

**Combination of adapalene and benzoyl peroxide for
treating acne lesions**

5 The present invention relates to the combined or associated use of adapalene and of benzoyl peroxide for reducing the number of acne lesions.

6-[3-(1-Adamantyl)-4-methoxyphenyl]-2-naphthoic acid (referred to hereinbelow as adapalene) is a naphthoic
10 acid derivative with retinoid and anti-inflammatory properties. This molecule was the subject of development for the topical treatment of common acne and of dermatoses sensitive to retinoids.

15 Adapalene is sold under the brand name Differin® at a weight concentration of 0.1%, in the form of an "alcoholic lotion" solution, an aqueous gel and a cream. These compositions are intended for treating acne. Patent application FR 2 837 101 describes
20 adapalene compositions at a weight concentration of 0.3%, for treating acne.

Patent application WO 03/055 472 moreover describes stable pharmaceutical compositions comprising adapalene
25 and benzoyl peroxide (BPO).

An article by Korkut and Piskin, J. Dermatology, 2005, **32**: 169-173, reports the results of a study comparing a treatment combining application of adapalene in the
30 evening and application of BPO in the morning, relative to an application of each of the active principles alone. The authors do not observe any superiority of the combined treatment over a period of 11 weeks of treatment.

35 The inventors have now demonstrated, surprisingly, that a therapeutic association or combination of adapalene and BPO can produce a degree of success in reducing the number of acne lesions and an improvement in the

clinical condition of patients that are markedly superior to those of a treatment based on adapalene alone or on BPO alone, while at the same time maintaining the same skin tolerance.

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The recommended treatment may take the form of a pharmaceutical composition combining adapalene and BPO, or a concomitant application of two pharmaceutical compositions, one comprising adapalene and the other comprising BPO.

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One subject of the invention is thus the use of adapalene or a pharmaceutically acceptable salt thereof for the preparation of a pharmaceutical composition, especially at set doses, intended to be administered in combination or in association with benzoyl peroxide (BPO), for the treatment of acne lesions, especially to reduce the number of acne lesions and to improve the clinical condition of patients.

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Preferably, the acne lesions are of inflammatory and/or non-inflammatory type.

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Acne is initially characterized by keratinization disorders, which are sometimes invisible to the naked eye. Visible acne lesions then develop, while the size of the sebaceous glands and the production of sebum increase.

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The present invention specifically concerns acne lesions. The term "acne lesions" means non-inflammatory lesions (open and closed comedones) and inflammatory lesions (papules, pustules, nodules and cysts) caused by acne. Preferably, the inflammatory lesions are treated with the association or the combination according to the invention.

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More preferably, the pharmaceutical composition is administered by daily cutaneous topical application. In

other words, the invention relates to the use of adapalene as an agent for potentiating the action of BPO. Reciprocally, BPO potentiates the action of adapalene.

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The term "adapalene salts" means the salts formed with a pharmaceutically acceptable base, especially mineral bases such as sodium hydroxide, potassium hydroxide and ammonia or organic bases such as lysine, arginine or
10 N-methylglucamine. The term "adapalene salts" also means the salts formed with fatty amines such as dioctylamine and stearylamine.

The expression "*combination* of adapalene or salts
15 thereof with benzoyl peroxide" means a single composition comprising both adapalene or salts thereof and benzoyl peroxide.

According to one preferred embodiment, the
20 pharmaceutical composition is a fixed combination and comprises, in a pharmaceutically acceptable medium, (i) at least one compound chosen from adapalene and pharmaceutically acceptable salts thereof, and (ii) benzoyl peroxide (BPO). Preferably, the
25 pharmaceutical composition is intended for a single topical application per day.

The term "pharmaceutically acceptable medium" means a medium that is compatible with the skin, mucous
30 membranes and the integuments.

The term "fixed combination" should be understood as meaning a combination whose active principles are combined at fixed doses in the same vehicle (single
35 formula) that delivers them together to the point of application. Preferably, the pharmaceutical composition in the form of a fixed combination is a gel; in this case, the two active principles are dispersed and intimately mixed, during the manufacture, in the same

vehicle, which delivers them together during the application of the gel.

In another embodiment of the invention, the pharmaceutical composition is in the form of a composition A comprising adapalene, intended to be applied concomitantly with a composition B comprising BPO. Preferably, composition A and composition B are presented in the form of a kit, preferably comprising two isolated compartments each containing one of the two pharmaceutical compositions A or B (dual pack) and allowing simultaneous administration of the two compositions, or alternatively in the form of a kit combining in the same presentation at least the two products (compositions A and B) in two separate packages, preferably in the form of tubes (co-packaging).

In this case, a person skilled in the art will adapt the formula that is the most appropriate in terms of viscosity, additives, etc. to the chosen kit.

The expression "concomitant" application means that the compositions are intended to be applied to the skin simultaneously or one after the other, in any order, or in a sequential order (for example, in which the application of a pharmaceutical composition B comprising BPO precedes the application of the pharmaceutical composition A comprising adapalene), but within a time interval of less than 1 hour, preferably less than 30 minutes, preferably less than 15 minutes, more preferably less than 5 minutes or even less than 1 minute.

A subject of the invention is thus also a composition in kit form comprising at least two components:

- a first component comprising at least adapalene or a pharmaceutically acceptable salt thereof,
- a second component comprising benzoyl peroxide,

these two components being intended to be applied concomitantly to the skin, mucous membranes and/or the integuments.

- 5 Compositions A and B are preferably intended for a single cutaneous topical application per day.

The treatments have a variable duration, depending on the patient and the severity of his acne. The treatment
10 period may thus run from several weeks to several months. A suitable treatment period is at least two weeks, preferably between 1 and 6 months and more preferably a duration of about 3 months is preferable, the duration of the treatment possibly being prolonged,
15 if necessary.

All the pharmaceutical compositions that are useful in the invention may comprise from 0.01% to 2%, preferably between 0.05% and 0.5% and preferentially between 0.1%
20 and 0.3% of adapalene, and from 0.1% to 20% and preferably from 0.5% to 10% of BPO, more preferably from 2% to 5% of BPO and preferentially 2.5% of BPO.

All the percentages are indicated by weight relative to
25 the total weight of the composition.

The adapalene:BPO ratio is between 1:1 and 1:200 and, conversely, the BPO:adapalene ratio is between 1:1 and 1:200. Preferably, the adapalene:BPO ratio is between
30 1:1 and 1:200 and the adapalene:BPO ratio is preferably 1:25.

Preferably, the effect of the combination of the two active principles is at least an additive effect and
35 preferentially a potentiation or synergistic effect. The terms "potentiation effect" and "synergistic effect" mean a therapeutic effect (degree of success) greater than the effect resulting from the addition of

the effects obtained by each of the two active principles taken separately.

When they are combined in the same pharmaceutical composition, the adapalene and the BPO are present in the pharmaceutical composition in synergistic amounts, i.e. such that a synergistic or potentiation effect on the acne lesions and on the clinical condition of the patient is observed. Preferably, the pharmaceutical composition comprises 0.1% of adapalene and 2.5% of BPO.

When compositions A and B are used separately, the adapalene and the BPO are, respectively, present in composition A and composition B in synergistic amounts, i.e. such that a synergistic or potentiation effect on the acne lesions and on the clinical condition of the patient is observed, especially when the compositions are applied in association in equal amounts. Preferably, composition A comprises 0.1% of adapalene and composition B comprises 2.5% of BPO.

In this regard, the examples demonstrate that thanks to the synergistic effect of adapalene and BPO, the invention provides greater efficacy for the treatment of acne in general and of acne lesions in particular and a quicker onset of action relative to monotherapies.

The pharmaceutical compositions that are useful according to the invention may be in the form of ointments, emulsions preferably in the form of creams, milks or pomades; powders, impregnated pads, solutions, gels, sprays, lotions or suspensions. They may also be in the form of suspensions of microspheres or nanospheres or of lipid or polymer vesicles or of polymer patches and/or of hydrogels allowing controlled release. These compositions may be in anhydrous form, in aqueous form or in the form of an emulsion.

In one preferred embodiment of the invention, the pharmaceutical compositions are in the form of a gel, a cream or a solution referred to as a lotion.

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Preferably, the pharmaceutical compositions combining adapalene and BPO, or the pharmaceutical compositions A and/or B, are gels.

10 The pharmaceutical compositions that are useful in the invention may contain inert additives or combinations of these additives, such as:

- wetting agents;
- texture enhancers;
- 15 - preserving agents such as para-hydroxybenzoic acid esters;
- stabilizers;
- humidity regulators;
- pH regulators;
- 20 - osmotic pressure modifiers;
- emulsifiers;
- UV-A and UV-B screening agents; and
- antioxidants, such as α -tocopherol, butylhydroxyanisole or butylhydroxytoluene, superoxide dismutase,
- 25 ubiquinol, or certain metal-chelating agents.

Needless to say, a person skilled in the art will take care to select the optional compound(s) to be added to these compositions such that the advantageous
30 properties intrinsically associated with the present invention are not, or are not substantially, adversely affected by the envisaged addition.

According to one particular embodiment, the
35 pharmaceutical composition A comprising adapalene may be an aqueous gel especially containing one or more ingredients chosen from the carbomer 940 (BF Goodrich Carbopol 980) and propylene glycol, or a cream especially containing one or more ingredients chosen

from perhydrosqualene, cyclomethicone, PEG-20 methylglucose sesquistearate and methylglucose sesquistearate or an "alcoholic lotion" solution based on polyethylene glycol.

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Useful pharmaceutical compositions, comprising adapalene and BPO, are moreover described in patent application WO 03/055 472. Examples of such compositions comprise, besides the active principles

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adapalene and BPO:

- from 5% to 25% of water;
- from 0 to 10%, preferably from 0 to 2% and preferably less than 0.5% of liquid wetting surfactant;
- 15 - from 0 to 10% of pro-penetrating agent; and
- an aqueous phase comprising a pH-independent gelling agent.

According to one preferred mode, the preferred

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pharmaceutical composition, comprising adapalene and BPO, is an aqueous gel having the following formulation:

- 2.5% of BPO;
- 0.1% of adapalene;
- 25 - 0.10% of disodium EDTA;
- 4.00% of glycerol;
- 4.00% of propylene glycol;
- and also, preferably:
- 0.05% of sodium docusate;
- 30 - 0.20% of poloxamer 124;
- 4.00% of sodium acryloyldimethyltaurate copolymer and isohexadecane and polysorbate 80;
- NaOH, in an amount sufficient to obtain a pH of 5.

35 The acne targeted comprises all forms of acne, including common acne, comedones, polymorphs, nodulocystic acne, acne conglobata, and secondary acne such as solar, medicational or occupational acne. The acne may in particular be of mild to severe intensity

and preferably of mild to moderate intensity. The composition according to the invention may be administered as a firstline treatment, and also after failure of other specific treatments including the
5 administration of adapalene and/or of BPO according to the conditions described by Korkut et al.

The association or combination of adapalene and of BPO makes it possible to reduce not only the number of
10 inflammatory acne lesions but also the non-inflammatory acne lesions and to observe an improvement in the patient's clinical condition. A potentiation or synergistic effect is observed. This potentiation effect described in the example is shown in the reduced
15 number of lesions and in the percentage of cured patients (clear) and almost cured patients (almost clear) by the size of the superiority of the combination at fixed doses of adapalene and of BPO, relative to the active substances taken individually at
20 the same doses as the combination.

Moreover, the results of the potentiation effect of the combination of adapalene and BPO presented in the example are statistically different from the results
25 obtained for the active substances taken individually.

The combination or association of adapalene and of BPO is thus particularly useful for reducing the number of inflammatory and/or non-inflammatory acne lesions.
30 Preferably, the reduction is at least about 40%, preferably at least about 50% and more preferably the reduction is at least about 60%. Similarly, it is demonstrated in the example that the reduction of the total lesions is from about 35% to 80% and preferably
35 from about 50% to 70%.

According to another aspect, the invention also relates to a pharmaceutical assembly (product) comprising:

- i) a container delimiting at least one compartment, the said container being closed by means of a closing member; and
- 5 ii) a pharmaceutical composition comprising adapalene or a pharmaceutically acceptable salt thereof and benzoyl peroxide as described above, and placed inside the said compartment.

10 The container may be in any suitable form. It may especially be in the form of a bottle, a tube, a jar, a case, a can, a sachet or a box.

Preferably, the container comprises two compartments,
15 and each of these compartments comprises either composition A or composition B.

The closing member may be in the form of a removable stopper, a lid, a cover, a tear-off strip or a cap,
20 especially of the type comprising a body fixed to the container and a cap articulated on the body. It may also be in the form of a member ensuring the selective closure of the container, especially a pump, a valve or a clapper.

25 The closing member may be coupled to the container by screwing. Alternatively, the coupling between the closing member and the container may take place other than by screwing, especially via a bayonet mechanism,
30 by click-fastening, gripping, welding, bonding or magnetic attraction. The term "click-fastening" in particular means any system involving the passing of a rim or bead of material by elastic deformation of a portion, especially of the closing member, followed by
35 return to the elastically unstressed position of the said portion after the rim or bead has been passed.

The container may be at least partly made of thermoplastic material. Examples of thermoplastic

materials that may be mentioned include polypropylene and polyethylene.

Alternatively, the container is made of a non-thermoplastic material, especially of glass or metal (or alloy).

The container may have rigid walls or deformable walls, especially in the form of a tube or a tube bottle.

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The container may comprise means for causing or facilitating the distribution of the composition. By way of example, the container may have deformable walls so as to make the composition come out in response to a positive pressure inside the container, this positive pressure being caused by elastic (or non-elastic) squeezing of the walls of the container. Alternatively, especially when the product is in the form of a stick, this stick may be driven by a piston mechanism. Still in the case of a stick, especially of makeup product, the container may comprise a mechanism, especially a wishbone mechanism, or a mechanism with a threaded stem, or with a helical ramp, which is capable of moving a stick in the direction of the said opening. Such a mechanism is described, for example, in patent FR 2 806 273 or in patent FR 2 775 566. Such a mechanism for a liquid product is described in patent FR 2 727 609.

30 The example that follows illustrates the invention without limiting its scope.

EXAMPLES:

Example 1: Clinical study results

35 A clinical study for confirmation of efficacy was performed for a topical gel combining adapalene + benzoyl peroxide (BPO).

This gel has the following formulation (expressed as % weight/total weight):

Adapalene	0.10%
Benzoyl peroxide	2.50%
Copolymer of acrylamide & sodium acryloyl- dimethyltaurate	4.00%
Sodium docusate	0.05%
Disodium EDTA	0.10%
Glycerol	4.00%
Poloxamer 124	0.20%
Propylene glycol	4.00%
Purified water	qs 100%

5 **Protocol:**

The clinical study was a multi-centre, randomized, double-blind study in parallel groups, to evaluate the tolerance and the efficacy of the above formulation, in comparison with its own individual active substances placed at the same doses in gels of the same formula as that of the fixed combination (individual formulae referred to as "monads") and in comparison with the gel vehicle (placebo formula):

15 adapalene gel (0.1%), BPO gel (2.5%) and vehicle gel.

All the treatments were applied once a day for 12 weeks, to 517 patients suffering from acne.

20 The main efficacy criteria were:

- the degree of success, defined as the percentage of patients considered as being "clear", i.e. the patient has no more acne lesions (neither comedones nor inflammatory lesions), reflecting an improvement in the patient's clinical condition, or "almost clear" on the evaluation scale;
- the reduction of the percentage of inflammatory and non-inflammatory lesions after 12 weeks of treatment.

Results:

The results are presented in the table that follows.

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Efficacy in week 12 ITT*				
	Adapalene 0.1% + BPO 2.5% N=149	Adapalene 0.1% alone N=148	BPO 2.5% alone N=149	Vehicle (gel) N=71
Degree of success (see figure 4)	27.5%	15.5%	15.4%	9.9%
Progress of the lesions (median percentages)				
Number of inflammatory lesions (see figure 2)	-62.8%	-45.7%	-43.6%	-37.8%
Number of non- inflammatory lesions (see figure 3)	-51.2%	-33.3%	-36.4%	-37.5%
Total number of lesions (see figure 1)	-51.0%	-35.4%	-35.6%	-31.0%
Progress of the lesions (as median absolute numbers)				
Number of inflammatory lesions	-17	-13.0	-13.0	-11.0
Number of non- inflammatory lesions	-22.0	-17.0	-16.0	-14.0
Total number of lesions	-40.0	-29.0	-27	-26.0

ITT* (analysis of intention to treat): all the patients randomized in a clinical test because they come under the indication selected for the treatment to be prescribed. The missing data are imputed by the last observation (LOCF method ** (Last Observation Carried Forward)).

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1) For the 4 main criteria of the study: degree of success and progress as a percentage of the three types of lesion, the fixed combination was found to be statistically superior to the two monads and to the vehicle.

2) When the effect of the gel used as vehicle (V) is subtracted from the effect of the fixed combination (C), the net clinical benefit of the fixed combination (C-V) is numerically superior to the sum of the net clinical benefits of each of the individual substances after subtraction of the vehicle effect from the adapalene (A) and BPO (B) branches, respectively, according to the equation:

$$(C-V) > (A-V) + (B-V).$$

These results systematically show a potentiation effect since the net benefit is in favour of the gel combining adapalene + BPO, with results, in terms of degree of success, that are superior to the addition of adapalene and BPO (28% for the combination, as opposed to 16%, 15% and 10% for adapalene, BPO and vehicle, respectively). In this case, the above equation shows $(28-10) > (16-10) + (15-10)$, i.e. $18 > 11$, which is true.

Similarly, the gel combining adapalene + BPO was numerically superior in terms of efficacy in comparison with the individual active substances and with the vehicle as regards the reduction in the number of all the lesions (reduction in the percentage of inflammatory and non-inflammatory lesions).

A potentiation effect of adapalene and BPO together is thus noted, since a 51% reduction in lesions is observed for the combination, as opposed to 35% for adapalene alone, 36% for BPO alone and 31% for the vehicle, which is expressed as a net benefit of efficacy with the above equation by $(51-31) > (35-31) + (36-31)$, i.e. $20 > 9$, which is true.

Example 2: Evaluation of the anti-inflammatory in ear oedema model on Balb/c mice

The study was carried out with 45 (5 par groups) female 9 weeks aged Balb/c ByJIC mice.

The Edema was induced by a single application of 20µl of TPA dissolved in acetone at 0.01%.

The treatment was administrated by single topical application of tested compounds dissolved in TPA at 0.01% (groups 3,4,5,6 and 7) and dissolved in TPA 0.01% + BPO (groups 8, 9 and 10).

The treatments activity was measured by inflammation evaluation with ear thickness at T+6hours.

The results are presented in the following table and in figure 5.

	Ear edema		Inhibition vs TPA (%)	Repeated Annova Testing vs TPA alone (Dose balanced)	Repeated Annova Testing vs TPA +BPO (Dose balanced)
	Mean	sem			
Acetone					
TPA 0.01%	26.80	3.35			
TPA 0,01 + CD153 0,01% (controle)	2.20	0.37	91.8		
TPA 0,01%+BPO at 2,5%	22.40	2.23	16.4	0.042	
TPA 0,01%+BPO at 5%	20.40	2.62	23.9		
TPA 0,01%+BPO at 10%	16.20	4.03	39.6		
TPA 0,01%+Adapalene at 0,1%	23.40	2.01	12.7		0.0015
TPA 0,01%+Adapalene at 0,1%+BPO at 2,5%	14.00	2.51	47.8		
TPA 0,01%+Adapalene at 0,1%+BPO at 5%	10.00	2.26	62.7		
TPA 0.01%+Adapalene at 0.1%+BPO at 10%	11.00	3.03	59.0		

Conclusion:

After a single topical application of the positive control CD0153 (0.01%) diluted in TPA solution, we observed a decrease of 92 % of the ear thickness.

BPO at 2.5%, 5% and 10% has a slight anti-inflammatory effect, reducing the TPA-induced ear edema respectively by 16%, 24 % and 40%, with a statistically significant dose balanced effect (0.042).

Adapalene alone has a low anti-inflammatory effect, reducing the TPA-induced ear edema by 13%.

Variation of concentration of BPO was measured in combination with adapalene. Therefore, combinations of

BPO at 2.5%, 5% and 10% with Adapalene at 0.1% reduce the TPA-induced ear edema respectively by 48%, 63% and 59%. Combination treatment is statistically more efficient than BPO alone (0.0015) even though the dose effect of the latest group is non-significant regarding the TPA alone group (0.1089).

Adapalene at 0.1% increase the anti-inflammatory effect obtained with BPO whatever tested doses.

Lower doses of BPO will be used to attempt to show a dose related effect for the association.

These results show a potential synergistic anti-inflammatory effect of the combination compared to the compounds singly applied.

Claims

1. Use of adapalene or a pharmaceutically acceptable salt thereof for the preparation of a pharmaceutical composition intended to be administered in combination with benzoyl peroxide to reduce the number of acne lesions, wherein the pharmaceutical composition is a fixed combination comprising, in a pharmaceutically acceptable medium, (i) at least one compound chosen from adapalene and pharmaceutically acceptable salts thereof, and (ii) benzoyl peroxide.
2. Use according to Claim 1, in which the acne lesions are of inflammatory and/or noninflammatory type.
3. Use according to Claim 2, in which the reduction of the number of inflammatory and/or noninflammatory acne lesions is at least about 40%, preferably at least about 50% and more preferably at least about 60%.
4. Use according to any one of the preceding Claims, in which the adapalene and the benzoyl peroxide are present in the pharmaceutical composition in synergistic amounts.
5. Use according to any one of the preceding Claims, in which the pharmaceutical composition comprises 0.1% of adapalene and 2.5% of benzoyl peroxide.
6. Use according to any one of the preceding Claims, in which the pharmaceutical composition is a gel.

7. Use according to any one of the preceding Claims, in which the pharmaceutical composition is adapted for topical application.
8. Use according to one of Claims 2 to 7, in which the pharmaceutical composition is intended for reducing the number of inflammatory acne lesions.
9. Use according to one of Claims 2 to 7, in which the pharmaceutical composition is intended for reducing the number of non-inflammatory acne lesions.
10. Use of adapalene or a pharmaceutically acceptable salt thereof as agent for potentiating the action of benzoyl peroxide.
11. Product comprising:
 - (i) a container delimiting at least one compartment, the said container being closed by means of a closing member; and
 - (ii) a pharmaceutical composition comprising adapalene or a pharmaceutically acceptable salt thereof and benzoyl peroxide, placed inside the said compartment.