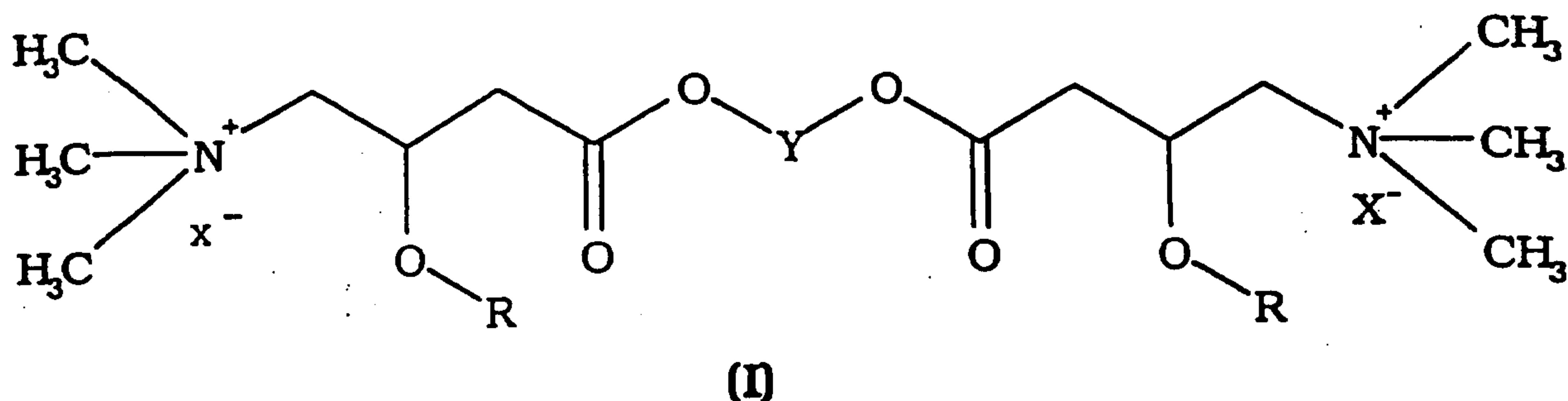
DL-, D- or L-carnitine esters of formula



wherein R, Y and X⁻ have the meaning shown in the specification which possess potent bactericidal, fungicidal and antiprozoal activity, processes for their preparation and composition topically applicable for treating infections of the skin, outer ear and mucosa, are disclosed.

BIS ALKANOYL ESTERS OF CARNITINE HAVING BACTERICIDAL, FUNGICIDAL AND ANTIPROTOZOAL ACTIVITY

The present invention relates to DL-, D- or L-carnitine esters of formula (I):



wherein:

R is a straight or branched, saturated or unsaturated alkanoyl group having 2-16 carbon atoms;

Y is a straight or branched alkylene chain having 3-6 carbon atoms, or ortho, meta or para-xylylene; and

X⁻ is the anion of a pharmacologically acceptable acid.

The compounds of formula (I) possess two chiral centers. Each one of them can present, independently from the other one, either the D or L configuration.

The compounds of formula (I) are endowed with potent bactericidal, fungicidal and antiprotozoal activity.

In one aspect, the invention provides a pharmaceutical composition which comprises as active ingredient a compound as described above and a pharmaceutically acceptable excipient thereof.

The present invention also relates to processes for preparing the compounds (I) and pharmaceutical compositions for the treatment of skin diseases sustained by bacteria, yeasts, fungi or protozoa as pathogens of simple or mixed infections.

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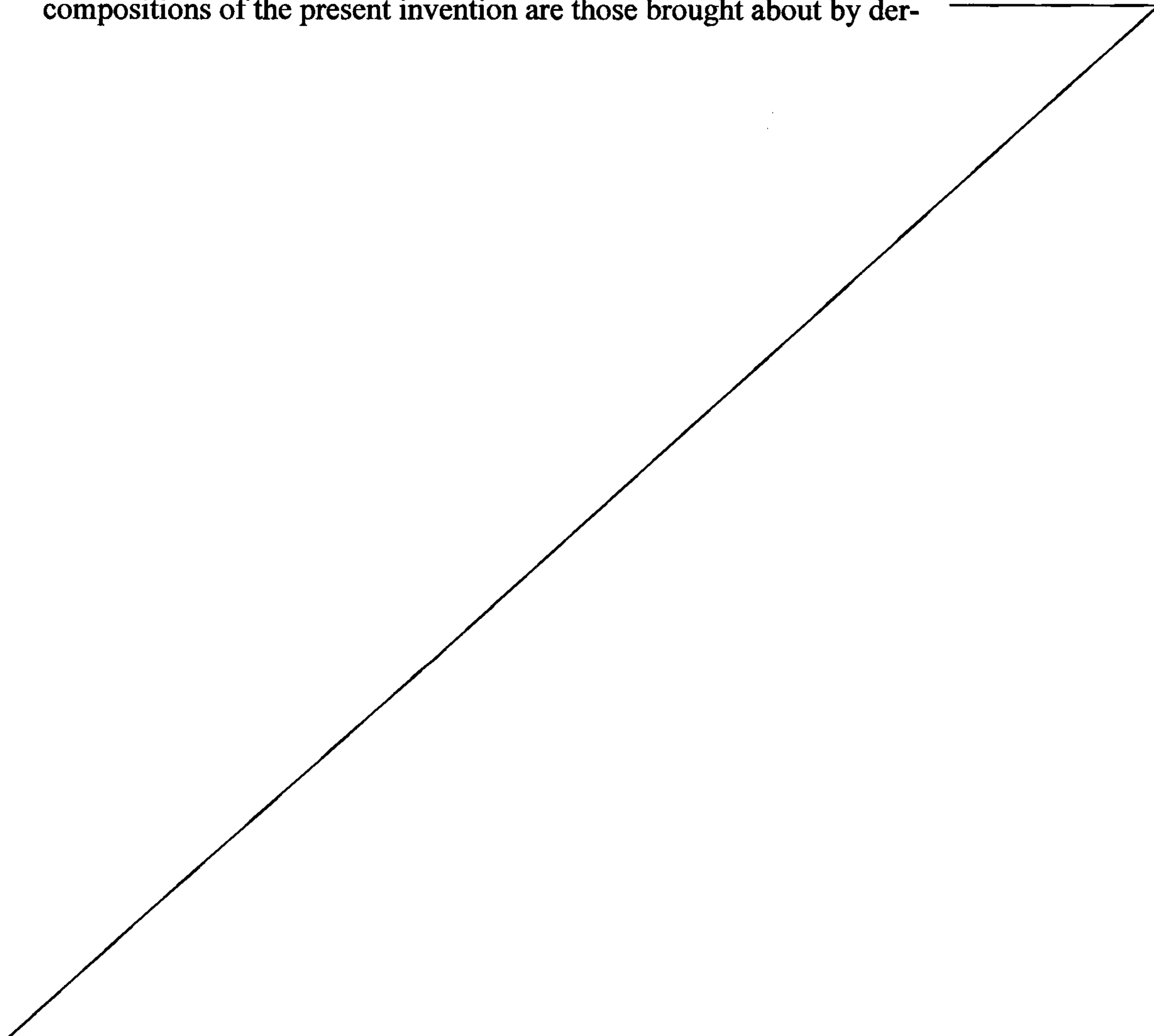
In another aspect, the invention provides a process for preparing a compound of formula (I) above wherein: R is a straight or branched, saturated or unsaturated alkanoyl group having 2-16 carbon atoms; Y is a straight or branched alkylene chain having 3-6 carbon atoms, or ortho, meta or para-sylilene; and X⁻ is the anion of a pharmacologically acceptable acid; which comprises the steps of: (a) suspending an alkanoyl L-carnitine inner salt in an organic, anhydrous inert solvent N,N-dimethylformamide, acetonitrile or methylene chloride; (b) adding to the suspension at 0°C-10°C a compound of formula Z-Y-Z wherein Y has the aforesaid meaning and Z is selected from halogen, O-mesyl or O-tosyl in an amount equivalent to one half of the moles of the alkanoyl L-carnitine; (c) keeping the suspension under stirring at 20°C-50°C for 24 hours till the suspension is completely solubilized; (d) precipitating the reaction raw product by adding a solvent as ethyl ether or hexane, filtering off the product and washing with acetone or methylethylketone till a solid product is obtained; (e) dissolving the product in water and eluting on a strongly basic resin such as Amberlite[™] IRA-402 activated with a suitable acid of formula HX to obtain the product salified in the sought-after form; (f) lyophilizing the eluate for isolating the solid product; and (g) purifying the solid of step (f) by chromatography on C₈ silica, eluting with H₂O/CH₃N 70:30.

In yet another aspect, the invention provides a process for preparing a compound of formula (I) above wherein: R is straight or branched, saturated or unsaturated alkanoyl group having 2-16 carbon atoms; Y is a straight or branched alkylene chain having 3-6 carbon atoms, or ortho, meta or para-xylilene; and X⁻ is the anion of a pharmacologically acceptable acid, which comprises the steps of: (a') suspending the alkanoyl L-carnitine acid chloride in an organic, anhydrous inert solvent

1b

N,N-dimethylformamide, acetonitrile or methylene chloride; (b') adding to the suspension at room temperature a compound of formula Z-Y-Z wherein Y has the aforesaid meaning and Z is OH in an amount equivalent to one half of the moles of the alkanoyl L-carnitine; (c') keeping the suspension under stirring at room temperature for 16-24 hours till the suspension is completely solubilized; (d') concentrating the solution to dryness under vacuum; (e') purifying the raw product thus obtained by silica gel chromatography, elutina with H₂O/CH₃CN solutions; and (f') isolating the compound by concentration and subsequent lyophilization.

As examples of cutaneous infections that can be treated with the compositions of the present invention are those brought about by der-



matophytes (*Tinea corporis*, *Tinea cruris*, *Tinea capitis*, *Tinea pedis*, *Tinea barbae*, *Tinea unguis*); by yeast-like strands such as thrush, chelitis, rhinopharyngitis, vulvovaginitis, balanoposthitis, intertrigo, pityriasis versicolor, otitis, onychauxis, perionychauxis; by bacteria such as impetigo, *Staphylococcus nasal carriage*, erythrasma, vaginosis; and by protozoa, such as cutaneous Leishmaniasis, keratitis sustained by *Acanthamoeba*, vaginitis sustained by *Trichomonas*.

Among the mixed cutaneous infections vulvovaginitis, vaginosis, balanitis and balanoposthitis, onychauxis and perionichauxis, infected cutaneous ulcers in patients suffering from diabetes, infections of the outer ear, and infections in immunocompromised patients should be mentioned.

The compositions of the present invention are also useful for the treatment of infectious pathologies sustained by strains resistant to the most common antimicrobics and antibiotics and in the disinfection of surgically exposed tissues.

In the compounds of formula (I), R has, preferably, 9-13 carbon atoms.

R is preferably decanoyl, undecanoyl and tridecanoyl.

Y is preferably selected from trimethylene, tetramethylene, pentamethylene, hexamethylene and ortho, meta or para-xylilene.

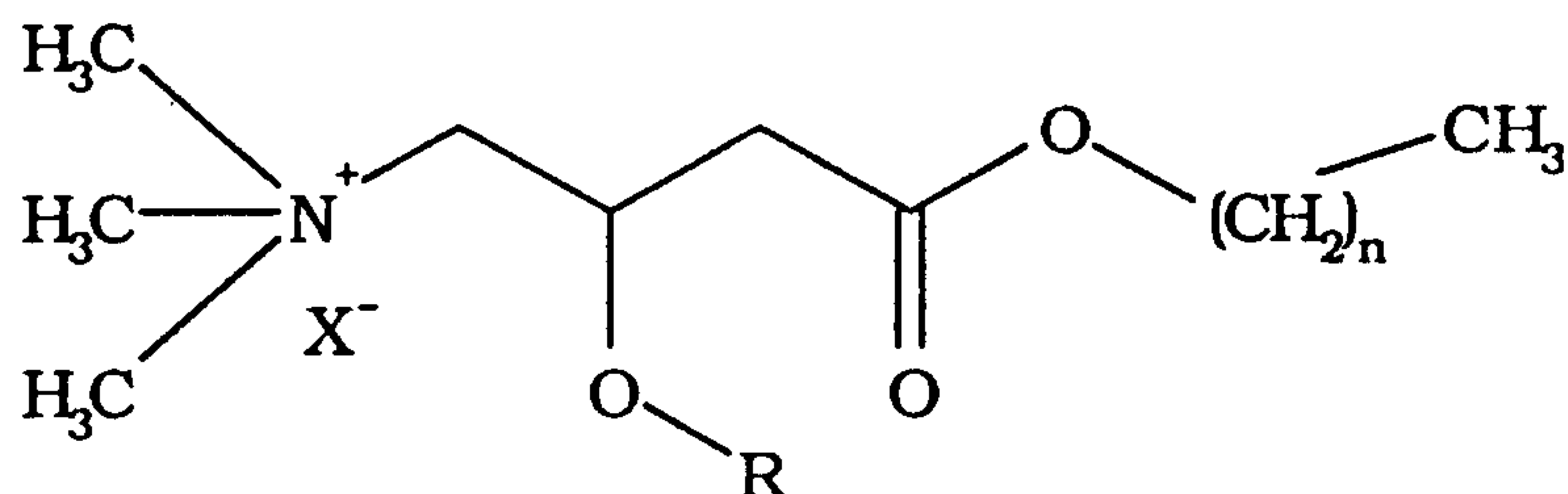
X⁻ is preferably selected from chloride, bromide, methanesulfonate, phosphate, acid fumarate, fumarate, acid tartrate and tartrate.

Since the compounds of formula (I) are particularly effective in the treatment of skin diseases, the preferred compositions of the present

invention are dermatological preparations suitable for the topical application, such as creams, ointments, gels, lotions, solutions and the like. Suitable compositions have been found to contain from 0.5 to 2% by weight, preferably from 1 to 1.5% by weight, of one of the compounds of formula (I).

The excipients for use in the preparation of the compositions of the invention are well-known and shall be apparent to those skilled in pharmacy and pharmaceutical technology having regard to the specific composition to be prepared.

As regard the prior art, the compounds known to the applicants which are closest to the compounds of the present invention having regard to both structure and activity considerations, are the long-chain esters of acyl L-carnitine of formula:



wherein R is a straight or branched acyl group having 2-16 carbon atoms; n is an integer from 7 to 15 and X⁻ is the anion of a pharmacologically acceptable acid, disclosed in EP-A-0 552 137 and EP-A-0 552 138 both in the name of the same Applicants as those of the present patent application. EP-A-0 552 137 discloses the bactericidal activity and EP-A-0 552 138 the fungicidal activity, respectively, of such compounds.

Among these known compounds, isovaleryl L-carnitine undecyl ester methanesulfonate (compound code: ST 1103) was shown to be the most active both as bactericidal and fungicidal agent.

It has now been found that the compounds of formula (I) are endowed with bactericidal and fungicidal activity even more potent, better cutaneous tolerability and lower citotoxicity than those of the known compounds.

These compounds have also been shown to exhibit antiprotozoal activity, not previously disclosed for the known compounds.

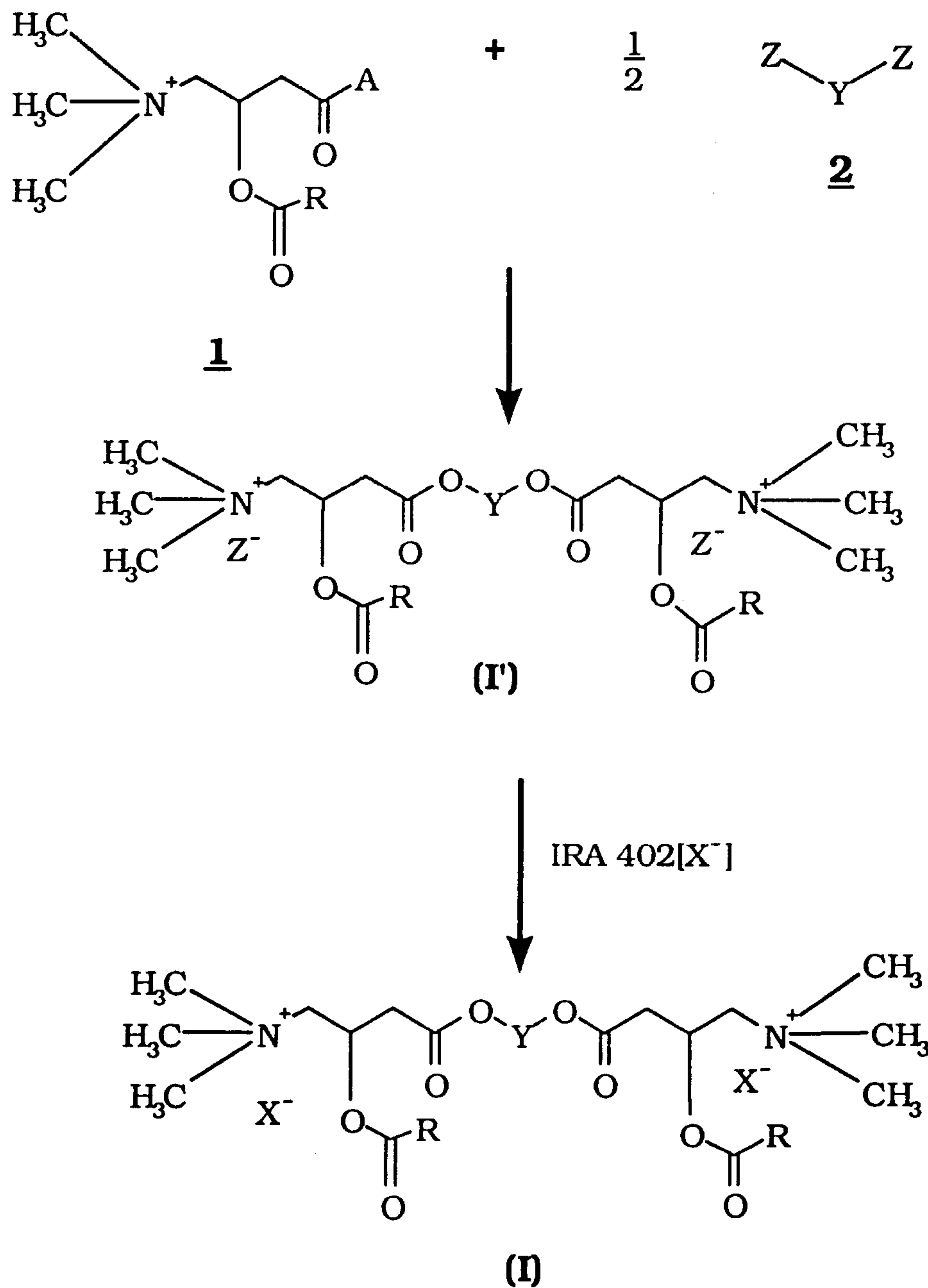
With reference to the reaction scheme, when $A=O^-$ (Cl^- is, then, missing), the process comprises the following steps:

- (a) suspending an alkanoyl L-carnitine inner salt in an organic, anhydrous inert solvent such as N,N-dimethylformamide, acetonitrile or methylene chloride;
- (b) adding to the suspension at $0^{\circ}C-10^{\circ}C$ a compound of formula Z-Y-Z wherein Y has the aforesaid meaning and Z is selected from halogen, preferably chlorine or bromine, O-mesyl or O-tosyl in an amount equivalent to one half of the moles of the alkanoyl L-carnitine;
- (c) keeping the suspension under stirring at $20^{\circ}C-50^{\circ}C$ for 24 hours till the suspension is completely solubilized;
- (d) precipitating the reaction raw product by adding a solvent such as ethyl ether or hexane, filtering off the product and washing with acetone or methylethyl ketone till a solid product is obtained;

- (e) dissolving the product in water and eluting on a strongly basic resin such as AmberliteTM IRA-402 activated with a suitable acid of formula HX to obtain the product salified in the sought-after form;
- (f) lyophilizing or concentrating the eluate for isolating the solid product; and
- (g) purifying the solid of step (f) by chromatography on C₈ silica, eluting with H₂O/CH₃N 70:30.

Alternatly, when A=Cl, the process comprises the following steps:

- (a') suspending the alkanoyl L-carnitine acid chloride in an organic, anhydrous inert solvent such as N,N-dimethylformamide, acetonitrile or methylene chloride;
- (b') adding to the suspension at room temperature a compound of formula Z-Y-Z wherein Y has the aforesaid meaning and Z is OH in an amount equivalent to one half of the moles of the alkanoyl L-carnitine;
- (c') keeping the suspension under stirring at room temperature for 16-24 hours till the suspension is completely solubilized;
- (d') concentrating the solution to dryness under vacuum;
- (e') purifying the raw product thus obtained by silica gel chromatography, eluting with H₂O/CH₃CN solutions; and
- (f') isolating the compound by concentration and subsequent lyophilization.

REACTION SCHEME

A = O^- , Cl

Y = as previously described

Z = Cl, Br, I, OMs, OTs, OH

Ms = mesyl

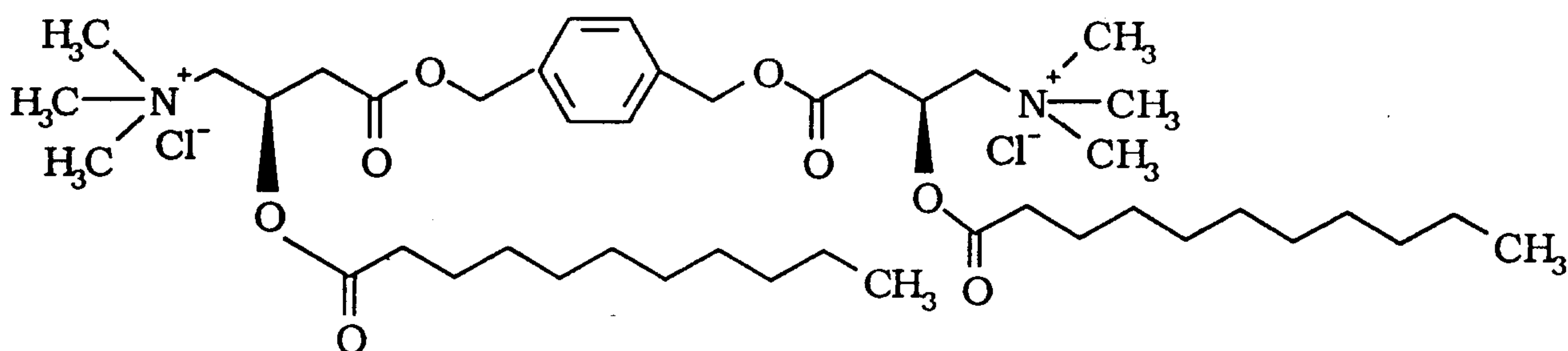
Ts = tosyl

X^- = anion of pharmacologically acceptable acid.

The preparation and physico-chemical characteristics of some compounds of the invention are shown in the following non-limiting examples.

EXAMPLE 1

Preparation of bis(undecanoyl L-carnitine chloride) p-xylilene diester (ST 1226)



Undecanoyl L-carnitine inner salt (8.5 g; 0.025 moles) was suspended in 50 mL of anhydrous N,N-dimethylformamide.

To the suspension, cooled to 0°C, α,α' -dibromo p-xylene (3.4 g; 0.013 moles) was added. The resulting mixture was kept under stirring for 4 hours till complete solubilization was achieved. Ethyl ether was added to the solution till precipitation of a gelly mass was completed.

The raw product thus obtained was repeatedly washed with acetone and filtered under vacuum yielding 7 g of a solid product. Molar yield 65% (calculated on α,α' -dibromo p-xylene).

The product was dissolved in water and eluted on IRA-402 (140 mL) activated in Cl⁻ form.

From the lyophilized eluate, 6.3 g of a slightly hygroscopic product were obtained.

Elementary Analysis for $C_{44}H_{78}O_8N_2Cl_2$

	C%	H%	N%	Cl%
Calculated	62.68	10.40	3.32	8.41
Found	60.25	8.98	3.03	8.10

H₂O 1.4%

HPLC

Column: SGE-SCX (5 μ m) 1 250 mm X 4.0 mm

temp.: 30°C

eluant: CH₃CN/NH₄H₂PO₄ 50 mM 65/35 pH= 7 (NH₄OH)

flow rate: 0.75 mL/min

Rt: 17.6 min

D

$$[\alpha]_{25} = -17 \text{ (c = 0.6\% H}_2\text{O)}$$

NMR CDCl₃ ¹H δ 7.4(4H,s,phenyl); 5.6(2H,m,2-CH-);

|
OCO

5.2(4H,s,2CH₂phenyl); 4.2-4.0(4H,dd,2N⁺CH₂); 3.4(18H,s,2(CH₃)₃N⁺);3.0-2.8(4H,m,2 CH₂COO); 2.3(4H,t,2 OCOCH₂); 1.6(4H,m,2 CH₂CH₃);1.1(32H,m,2(CH₂)₈); 0.9(6H,t,2CH₃)**EXAMPLE 2**

Preparation (via the acid chloride route, see reaction scheme, A=Cl) of Bis(undecanoyl L-carnitine chloride)p-xylilene diester (ST 1226).

Undecanoyl L-carnitine chloride (18 g; 0.05 moles) was suspended in 50 mL methylene chloride and to the resulting mixture thionyl chloride (7.5 mL; 0.1 moles) was added. The mixture was kept

under stirring at room temperature for 3 hours.

The mixture was then concentrated under vacuum, the residue washed repeatedly with Et₂O and concentrated.

The reaction product was suspended in anhydrous methylene chloride (50 mL) and to the mixture 1,4-benzenedimethanol was added portionwise over 2 hours. The resulting mixture was kept under stirring at room temperature overnight. The reaction mixture was concentrated under vacuum.

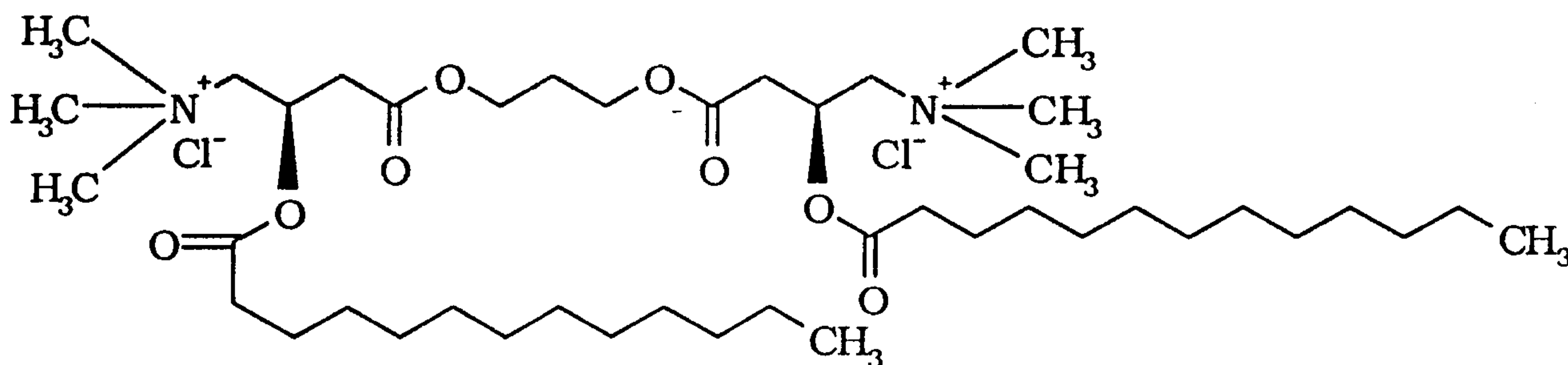
The reaction raw product was purified by chromatography over C₈ silica gel, eluting with H₂O/CH₃CN 70:30.

The fractions containing the title compound (ST 1226) were concentrated and then lyophilized.

The product thus obtained showed the same characteristics as those of the compound obtained in Example 1.

EXAMPLE 3

Preparation of bis(tridecanoyl L-carnitine chloride) trimethylene diester (ST 1233)



Tridecanoyl L-carnitine inner salt (5.15 g; 0.0144 moles) was suspended in 50 mL of anhydrous N,N-DMF. To the suspension, cooled

to 0°C, 1,3-dibromopropane (0.73 mL; 0.0072 moles) was added. The resulting mixture was kept under stirring overnight at room temperature.

Then, an excess of tridecanoyl L-carnitine inner salt (0.5 g) was twice added and the mixture was further kept under stirring overnight till the reaction mixture was completely dissolved.

At the end of the reaction, ethyl ether was added till the reaction raw product completely precipitated.

The solid was filtered off giving 6 g of a product which was dissolved in water and eluted on IRA-402 (120 mL) activated in Cl⁻ form.

5 g of the title compound (ST 1233) were obtained. Yield 44%.

Elementary Analysis for C₄₃H₈₄O₈N₂Cl₂

	C%	H%	N%	Cl%
Calculated with 3.35% H ₂ O	60.28	10.25	3.27	8.27
Found	60.82	10.46	3.17	8.50

25

$[\alpha]_D = -13.2^\circ$ (c = 1% H₂O)

NMR CDCl₃ ¹H δ 5.6(2H,m,2-CHOCO); 4.5(2H,d,2N⁺-CHH);

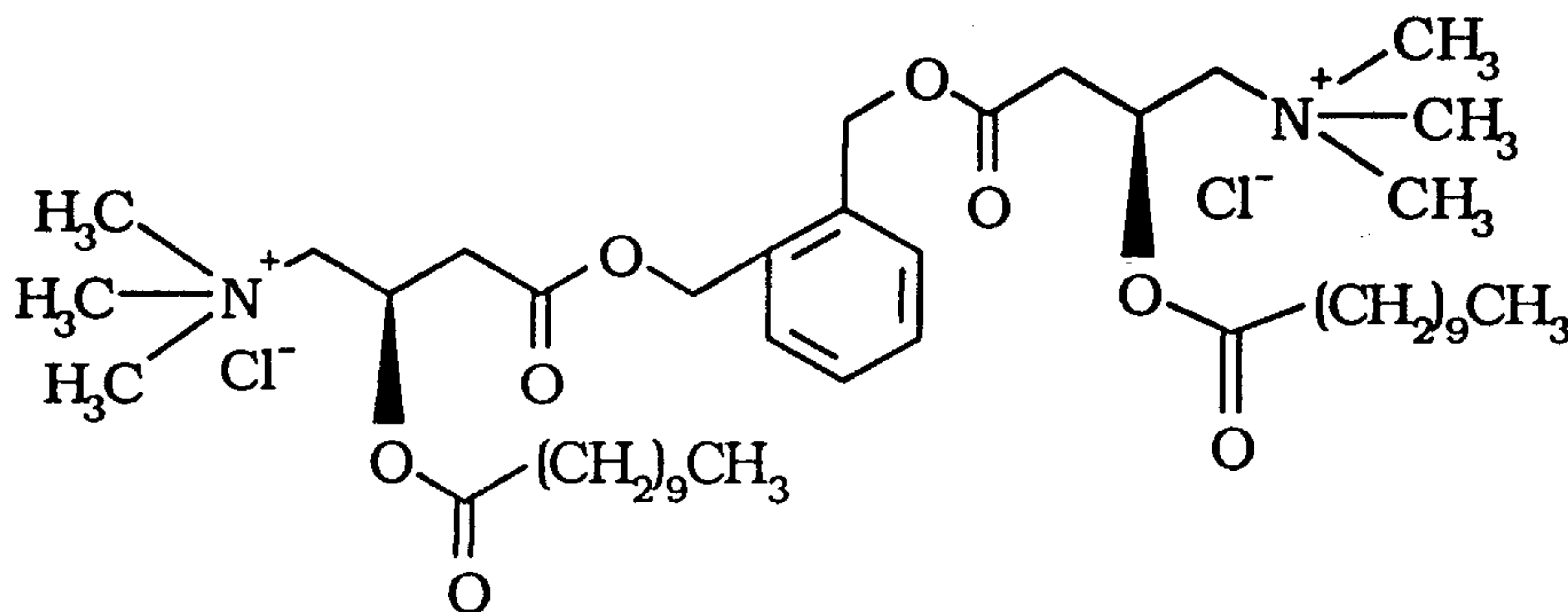
4.3-3.9(6H,m,2N⁺-CHH;2CH₂O); 3.5(18H,s,2(CH₃)₃N⁺);

3.0-2.8(4H,2CH₂COO); 2.3(4H,t,OCOCH₂); 2.0(2H,m,-CH₂-CH₂-CH₂-);

1.6(4H,m,2CH₂CH₃); 1.2(36H,s,2(CH₂)₉); 0.8(6H,t,2CH₃)

EXAMPLE 4

Preparation of bis(undecanoyl L-carnitine chloride) o-xylilene diester (ST 1249)



The title compound was prepared and isolated as described in Example 1. Yield 58%.

Elementary Analysis corresponding to $C_{44}H_{78}O_8N_2Cl_2$

HPLC

Column: SGE-SCX (5 μ m) 1 250 mm X 4.0 mm

temp.: 30°C

eluant: $CH_3CN/NH_4H_2PO_4$ 50 mM 65/35 pH= 7.2 (NH_4OH)

flow rate: 1 mL/min

Rt: 9.68 min

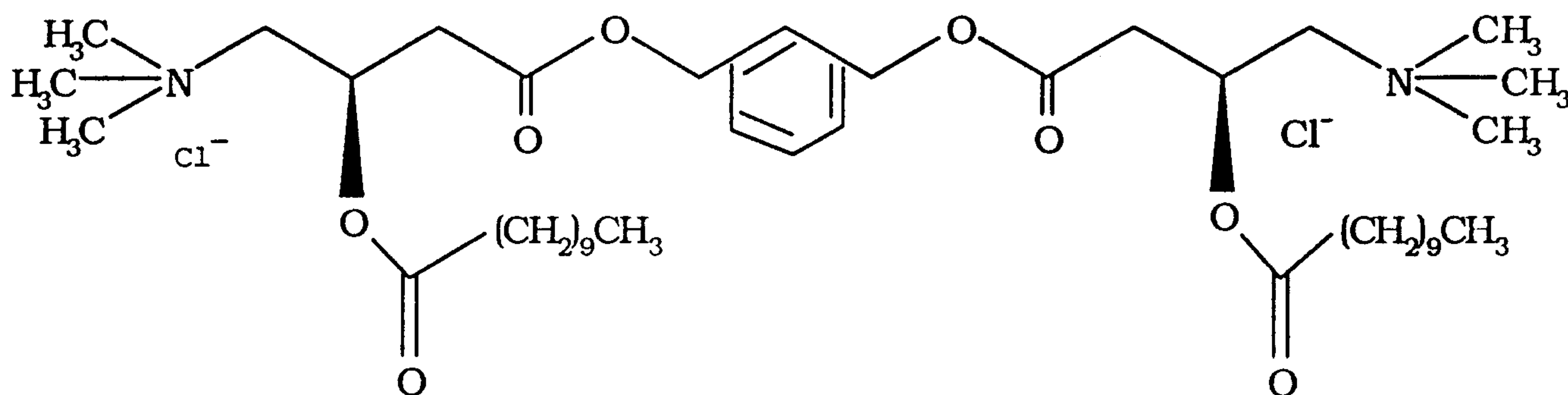
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$[\alpha]_D^{25} = -16^\circ$ (c = 1% H_2O)

NMR corresponding, as in Example 1.

EXAMPLE 5

Preparation of bis-(undecanoyl-L-carnitine chloride) m-xylilene diester (ST 1250).



The title compound was prepared and isolated as described in Example 1. Yield 78%.

Elementary Analysis corresponding to $C_{44}H_{78}O_8N_2Cl_2$

HPLC as described in Example 1

Rt= 9.18 min

NMR corresponding, as described in Example 1

25

$[\alpha] = -18.2^\circ$ (c = 0,5% H_2O)

The potent bactericidal, fungicidal and antiprotozoal activity of the compounds of the present invention and their superiority to the closest prior art compounds, such as the above-mentioned isovaleryl L-carnitine undecyl ester methanesulfonate (ST 1103) was assessed in several pharmacological tests, some of which are hereinbelow described.

IN VITRO ANTIMICROBIAL ACTIVITY

**MINIMAL INHIBITORY CONCENTRATION (mcg/ml) OF ST1226 IN
COMPARISON WITH ST 1103 ON GRAM POSITIVE AND GRAM
5 NEGATIVE BACTERIA (LAB COLLECTION AND FRESH CLINICAL
ISOLATES OF DERMATOLOGICAL INTEREST).**

MATERIAL AND METHODS

Bacterial suspensions are prepared from an overnight culture in
10 Mueller-Hinton broth and are adjusted, in the same medium, to a final
concentration of 5.0×10^4 cells/ml in each well of a 96-well microtiter
plate. Substance dilutions (0.3 log) in Mueller-Hinton broth are added
to the suspensions in order to have a range of final concentrations from
0.19 to 100 mcg/ml.

15 Microtiters are then incubated at 37°C for 18 hours. (See L. D.
THRUPP, Susceptibility testing of antibiotics in liquid media, in:
Antibiotics in laboratory medicine. V. LORIAN Ed., II edition, 4, 93-150,
Williams & Wilkins, Baltimore, MD 21202 U.S.A.).

RESULTS

20 The data concerning the strains of lab collection and clinical
isolates are reported in tables 1 and 2, respectively. As it can be seen
from both single results and from mean MIC values, ST 1226 exhibits a
higher activity than ST 1103 on Gram positive bacteria (Tab. 1a and 1b).

On the contrary, no significant differences have been found

between the two substances on Gram negative bacteria (Table 2a and 2b).

Table 1a Minimal Inhibitory Concentration (mcg/ml) of ST 1226 and
ST 1103 against Gram positive bacteria (lab collection).

Microbial strains		ST 1226	ST 1103
Gram+			
10	<i>B. pumilus</i> CN 607	1.56	3.12
	<i>S. faecalis</i> 509	1.56	1.56
	<i>S. faecalis</i> 501	3.12	3.12
	<i>S. aureus</i> 306 MR	3.12	6.25
	<i>S. aureus</i> 303	3.12	6.25
15	Mean MIC	2.49	4.06

Table 1b Minimal Inhibitory Concentration (mcg/ml) of ST 1226 and ST 1103 against Gram positive bacteria (clinical isolates)^a.

The diagnosis of the cutaneous infection from which the bacterial strains were isolated is indicated only when it was known.

	Microbial strains	ST 1226	ST 1103	Diagnosis
10	<i>Staph. sp.</i> SG 1 II	3.12	6.25	—
	<i>Staph. aureus</i> IDI 3530	3.12	3.12	ulcer
	<i>Staph. aureus</i> IDI 3593	3.12	3.12	ulcer
	<i>Staph. aureus</i> SG II	3.12	3.12	—
	<i>Staph. epider.</i> IDI 3482	3.12	1.56	suppurative wound
15	<i>Staph. capitis</i> IDI 3502	1.56	3.12	pustule (scalp)
	<i>Staph. warneri</i> IDI 3482	3.12	6.25	suppurative wound
	<i>Strept. faecalis</i> IDI 3580	6.25	6.25	ulcer
	<i>Strept. sp.</i> SG 7 II	3.12	3.12	—
	<i>Micrococcus sp.</i> IDI 3502	1.56	3.12	pustule (scalp)
20	Mean MIC	3.12	3.90	

a = SG strains (from S. Gallicano Hospital of Rome). IDI strains (from Immacolata Dermatological Institute of Rome).

Table 2a Minimal Inhibitory Concentration (mcg/ml) of ST 1226 and ST 1103 against Gram negative bacteria (lab collection).

Microbial strains		ST 1226	ST 1103
5	Gram-		
	<i>S. typhimurium</i> DS	25	25
	<i>E. aerogenes</i> UM	6.25	25
	<i>P. vulgaris</i> UM	50	50
10	<i>K. oxytoca</i> 552	25	12.5
	<i>E. coli</i> 92 F	25	25
	Mean MIC	26.25	27.5

Table 2b Minimal Inhibitory Concentration (mcg/ml) of ST 1226 and ST 1103 against Gram negative bacteria (clinical isolates)^a.

The diagnosis of the cutaneous infection from which the bacterial strains were isolated is indicated only when it was known.

5

Microbial strains		ST 1226	ST 1103	Diagnosis
<i>Pseudomonas aeruginosa</i> IDI 3530		50	25	ulcer
10	<i>Klebsiella pneumoniae</i> SG 5 II	50	50	—
	<i>Enterobacter cloacae</i> SG 3 II	12.5	25	—
	<i>Escherichia coli</i> SG 4 II	12.5	25	—
	<i>Proteus sp.</i> SG 9 II	50	50	—
Mean MIC		35.0	35.0	

15

a = SG strains (from S. Gallicano Hospital of Rome). IDI strains (from Immacolata Dermatological Institute of Rome).

MINIMAL INHIBITORY CONCENTRATION (mcg/ml) OF ST 1226 IN COMPARISON WITH ST 1103 ON GRAM POSITIVE AND GRAM NEGATIVE ANAEROBIC BACTERIA (LAB COLLECTION AND CLINICAL ISOLATES).

5

MATERIALS AND METHODS

Bacteria from cultures in WILKINS-CHALGREN (W. C.) medium on Petri dishes, grown overnight at 35°C in an anaerobic jar, were resuspended in Brucella broth. The suspensions were adjusted to 1.0x10⁸ cells/ml and distributed (0.2 ml/well) in microtiter plates (96-well U-bottomed plate). At the same time, 0.3 log dilutions of the substances are mixed with W. C. agar medium in four-sectioned Petri dishes, which are then seeded with the bacterial suspension by means of a multipoint inoculator (1.0x10⁵ cells/spot). The plates are then incubated at 35°C for 48 hours in an anaerobic jar) (See J. E. ROSENBLATT, Antimicrobial susceptibility testing of anaerobes, in *Antibiotics in laboratory medicine*. V. LORIAN Ed., II edition, 6, 159-180, Williams & Wilkins, Baltimore, MD 21202 U.S.A.).

RESULTS

The MIC values (mcg/ml) of the compounds against 3 anaerobic bacterial strains are reported in Table 3. The mean MIC value of ST 1226 is smaller than ST 1103.

Table 3 Minimal Inhibitory Concentration (mcg/ml) of ST 1226 and ST 1103 against anaerobic bacteria. The diagnosis of the cutaneous infection from which the bacterial strains were isolated is indicated only when it was known.

5	Microbial strains	ST 1226	ST 1103	Diagnosis
	<i>Eubacterium lentum</i> IDI 3502*	6.25	3.12	suppurative wound
	<i>Propionibacterium acnes</i> IDI 3482*	6.25	6.25	suppurative acne
10	<i>Bacteroides fragilis</i> ATCC 25285**	12.5	25	—
	Mean MIC	8.33	11.45	

* = Gram positive bacteria (clinical isolates from Immacolata
15 Dermatological Institute of Rome).

** = Gram negative bacterium (lab collection).

MINIMAL INHIBITORY CONCENTRATION (mcg/ml) OF ST 1226 IN
COMPARISON WITH ST 1103 ON YEAST-LIKE STRAINS (LAB
20 COLLECTION AND CLINICAL ISOLATES).

MATERIALS AND METHODS

Overnight yeast cultures in Sabouraud broth are appropriately washed and diluted in Yeast Nitrogen Base supplemented with
25 asparagine and glucose (Y.N.B.s.) to yield approximately 5.0×10^4 CFU/ml in microtiter wells. Substance dilutions (0.3 log) in Y.N.B.s. are added to

these suspensions to a final concentration range from 0.19 to 100 mcg/ml. Microtiter plates are then incubated at 35°C for 24-48 hours (See PFALLER M., RINALDI M. G., GALGANI J. M., BARTLETT M. S., BODY B. A., ESPINEL-INGROFF A., FROMTLING R. A., HALL G. S.,
5 HUGHES G. E., ODDS F. C., SUGAR A. M., Collaborative investigator of variables in susceptibility testing of yeasts, *Ant. Agent and Chemoth.*, 34, 9:1648-1656, 1990. COOK R., McINTYRE K. A., GALGANI J. M., Effects of incubation temperature, inoculum size, and medium on agreement of macro and microdilution broth susceptibility test, results
10 for yeasts, *Ant. Agent and Chemoth.*, 34, 8:1542-1545, 1990. ANAÏSSIE E., PAETZNICK V., BODEY G. P., Fluconazole susceptibility testing of "Candida albicans" microtiter method that is independent of inoculum size, temperature, and time of reaching, *Ant. Agent and Chemoth.*, 35, 8:1641-1646, 1991).

15 RESULTS

The data concerning the lab collection strains and the clinical isolates are reported in tables 4 and 5, respectively. ST 1226 exhibits a higher activity than ST 1103, mostly against *Candida* clinical isolates of dermatological interest.

Table 4 Minimal Inhibitory Concentration (mcg/ml) of ST 1226 and ST 1103 against yeast-like strains (lab collection).

Microbial strains		ST 1226	ST 1103
5	<i>S. cerevisiae</i> ATCC 7752	1.56	3.12
	<i>C. krusei</i> ISS 1	3.12	3.12
	<i>C. tropicalis</i> ISS 1	1.56	3.12
	<i>C. albicans</i> ISS 1	3.12	1.56
10	<i>C. albicans</i> 562	3.12	3.12
Mean MIC		2.49	2.80

Table 5 Minimal Inhibitory Concentration (mcg/ml) of ST 1226 and ST 1103 against *Candida* strains (clinical isolates)^a. The diagnosis of the cutaneous infection from which the *Candida* strains were isolated is indicated only when it was known.

5				
Microbial strains	ST 1226	ST 1103	Diagnosis	Treatment ^b
<i>Candida albicans</i>				
SG 14 III	1.56	6.25	Vaginitis	—
10 <i>Candida albicans</i>				
SG 7 I	3.12	3.12	Tinea unguis (hands)	—
<i>Candida albicans</i>				
IDI D 3575	3.12	6.25	—	—
<i>Candida albicans</i>				
15 IDI D 0297	3.12	3.12	Vulvar vaginitis	Pevaryl®
<i>Candida albicans</i>				
IDI D 1088	3.12	3.12	—	—
<i>Candida albicans</i>				
IDI D 0101	1.56	6.25	Eczema (internatal)	Versus®
20 <i>Candida albicans</i>				
IDI D 1056	1.56	3.12	—	—
<i>Candida albicans</i>				
SG 2 III	1.56	6.25	Vaginitis	—
<i>Candida albicans</i>				
25 1786/94	3.12	6.25	—	—
<i>Candida albicans</i>				
IDI D 1046	3.12	3.12	Glossitis	Daktarin®
Mean MIC	2.49	4.68		

30 a = SG strains (from S. Gallicano Hospital of Rome). IDI strains (from Immacolata Dermatological Institute of Rome). SM strains (from S. Matteo Hospital of Pavia).

b = Treatment administered prior to clinical diagnosis.

**MINIMAL INHIBITORY CONCENTRATION (mcg/ml) OF ST 1226 IN
COMPARISON WITH ST 1103 ON FILAMENTOUS FUNGI (LAB
COLLECTION).**

5 MATERIALS AND METHODS

The conidia are collected from 72-hour cultures in Sabouraud agar by washing them with Sabouraud broth and 0.5% Tween 80. After a coarse filtration and washing, the resulting suspensions are adjusted to a final concentration of approx. 5.0×10^4 CFU/ml in a microtiter plate. The
10 substances (0.3 log dilutions in Y.N.B.s.) are added to the fungal suspensions in order to generate a range of final concentrations from 0.19 to 100 mcg/ml. The microtiter plates are then incubated at 35°C for 48-72 hours.

RESULTS

15 The results obtained with the two compounds are shown in table 6. Both single results and mean MIC values clearly show that ST 1226 exhibits a markedly higher activity than ST 1103.

Table 6 Minimal Inhibitory Concentration (mcg/ml) of ST 1226 and ST 1103 against filamentous fungi (lab collection).

Microbial strains	ST 1226	ST 1103
<i>Fusarium</i> sp. F 77	3.12	6.25
<i>Penicillium</i> sp. 1302	1.56	12.5
<i>Mucor mucedo</i> ATCC 7941	25	50
<i>Aspergillus niger</i> ATCC 16404	6.25	12.5
<i>Aspergillus fumigatus</i> ATCC 28212	6.25	12.5
Mean MIC	8.43	18.75

**MINIMAL INHIBITORY CONCENTRATION (mcg/ml) OF ST 1226 IN
COMPARISON WITH ST 1103 ON DERMATOPHYTES (CLINICAL
ISOLATES OF DERMATOLOGICAL INTEREST).**

MATERIALS AND METHODS

Mycelium fragments, micro and macroaleuriospores are harvested from 7-day fungal cultures grown at 30°C in Potato Dextrose agar by washing them with Sabouraud broth and 0.5% Tween 80. After a coarse filtration and washing, the fungal suspension is resuspended in Yeast Nitrogen Base supplemented with asparagine and glucose (YNBs) to yield a final concentration of 1.0×10^5 infective units/ml in a microtiter plate.

The substances (0.3 log dilutions in Y.N.B.s.) are added to the fungal suspensions in order to generate a range of final concentrations from 0.19 to 100 mcg/ml. The microtiter plates are then incubated at 30°C for 96-120 hours.

5

RESULTS

The results obtained with the two compounds are reported in table 7. It can be easily seen that ST 1226 displays a higher activity than ST 1103 against dermatophytes.

10

Table 7 Minimal Inhibitory Concentration (mcg/ml) of ST 1226 and ST 1103 against dermatophytes (clinical isolates)^a. The diagnosis of the cutaneous infection from which the bacterial strains were isolated is indicated only when it was known.

5	Microbial strains	ST 1226	ST 1103	Diagnosis	Treatment ^b
10	<i>Tr. mentagrophytes</i> IDI D 1101	1.56	12.5	Epidermatomycosis (face)	—
	<i>Tr. mentagrophytes</i> SG 8 II	1.56	12.5	Tinea cruris	—
15	<i>Tr. mentagrophytes</i> SG 3 I	1.56	12.5	Tinea pedis	—
	<i>Tr. mentagrophytes</i> SG 4 II	1.56	12.5	Tinea cruris	—
20	<i>Tr. mentagrophytes</i> SG 5 III	3.12	12.5	Tinea pedis	—
25	<i>Tr. mentagrophytes</i> IDI D 1027	3.12	12.5	Impetiginous eczema (chin)	—
	<i>Tr. mentagrophytes</i> IDI D 1049	1.56	12.5	—	—
30	<i>Tr. quinckeanum</i> NCPF 309*	1.56	6.25	—	—
	<i>Tr. rubrum</i> IDI D 0222	1.56	12.5	Onychomycosis (left and right big toes)	—
35	<i>Tr. rubrum</i> IDI D 0261	1.56	12.5	Dyshidrotic eczema (right foot)	Fargan® Gentalyn β® and cortisone
40	<i>Tr. rubrum</i> SG 13 III	1.56	12.5	Tinea pedis	—
45					continued

	Microbial strains	ST 1226	ST 1103	Diagnosis	Treatment ^b
5	<i>Tr. rubrum</i> IDI D 1017	1.56	12.5	Onychomycosis (right big toe)	Azolmen®
	<i>Tr. rubrum</i> IDI D 0252	1.56	25	Impetigo (left arm)	Rifocin®
10	<i>Tr. rubrum</i> IDI D 1150	1.56	12.5	Epidermophytosis (arms, legs and buttocks)	Gentalyn®
	<i>Tr. rubrum</i> IDI D 1155	1.56	3.12	—	—
15	<i>Microsporum canis</i> IDI D 1123	1.56	12.5	Epidermophytosis (back)	Gentalyn®
20	<i>Microsporum canis</i> IDI D 0238	12.5	25	Tricophytosis (right arm)	Nerisona®
	<i>Microsporum canis</i> IDI D 1011	3.12	12.5	Eczema (neck)	Gentalyn® and cortisone
25	<i>Microsporum canis</i> IMM 3868*	1.56	12.5	—	—
30	<i>Epidermoph. floccosum</i> IDI D 0011	12.5	12.5	Epidermophytosis (foot interdigital)	—
	<i>Epidermoph. floccosum</i> SG 6 II	6.25	12.5	Tinea pedis	—
35	<i>Epidermoph. floccosum</i> SG 3 III	6.25	25	—	—
	Mean MIC	3.19	13.49		

40 * lab collection strains.

^a SG strains (from S. Gallicano Hospital of Rome). IDI strains (from Immacolata Dermatological Institute of Rome).

^b Treatment administered prior to clinical diagnosis.

**MINIMAL INHIBITORY CONCENTRATION (mcg/ml) OF ST 1226 IN
COMPARISON WITH ST 1103 ON PROTOZOA (*Trichomonas vaginalis*).**

MATERIALS AND METHODS

5 Protozoal suspensions are prepared from 24-hour cultures grown
at 37°C and 5% CO₂ in DIAMOND T.Y.M. broth supplemented with 10%
heat-inactivated FCS.

 The suspensions are adjusted, in the same medium, to a final
concentration of 2.5×10^5 cells/ml in each well of a 96-well microtiter
10 plate. Substance dilutions (0.3 log) are added to the suspensions in order
to have a range of final concentrations from 0.19 to 100 mcg/ml.
Microtiters are then incubated at 37°C and 5% CO₂ for 24 hours. MIC is
referred to as the minimal concentration inhibiting either protozoa or
flagella or undulating membrane motility (Cf. JULIANO C., MARTINOTTI
15 M. G., CAPPUCCINELLI P., In vitro effect of microtubule inhibitors on *T.*
vaginalis, *Microbiologia*, 8:31-42, 1985. LÖVGREN T. and SALMELA I., In
vitro sensitivity of *T. vaginalis* and *C. albicans* to chemotherapeutic agents,
Acta Path. Microbiol. Scand., 86:155-158, 1978).

RESULTS

20 The results obtained with the two substances are shown in table 8:
ST 1226 exhibits a greater (2-fold) activity than ST 1103.

Table 8 Minimal Inhibitory Concentration (mcg/ml) of ST 1226 and ST 1103 against *T. vaginalis* strains^a.

Microbial strains		ST 1226	ST 1103
5	<i>T. vaginalis</i> SS-2	12.5	25
	<i>T. vaginalis</i> SS-9	12.5	25
	<i>T. vaginalis</i> SS-20 ^b	12.5	25
	<i>T. vaginalis</i> SS-22 ^b	12.5	25
10	Mean MIC	12.5	25

a = Strains from the Institute of Microbiology and Virology of the Univerisity of Sassari.

b = Strains Metronidazole-resistant (MIC of 25 and 50 mcg/ml).

IN VIVO ACTIVITY

EVALUATION OF THE IN VIVO ANTIINFECTIVE EFFECT OF ST 1226 AND 1103 ON TOPICAL MIXED INFECTION SUSTAINED BY A DERMATOPHYTE (*Tricophyton quinckeanum*) AND BY A GRAM POSITIVE BACTERIUM (*Staphylococcus aureus*).

MATERIALS AND METHODS**Animals**

10 Male inbred BALB/c mice (C. RIVER), aged 6 weeks were used (5 animals per group).

Microbial strains

The animals were topically infected with pathogenic strains of *Tricophyton* (*Tricophyton quinckeanum* NCPF 309) and *Staphylococcus*
15 (*Staphylococcus aureus* LC1).

Experimental procedure

Suspensions of fungal microaleuriospores and bacteria were adjusted to a final concentration of 5.0×10^7 and 1.0×10^7 cells/ml, respectively. Volumes of 0.2 ml of each suspension were applied onto the
20 upper posterior zone of the animals, which had previously been shaved and gently abraded with a scalpel blade until "glistening". Treatment started 30 hours after the inocula by administering 50 mg of each substance in a gel form (1% test article) on the infected skin once a day for 5 consecutive days. Two days following the last treatment, animals

were sacrificed and infected tissue samples were collected. Following homogenization and appropriate dilution in medium, tissue samples were plated (in Mycobiotic agar and Mannitol Salt agar for fungi and bacteria, respectively) to selectively assess the growth of the pathogens. Fungal growth is evaluated by means of an arbitrary scale, while bacterial growth is evaluated by determining the CFUs (Colony Forming Units).

RESULTS

The results obtained with both molecules are shown in Table 9. It can be inferred that the molecules have both an identical activity on *S. aureus*, while ST 1226 exhibits a greater antifungal activity than ST 1103.

Table 9 In vivo antiinfective efficacy of ST 1226 in comparison with ST 1103 on a mixed topical infection (*Tricophyton quinckeanum* NCPF 309 and *Staphylococcus aureus* LC1) in mice^a.

5	Treatment	<i>S. aureus</i>		<i>T. quinckeanum</i>	
		Cured animals (%)	Not cured animals (mean CFU/mouse)	Cured animals (%)	Not cured animals (fungal growth) ^c
10	Control	0	2.73x10 ⁴	0	++
	Vehicle	0	3.36x10 ⁴	0	++/+
	ST 1103 ^b	80	40	80	+
	ST 1226 ^b	80	50	100	—

15

a = 5 animals per experimental group.

b = Animals were topically treated for 5 consecutive days by administering 50 mg/day of each substance at 1% in gel (Hydroxyethyl-cellulose, 2.5 gr.; Glycerin, 7.0 gr.; Propylene Glycol, 7.0 gr.; depurated water up to 100 ml).

20

c = +++ confluent fungal growth (from a 1-ml skin homogenate)
 ++ semiconfluent fungal growth (from a 1-ml skin homogenate)
 + moderate fungal growth (from a 1-ml skin homogenate).

25

**EVALUATION OF DERMAL TOLERABILITY AFTER REPEATED
TREATMENTS (10 DAYS) WITH ST 1226 AND ST 1103 ON MOUSE
SCARIFIED SKIN**

5 MATERIALS AND METHODS

Animals

Male CD1 mice (C. RIVER), aged 6 weeks, were used (5 animals per group).

Substances

10 Substance formulations (1% of test article) were prepared in gel (Hydroxyethyl-cellulose, 2.5 gr.; Glycerin, 7.0 gr.; Propylene Glycol, 7.0 gr.; water up to 100 ml).

Experimental procedure

The central dorsal zone of the animals was first shaved, and then
15 gently abraded with a scalpel blade. Treatment was performed 1 day following the dermal abrasion by administering 50 mg of each substance formulation once a day, for 10 consecutive days. The treated skin areas were examined at 5, 7, 9, and 11 days following scarification. The
20 evaluation was based upon grading of the lesions as ERYTHEMA (E), DESQUAMATION (D), and CRACKING (C), according to the following scale:

E	D	C
0 = no erythema 1 = slight (barely visible) 2 = moderate (well defined) 3 = severe (purplish red)	0 = none 1 = slight (barely visible) 2 = moderate (scabs and scales) 3 = pronounced (scales with denuded areas)	0 = none 1 = slight (cracks in epidermis) 2 = moderate (cracks in dermis) 3 = pronounced (cracks with bleeding)

The mean of the values of each parameter in the same animal group allowed us to evaluate the tissue damage provoked by the substance under examination.

5 RESULTS

The results obtained with the compounds, expressed as the mean of each parameter evaluated in the same experimental group, are reported in Table 10. It can be seen that ST 1226 is better tolerated than ST1103.

10

Table 10 Dermal tolerability of repeated administrations of ST 1226 and ST 1103 on murine scarified skin. Evaluation on days 5, 7, 9, and 11 following scarification by means of an arbitrary scale (erythema, desquamation, and cracking) ranging from 0 (no effect) to 3 (severe damage). The results are expressed as mean values of each experimental group (5 animals/group).

15

Treatment	+5 ^a			+7 ^a			+9 ^a			+11 ^a		
	E	D	C	E	D	C	E	D	C	E	D	C
Control	0.2	0	0	0	0	0	0	0	0	0	0	0
Vehicle	0.2	0	0	0	0	0	0	0	0	0	0	0
ST 1103	1.2	0.4	0	0.4	0.4	0	0	0	0	0	0	0
ST 1226	0.2	0	0	0	0	0	0	0	0	0	0	0

a = days following dermal scarification.

./.

EVALUATION OF THE ANTIFUNGAL ACTIVITY OF ST 1226 (1% AND 1.5%) AND MICONAZOLE (1.5%) IN AN EXPERIMENTAL INFECTION MODEL (*Tinea pedis*) INDUCED IN THE PAW OF THE GUINEA-PIG WITH A STRAIN OF TRICHOPHYTON (*T. mentagrophytes* IDI D1049).

5

The characteristics of chronic infection and the similarity with the human infection, from an histological and clinical standpoint, make this model very useful to study the most wide-spread topical fungal pathology (athlete's foot). Besides, the outcome of the treatment may constitute a
10 good point of reference from which one can extrapolate valuable indications on other dermatophytes infecting different body areas. Moreover, the chronicity of this infection (up to 6 months) allows the substances to be studied even with long-lasting treatments, as it usually happens in man.

15 In the present investigation, we have evaluated in the guinea-pig model whether ST 1226, at two different concentrations, was able to cure this typical cutaneous dermatophytic infection, which is long-lasting and of frequent occurrence in man.

20 **MATERIALS AND METHODS.**

Animals

Twelve male Hartley guinea-pig (C. RIVER), weighing 350-400 gr, have been utilized (3 animals per experimental group).

Infective strain

One clinical isolate (*Tricophyton mentagrophytes* IDI D1049, from Immacolata Dermatological Institute of Rome) was utilized.

Inoculum preparation

- 5 Microaleuriospores were first harvested by scraping from a 7-day fungal culture grown in Potato dextrose agar, and then resuspended in Sabouraud broth with 0.5% Tween 80.

After washing, the spores were standardized in sterile saline to yield a final concentration of 1.0×10^8 spores/ml.

10 **Experimental group**

Five experimental groups were set up as follows:

Control I: infected animals

Control II: infected and placebo-treated animals

Treated I: infected and 1% ST 1226-treated animals

- 15 Treated II: infected and 1.5% ST 1226-treated animals

Treated III: infected and 1.5% Miconazole-treated animals.

Each group included 3 animals, and only the left hind paw was inoculated. For the 2 control groups, 3 animals in total were used, as both hind paws of each animal were inoculated.

20 **Experimental procedure**

Filter paper discs (12-mm diameter and 0.3-mm thickness) were covered with aluminum foil in the lower part to prevent the inoculum spreading. This filter was then stucked to a 1x3-cm piece of biadesive plaster, which adhered to a gauze wrapped around the paw.

The filter paper disc was then wetted with 100 μ l of the infective suspension, and subsequently fixed to the guinea-pig paw.

The animal paw was tied up with bandage and plaster, and then left in these conditions for 7 days.

- 5 Seven days after infection, the infected areas were uncovered and the type of lesion was graded according to an arbitrary scale, as follows:

ERYTHEMA	EROSION	DESQUAMATION
0= none	0= none	0= none
1= slight	1= slight	1= slight
2= moderate	2= moderate	2= moderate
3= severe	3= severe	3= severe

- 10 These "clinical" signs were examined again on days +14, +21, and +31 (day of sacrifice of animals). Three days following the first observation of the type of lesion (day +10), treatments with the different formulations were started, and they went on for 20 days (once a day). Two days following the last treatment (day +31), animals were sacrificed and plantar areas of the paws were dissected into 10 parts for each paw.

- 15 These sections were plated onto Mycobiotic agar supplemented with Penicillin G and Streptomycin (100 mcg/ml). Volumes of 50 μ l of both antibiotics were then added to the plantar sections to prevent any bacterial growth that might interfere with the growth of *T. mentagrophytes* in the samples under examination.

The data obtained were expressed as the number of microbiologically sterile cutaneous sections over the total examined sections.

RESULTS

The results obtained with ST 1226 in this experimental model were favourable in terms of "microbiological recovery" (80% and 100% with 1% and 1.5% ST 1226, respectively) (Tab 11).

Treatment with Miconazole (1.5%) was similarly capable of eradicating infection from all treated samples.

Table 11 Clinical and microbiological evaluation of a cutaneous treatment with ST 1226 and Miconazole in a guinea-pig plantar infection by a strain of *Trichophyton* (*T. mentagrophytes* IDI D1049).

Treatment	7 th day ^a			14 th day ^a			21 st days ^a			31 st day ^a			sterile samples (n=30) (%)
	A	E	D	A	E	D	A	E	D	A	E	D	
Control I	0	0	0	0	0.3	0	0	0.3	0.3	0.3	0.6	0.6	1/30 (3.33)
Control II ^b	0	0	0	0	0.3	0	0	0.3	0	0.3	0.6	0.6	0/30 (0)
ST 1226 (1%)	0	0	0	0	0	0	0	0	0	0	0	0	24/30 (80)
ST 1226 (1.5%)	0	0	0	0	0	0	0	0	0	0	0	0	20/20 (100)
MCZ (1.5%)	0	0	0	0	0	0	0	0	0	0	0	0	30/30 (100)

a = days following the infective inoculum.

b = infected animals treated with placebo (Hydroxyethyl-cellulose, 2.5 gr.; Glycerin, 7.0 gr.; Propylene Glycol, 7.0 gr.; depurated water up to 100 ml).

**COMPARATIVE EVALUATION OF DERMAL TOLERABILITY OF 4
ACQUEOUS FORMULATIONS CONTAINING 1% ST 1226 ON MOUSE
SCARIFIED SKIN.**

5 MATERIALS AND METHODS

Animals

Forty-five male CD1 mice (C. RIVER), aged 7 weeks, were used (5 animals per experimental group).

10 Substance formulations

Cream TF 24/6327

<u>Components</u>	<u>%</u>
ST 1226	1
Para combin	0.25
15 Propylene Glicol	2
Sepigel 305	5
Vaseline oil	10
H ₂ O to	100

Cream TF 25/6327

	<u>Components</u>	<u>%</u>
	ST 1226	1
	Fatty lan	16
5	Glycerin	3
	Propylene glycol	5
	Nipa sept.	0.2
	H ₂ O to	100

10 Cream TF 28/6327

	<u>Components</u>	<u>%</u>
	ST 1226	1
	Fatty lan	11.5
	Tween 80	0.3
15	BHA	0.004
	Sorbic acid	0.2
	EDTA	0.1
	Vaseline	12
	Propylene glycol	2.5
20	Silicon oil	.
	AK 350	0.1
	Vaseline oil	5
	H ₂ O to	100

Cream TF 14/6327

<u>Components</u>	<u>%</u>
ST 1226	1
Hydroxyethyl cellulose	1.6
5 Glycerin	8
Propylene Glicol	3
Ethanol	15
Perfume	0.050
H ₂ O to	100

10

Experimental procedure

The central dorsal zone of the animals was first shaved, and then gently abraded with a scalpel blade.

Treatment started 1 day following the dermal abrasion by
15 administering 50 mg of each substance formulation once a day for 10 consecutive days. The treated skin areas were clinically examined 5, 7, 9, and 13 days following scarification. The evaluation was based upon grading of the lesions as ERYTHEMA (E), DESQUAMATION (D), and CRACKING (C) according to the following scale:

20

E	D	C
0 = no erythema 1 = slight (barely visible) 2 = moderate (well defined) 3 = severe (purplish red)	0 = none 1 = slight (barely visible) 2 = moderate (scabs and scales) 3 = pronounced (scales with denuded areas)	0 = none 1 = slight (cracks in epidermis) 2 = moderate (cracks in dermis) 3 = pronounced (cracks with bleeding)

The mean of the values of each parameter in the same animal group allowed us to evaluate the tissue damage provoked by the substance under examination.

5 RESULTS

All placebos appear to be very well tolerated. On the contrary, among the 1% ST 1226 aqueous creams, only TF 24/6327 and TF 14/6327 are completely safe, while both TF 25/6327, to a lesser extent, and TF 28/6327, to a greater extent, result to be badly tolerated

10 (Table 12).

Table 12 Evaluation of dermal tolerability after repeated topical treatments with ST 1226 1% in 4 different vehicles on mouse scarified skin (50 mg/mouse for 10 consecutive days).

	Days following the scarification											
	+ 5			+ 7			+ 9			+ 13		
Treatment	E	D	C	E	D	C	E	D	C	E	D	C
Control	0	0	0	0	0	0	0	0	0	0	0	0
TF 19/6327 (P)	0	0	0	0	0	0	0	0	0	0	0	0
TF 24/6327 (F)	0	0	0	0	0	0	0	0	0	0	0	0
TF 20/6327 (P)	0	0	0	0	0	0	0	0	0	0	0	0
TF 25/6327 (F)	0.4	0	0	0	0.4	0	0	0	0	0	0	0
TF 27/6327 (P)	0	0	0	0	0	0	0	0	0	0	0	0
TF 28/6327 (F)	1.0	0.6	0	1.0	1.2	0	0	0.2	0	0	0	0
TF 12/6327 (P)	0	0	0	0	0	0	0	0	0	0	0	0
TF 14/6327 (F)	0.2	0	0	0	0	0	0	0	0	0	0	0

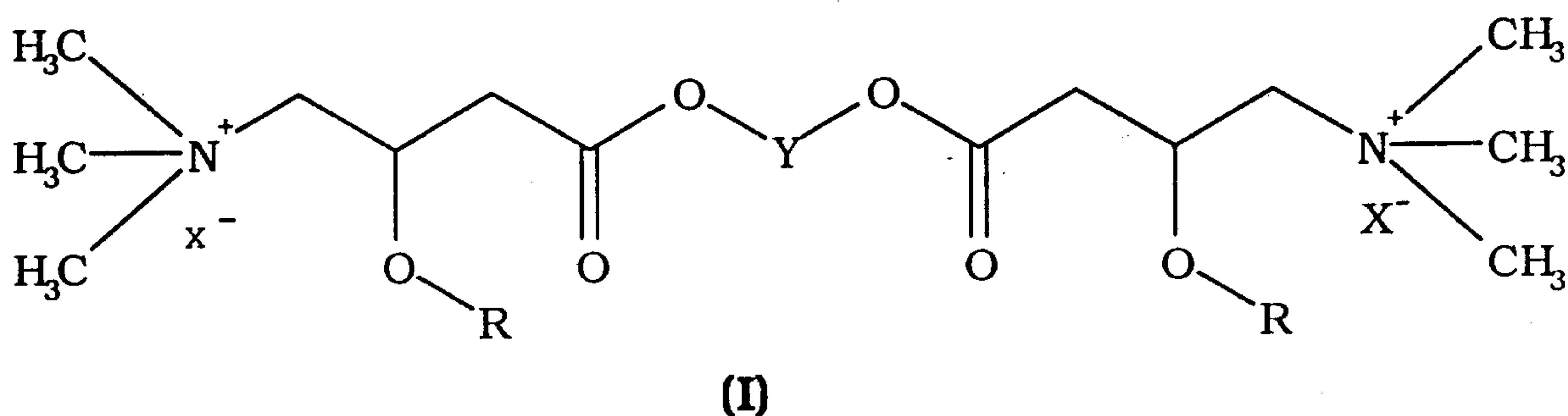
5

E = Erythema; D = Desquamation; C = craking

P = Placebo; F = Complete formulation (placebo + 1% ST 1226).

CLAIMS

1. A DL-, D- or L-carnitine ester of formula (I)



5

wherein:

R is a straight or branched, saturated or unsaturated alkanoyl group having 2-16 carbon atoms;

10 Y is a straight or branched alkylene chain having 3-6 carbon atoms, or ortho, meta or para-xylilene; and

X⁻ is the anion of a pharmacologically acceptable acid.

2. The ester of claim 1, wherein R is an alkanoyl group having 9-13 carbon atoms.

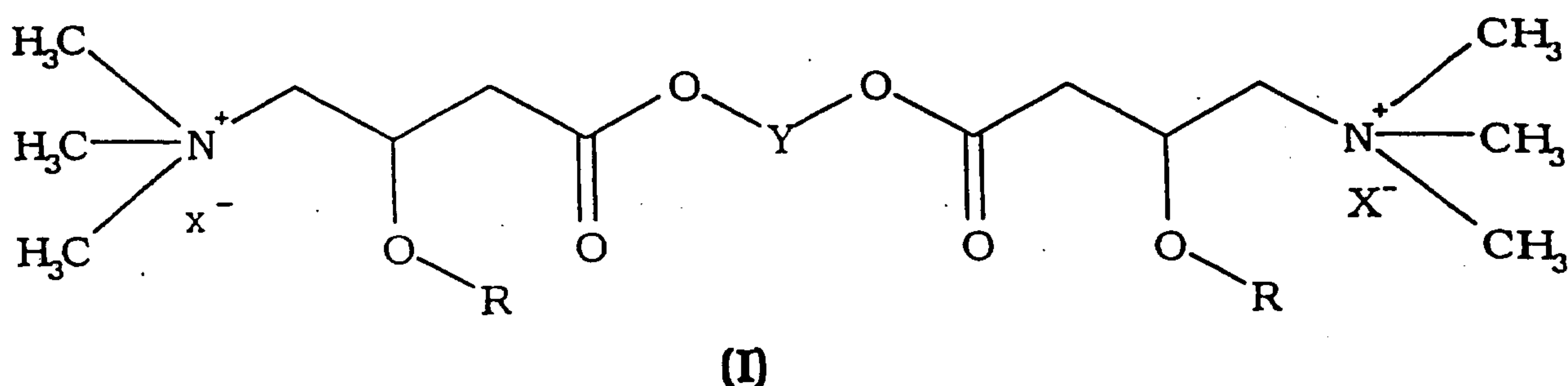
15 3. The ester of claim 1, wherein Y is selected from trimethylene, tetramethylene, pentamethylene and hexamethylene.

4. The ester of claim 1, wherein X⁻ is selected from chloride, bromide, methanesulfonate, phosphate, acid fumarate, fumarate, acid tartrate and tartrate.

20 5. An ester of claim 1, selected from the group consisting of bis(undecanoyl-L-carnitine chloride) p-xylilene diester, bis (tridecanoyl-L-carnitine

chloride) trimethylene diester, bis(undecanoyl-L-carnitine chloride) o-xylilene diester, bis(undecanoyl-L-carnitine chloride) m-xylilene diester, bis(undecanoyl-D-carnitine chloride) p-xylilene diester; bis(decanoyl-L-carnitine chloride) p-xylilene diester; bis(decanoyl-D-carnitine chloride) p-xylilene diester; bis(dodecanoyl-L-carnitine chloride) p-xylilene diester; and bis(dodecanoyl-D-carnitine chloride) p-xylilene diester.

6. A pharmaceutical composition which comprises as active ingredient a compound of formula (I):



wherein:

R is a straight or branched, saturated or unsaturated alkanoyl group having 2-16 carbon atoms;

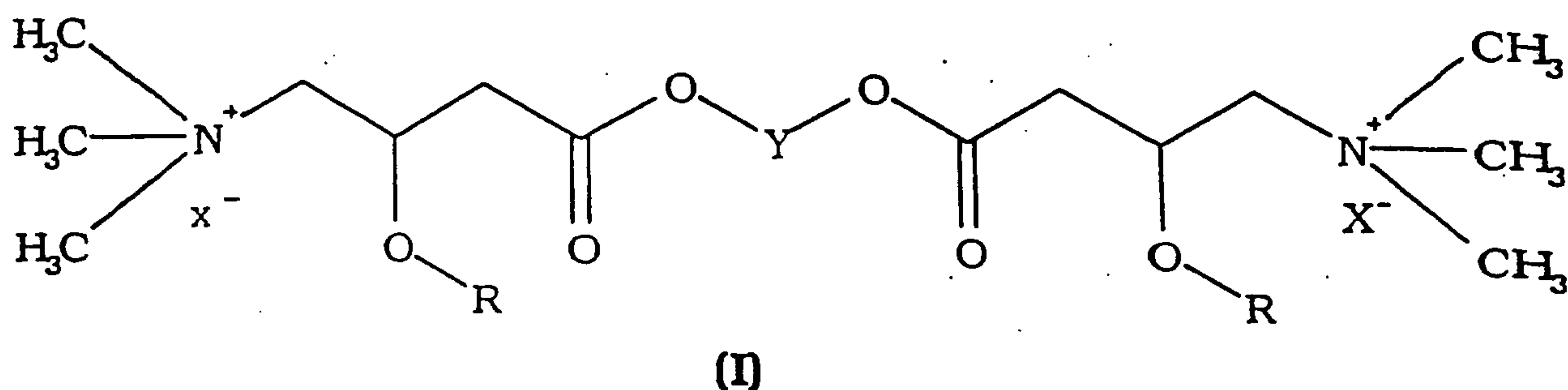
Y is a straight or branched alkylene chain having 3-6 carbon atoms, or ortho, meta or para-xylilene; and

X⁻ is the anion of a pharmacologically acceptable acid; and

a pharmacologically acceptable excipient thereof.

7. The composition of claim 6, suitable to be topically applied, for the treatment of skin diseases sustained by bacteria, yeasts, fungi or protozoa.
8. The composition of claim 7, comprising from 0.5 to 2% by weight of a compound of formula (I) and a pharmacologically acceptable excipient thereof.

9. The composition of claim 8, comprising from 1 to 1.5% by weight of a compound of formula (I) and a pharmacologically acceptable excipient thereof.
10. The composition of any one of claims 7 to 9, in the form of a cream, ointment, gel, lotion or solution.
11. A process for preparing a compound of formula (I):



wherein:

R is a straight or branched, saturated or unsaturated alkanoyl group having 2-16 carbon atoms;

Y is a straight or branched alkylene chain having 3-6 carbon atoms, or ortho, meta or para-xylylene; and

X⁻ is the anion of a pharmacologically acceptable acid;

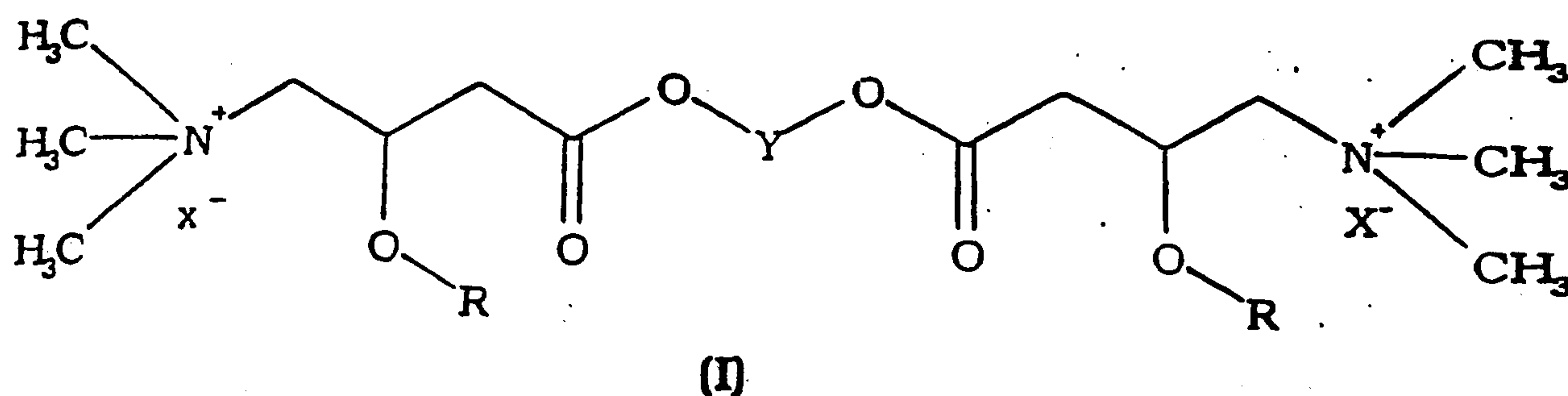
which comprises the steps of:

- (a) suspending an alkanoyl L-carnitine inner salt in an organic, anhydrous inert solvent;
- (b) adding to the suspension at 0°C-10°C a compound of formula Z-Y-Z wherein Y has the aforesaid meaning and Z is selected from halogen, O-mesyl or O-tosyl in an amount equivalent to one half of the moles of the alkanoyl L-carnitine;
- (c) keeping the suspension under stirring at 20°C-50°C for 24 hours till the suspension is completely solubilized;

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- (d) precipitating the reaction raw product by adding a solvent as ethyl ether or hexane, filtering off the product and washing with acetone or methylethylketone till a solid product is obtained;
- (e) dissolving the product in water and eluting on a strongly basic resin activated with a suitable acid of formula HX to obtain the product salified in the sought-after form;
- (f) lyophilizing the eluate for isolating the solid product; and
- (g) purifying the solid of step (f) by chromatography on C₈ silica, eluting with H₂O/CH₃N 70:30.

12. The process of claim 11 wherein the strongly basic resin is Amerlite™ IRA-402.
13. The process of claim 11 or claim 12 wherein the organic anhydrous inert solvent is N,N-dimethylformamide, acetonitrile or methylene chloride.
14. The process of any one of claims 11 to 13 wherein the halogen is chlorine or bromine.
15. A process for preparing a compound of formula (I):



wherein:

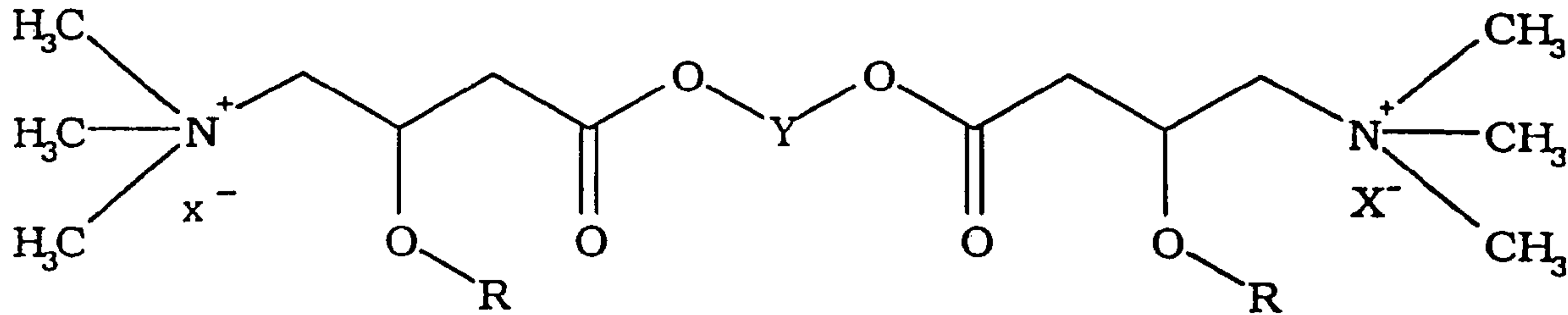
R is a straight or branched, saturated or unsaturated alkanoyl group having 2-16 carbon atoms;

Y is a straight or branched alkylene chain having 3-6 carbon atoms, or ortho, meta or para-xylylene; and

X⁻ is the anion of a pharmacologically acceptable acid,

which comprises the steps of:

- (a') suspending the alkanoyl L-carnitine acid chloride in an organic, anhydrous inert solvent;
 - (b') adding to the suspension at room temperature a compound of formula Z-Y-Z wherein Y has the aforesaid meaning and Z is OH in an amount equivalent to one half of the moles of the alkanoyl L-carnitine;
 - (c') keeping the suspension under stirring at room temperature for 16-24 hours till the suspension is completely solubilized;
 - (d') concentrating the solution to dryness under vacuum;
 - (e') purifying the raw product thus obtained by silica gel chromatography, eluting with H₂O/CH₃CN solutions; and
 - (f') isolating the compound by concentration and subsequent lyophilization.
16. The process of claim 15 wherein the organic, anhydrous inert solvent is N,N-dimethylformamide, acetonitrile or methylene chloride.



(I)