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CA 2794734 C 2017/12/12

(11)(21) 2 794 734

(12) BREVET CANADIEN
CANADIAN PATENT

(13) C

(86) Date de dépôt PCT/PCT Filing Date: 2011/03/30
(87) Date publication PCT/PCT Publication Date: 2011/10/06
(45) Date de délivrance/Issue Date: 2017/12/12
(85) Entrée phase nationale/National Entry: 2012/09/27
(86) N° demande PCT/PCT Application No.: AU 2011/000358
(87) N° publication PCT/PCT Publication No.: 2011/120084
(30) Priorités/Priorities: 2010/03/30 (US61/319,007);
2010/03/30 (US61/319,002)

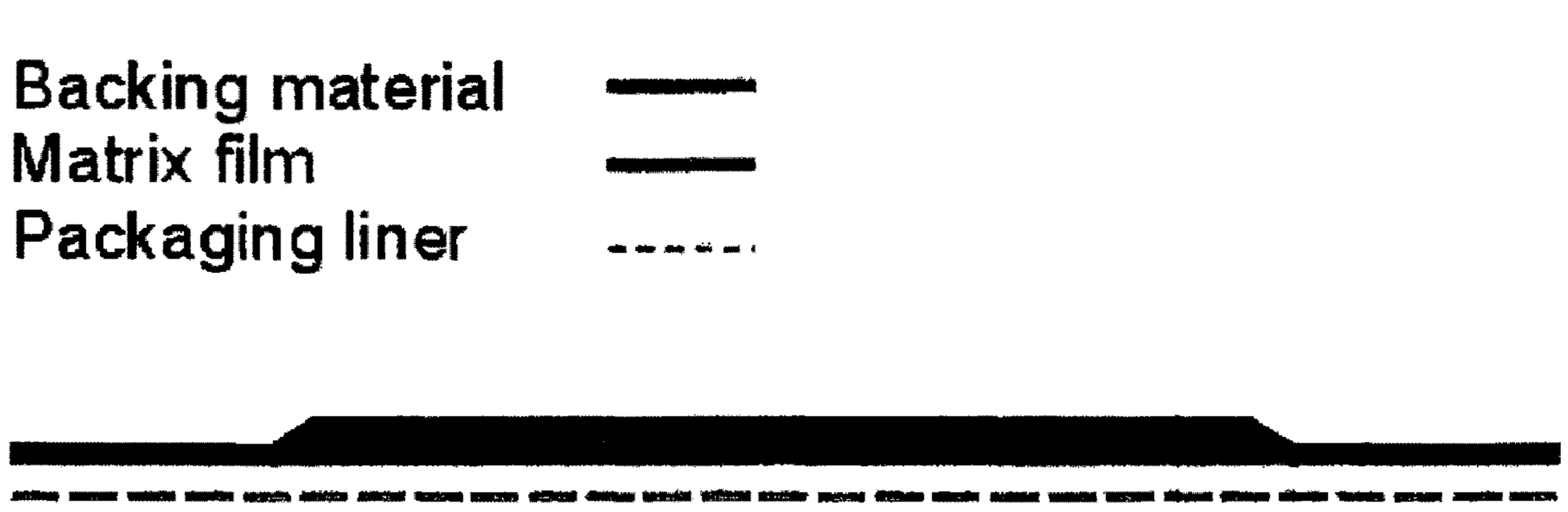
(51) Cl.Int./Int.Cl. *A61K 47/06* (2006.01),
A61F 13/02 (2006.01), *A61K 31/00* (2006.01),
A61K 9/70 (2006.01), *A61P 25/04* (2006.01),
A61P 3/10 (2006.01)

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(54) Titre : TIMBRE TRANSDERMIQUE
(54) Title: TRANSDERMAL DELIVERY PATCH



(57) Abrégé/Abstract:
A composition suitable for use in a transdermal delivery patch for administration of a biologically active compound, the composition comprising a phosphate compound of tocopherol and a polymer carrier.

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
6 October 2011 (06.10.2011)

PCT

(10) International Publication Number
WO 2011/120084 A1

(51) International Patent Classification:
A61K 47/06 (2006.01) *A61P 25/04* (2006.01)
A61K 9/70 (2006.01) *A61P 3/10* (2006.01)
A61K 31/00 (2006.01) *A61F 13/02* (2006.01)

(21) International Application Number:
PCT/AU2011/000358

(22) International Filing Date:
30 March 2011 (30.03.2011)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/319,002 30 March 2010 (30.03.2010) US
61/319,007 30 March 2010 (30.03.2010) US

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

WO 2011/120084 A1

(54) **Title**: TRANSDERMAL DELIVERY PATCH

(57) **Abstract**: A composition suitable for use in a transdermal delivery patch for administration of a biologically active compound, the composition comprising a phosphate compound of tocopherol and a polymer carrier.

PCT/AU2011/000358
Received 11/05/2012

TRANSDERMAL DELIVERY PATCH

TECHNICAL FIELD

The present invention relates to a composition suitable for use in a transdermal delivery patch for administration of a biologically active compound, and a transdermal delivery patch comprising the composition, or matrix layer.

BACKGROUND

In this specification where a document, act or item of knowledge is referred to or discussed, this reference or discussion is not an admission that the document, act or item of knowledge or any combination thereof was at the priority date, publicly available, known to the public, part of common general knowledge; or known to be relevant to an attempt to solve any problem with which this specification is concerned.

Drug delivery is the method or process of administering a pharmaceutical compound to achieve a therapeutic effect in humans and animals.

Drug delivery technologies have been developed to improve bioavailability, safety, duration, onset or release, of the pharmaceutical compound.

When developing drug delivery technologies, problems likely to be encountered include compatibility of the drug delivery system and the pharmaceutical compound, maintaining an adequate and effective duration, potential for side effects, and meeting patient convenience and compliance. As a consequence, many drug delivery technologies fall short of desired improvements and requirements.

Accordingly, there is still a need for alternate delivery systems that effectively deliver drugs and other biologically active compounds.

SUMMARY

The present invention relates to a composition suitable for use in a transdermal delivery patch for administration of a biologically active compound, and a transdermal delivery patch comprising the composition, or matrix layer.

Accordingly, a first aspect of the present invention provides a matrix layer for use in a transdermal delivery patch for administration of a biologically active compound, the matrix layer comprising a mixture of a mono-tocopheryl phosphate compound and a di-tocopheryl phosphate compound and a polymer carrier wherein the polymer carrier is present in an amount within the range of about 30%w/w to about 95%w/w.

The present invention also provides use of the composition, or matrix layer, in a transdermal delivery patch for administration of a biologically active compound.

It has surprisingly been found that biologically active compounds can be effectively administered using a transdermal delivery patch.

A second aspect of the present invention provides a transdermal delivery patch for administration of a biologically active compound comprising the composition, or matrix layer. The composition, or matrix layer, may be a solid or semi-solid layer. The transdermal delivery patch may comprise further layers.

A third aspect of the present invention provides a method for preparing a transdermal delivery patch for administration of a biologically active compound comprising the steps of:

(i) combining a polymer carrier and optional inert carrier components with a suitable solvent;

(ii) combining (i) with a dispersion comprising a biologically active compound and a mixture of a mono-tocopheryl phosphate compound and a di-tocopheryl phosphate compound;

(iii) stirring (ii) until complete homogenisation is achieved;

(iv) placing the composition of (iii) in a suitable mould or casting the composition of (iii) on a surface;

(v) drying the composition under heat.

In accordance with an aspect of the present invention, there is provided a matrix layer for use in a transdermal delivery patch for administration of a biologically active compound, the matrix layer comprising a mixture of a mono-tocopheryl phosphate compound and a di-tocopheryl phosphate compound and a polymer carrier wherein the polymer carrier is present in an amount within the range of about 30%w/w to about 95%w/w of the total concentration of the matrix layer.

In accordance with a further aspect of the present invention, there is provided a method for preparing a matrix layer for use in a transdermal delivery patch for administration of a biologically active compound comprising the steps of:

(i) combining a polymer carrier and optional inert carrier components with a suitable solvent;

(ii) combining (i) with a dispersion comprising a biologically active compound and a mixture of a mono-tocopheryl phosphate compound and a di-tocopheryl phosphate compound;

(iii) stirring (ii) until complete homogenisation is achieved;

(iv) placing the composition of (iii) in a suitable mould or casting the composition of (iii) on a surface; and

(v) drying the composition under heat;

wherein the polymer carrier is present in an amount within the range of about 30%w/w to about 95%w/w of the total concentration of the matrix layer.

FIGURES

The examples will be described with reference to the accompanying figures in which:

Figure 1 is a schematic diagram of a transdermal delivery patch of one embodiment of the present invention;

Figure 2 is a graph comparing the delivery of oxycodone using a transdermal delivery patches of the present invention prepared with different drying regimes;

Figure 3 is a graph comparing the delivery of oxycodone using transdermal delivery patches of the present invention prepared with and without a glue layer;

Figure 4 is a graph comparing the delivery of oxycodone using transdermal delivery patches of the present invention prepared with and without an occlusive backing layer;

Figure 5 is a graph showing the results of pharmacokinetic testing conducted after application of transdermal delivery patches of the present invention;

Figure 6 is a graph showing the results of pharmacodynamic testing conducted after application of transdermal delivery patches of the present invention;

Figure 7 is a graph comparing the delivery of oxycodone using transdermal delivery patches of the present invention comprising different plasticisers;

Figure 8 is a graph comparing the delivery of oxycodone using transdermal delivery patches of the present invention comprising different plasticisers and polymer carriers;

Figure 9 is a graph showing the average change in blood glucose after application of transdermal delivery patches of the present invention to each of the animals;

Figure 10 is a graph showing the area under the curve of the graph of Figure 9;

Figures 11 and 12 are graphs comparing the deposition in skin of two diclofenac transdermal delivery patches; and

Figure 13 is a graph comparing the permeation of two lidocaine transdermal delivery patches.

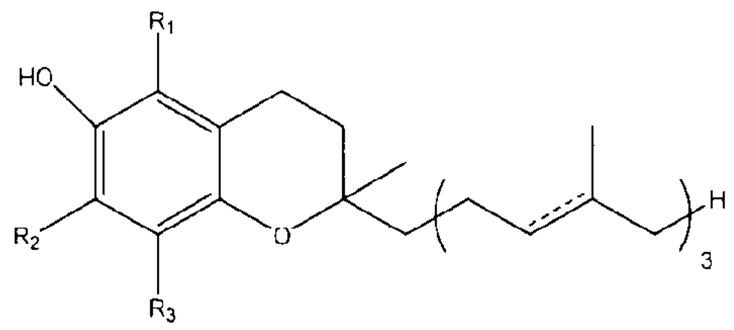
DETAILED DESCRIPTION

The present invention relates to a composition suitable for use in a transdermal delivery patch for administration of a biologically active compound, the composition comprising a phosphate compound of tocopherol and a polymer carrier. The composition, or matrix layer, may form part of a transdermal delivery matrix patch. It has been surprisingly found that a transdermal delivery patch comprising this composition, or matrix layer, can effectively administer biologically active compounds.

Tocopheryl phosphate compound

The composition, or matrix layer, comprises a mixture of a mono-tocopheryl phosphate compound and a di-tocopheryl phosphate compound.

Vitamin E exists in eight different forms, namely four tocopherols and four tocotrienols. All feature a chroman ring, with a hydroxyl group that can donate a hydrogen atom to reduce free radicals and a hydrophobic side chain which allows for penetration into biological membranes. Such derivatives of vitamin E may be classified as “hydroxy chromans”. Both tocopherols and tocotrienols occur in alpha, beta, gamma and delta forms, determined by the number and location of methyl groups on the chroman ring. The tocotrienols differ from the analogous tocopherols by the presence of three double bonds in the hydrophobic side chain. The various forms of vitamin E are shown by Formula (I):



(I)

	R_1	R_2	R_3
α-tocopherol α-tocotrienol	CH_3	CH_3	CH_3
β-tocopherol β-tocotrienol	CH_3	H	CH_3
γ-tocopherol γ-tocotrienol	H	CH_3	CH_3
δ-tocopherol δ-tocotrienol	H	H	CH_3

In the present invention, tocopherol in any of the four forms may be used. The alpha form of tocopherol is preferred.

PCT/AU2011/000358
Received 11/05/2012

The term "phosphate compound" refers to phosphorylated tocopherol, where a covalent bond is formed between an oxygen atom (typically originating from a hydroxyl group) of the tocopherol compound and the phosphorous atom of a phosphate group (PO_4).

The phosphate compound may be a phosphate mono-ester, phosphate di-ester, phosphate tri-ester, pyrophosphate mono-ester, pyrophosphate di-ester, or a salt or derivative thereof, or a combination thereof. The di- and tri-esters may comprise the same tocopherol form or different tocopherol forms.

The "salts" include metal salts such as alkali or alkaline earth metal salts, for example sodium, magnesium, potassium and calcium salts. Sodium and potassium salts are preferred.

The "derivatives" include phosphate compounds where one or more phosphate protons are replaced by a substituent. Some non-limiting examples of derivatives include phosphatidyl derivatives where a phosphate proton is substituted with an amino-alkyl group, sugar derivatives where a phosphate proton is substituted with a sugar such as glucose.

The term "amino-alkyl group" refers to a group comprising an amino ($-NH_2$) group and an alkyl group. The term "alkyl" refers to straight chain, branched chain or cyclic hydrocarbon groups having from 1 to 8 carbon atoms. Examples include methyl, ethyl, propyl, isopropyl, butyl, isobutyl, sec-butyl, tert-butyl, pentyl, hexyl, cyclohexyl, heptyl, and octyl. Phosphatidyl choline derivatives are most preferred.

The mono-tocopheryl phosphate compound may be selected from the group consisting of mono-(tocopheryl) phosphate, mono-(tocopheryl) phosphate monosodium salt, mono-(tocopheryl) phosphate disodium salt, mono-(tocopheryl) phosphate monopotassium salt and mono-(tocopheryl) phosphate dipotassium salt, and the di-tocopheryl phosphate compound may be selected from the group consisting of di-(tocopheryl) phosphate, di-(tocopheryl) phosphate monosodium salt and di-(tocopheryl) phosphate monopotassium salt. These phosphate compounds may be derived from the alpha, beta, gamma or delta form of tocopherol, or a combination thereof.

When a combination of a mono-phosphate ester and a di-phosphate ester, that is a mono-(tocopheryl) phosphate and di-(tocopheryl) phosphate (which may in some instances herein be referred to as tocopheryl phosphate mixture or simply "TPM"), the ratio (%w/w) is at least 2:1, within a range of about 4:1 to about 1:4, within a range of about 6:4 to about 8:2. The ratio may be about 2:1, about 6:4, or about 8:2.

The mixture of the mono-tocopheryl phosphate compound and the di-tocopheryl phosphate compound may be present in an amount within a range of about 0.01%w/w to about 10%w/w, within the range of about 0.1%w/w to about 5%w/w, within the range of about 0.1%w/w to about 3%w/w, within the range of about 0.1%w/w to about 2%w/w, within the range of about 0.1%w/w to about 1%w/w or within the range of about 0.1%w/w to about 0.5%w/w, of the total concentration of the composition, or matrix layer. In some embodiments, the mixture of the mono-tocopheryl phosphate compound and the di-tocopheryl phosphate compound may be present in an amount within a range of about 0.5%w/w to about 1.5%w/w, or in an amount of about 0.1%w/w, of the total concentration of the composition, or matrix layer.

Polymer carrier

The composition, or matrix layer, also comprises a polymer carrier.

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The polymer carrier may comprise natural and synthetic polymers, co-polymers, or terpolymers.

Natural polymers include rubbers, elastomers, polysaccharides such as cellulose, natural resins such as shellac and amber.

Synthetic polymers include, for example, acrylates, polyacrylates, polyalkyl acrylates, polyamides, polyesters, polycarbonates, polyimides, polystyrenes, acrylonitrile butadiene styrene, polyacrylonitrile, polybutadiene, poly(butylene terephthalate), poly(ether sulphone), poly(ether)ketones, polyethylene, poly(ethylene glycol), poly(ethylene terphthalate), polypropylene, polytetratfluroethylene, styrene-acrylonitrile resin, poly(trimethylene terephthalate), polyurethanes, polyvinyl butyral, polyvinylchlorides, polyvinylidenedifluoride, povidones, poly(vinyl pyrrolidone), polychloroprene, fluoroelastomers, chloro-sulphonated rubbers, hypromellose, polyolefine elastomer, polyacrylamide, chlorinated polyethylene, polyethersulphone, nylon, liquid crystal polymers, polyethylene terephthalate (PET), polyphenylsulphone, polypthalaminepolyvinyl alcohol derivatives, poly ethylene glycols, ethylene vinyl acetate, polymethyl methacrylate, cellulose derivatives such as ethyl cellulose, hydroxyl propyl methyl cellulose, sugar derivatives (gums) including derivatives of sorbitol and mannitol, silicone oil and silicone oil derivatives, polysiloxanes including amine-resistant polysiloxanes, and siloxanes.

Preferred polymer carriers suitable for use in the composition, or matrix layer, of the present invention include acrylates, povidones and siloxanes. Particularly preferred polymer carriers include polyvinyl pyrrolidone (e.g. PVP K90, MW 360,000Da), polysiloxanes, polyalkyl acrylates (e.g. DuroTak) and polymethyl methacrylate (e.g. Eudragit E100). In one embodiment, the polymer carrier is polyvinyl pyrrolidone. In an alternate embodiment, the polymer carrier is polymethyl methacrylate.

The polymer carrier used in the composition, or matrix layer, may have sufficient tackiness to enable the transdermal delivery patch to adhere to skin. For instance, amine-resistant polysiloxanes and combinations thereof can be used in the composition, or matrix layer. A combination of a polysiloxane of medium tack and a polysiloxane of high tack is used would be most suitable. The polysiloxanes may be synthesized from linear bifunctional and branched polyfunctional oligomers. It has been found that the ratio of both types of oligomers determines the physical properties of the polymers. More polyfunctional oligomers result in a more cross-linked polymer with a higher cohesion and a reduced tack, less polyfunctional oligomers result in a higher tack and a reduced cohesion. A high tack version should be tacky enough for the transdermal delivery patch to adhere to the surface of skin. A medium tack version, on the other hand, may not be tacky at all but could be useful by providing a softening effect to other components included in the composition, or matrix layer. To increase the adhesive power of the composition, or matrix layer, a silicone oil (e.g. dimethicone) could be added.

The polymer carrier may be present in an amount within the range of about 30%w/w to about 95%w/w, within the range of about 30%w/w to about 80%w/w, or within the range of about 55%w/w to about 65%w/w, of the total weight of the composition, or matrix layer.

The polymer carrier may also comprise inert carrier components, such as for example, anti-tacking agents, tackifiers, and plasticizers to achieve appropriate softness, flexibility and "tackiness" for the polymer carrier to enable the composition, or matrix layer, to adhere to the surface of skin, and thus provide consistent delivery.

For polymers which are naturally "tacky" and may need anti-tackiness to have an appropriate consistency, anti-tacking agents that are solid with no stickiness property (i.e. low ability to retain solvents upon drying) and that can be mixed well (i.e. do not crystallise upon drying) with the polymer carrier may be suitable. The selection would be based on the polymer-type. Many surfactants are suitable for use as an anti-tacking agent with a polymer carrier. A more specific example of an anti-tacking agent is succinic acid. In specific embodiments, the anti-tacking agent may be present in an amount or less than 1%w/w, up to about 1%w/w, or up to about 5%w/w, of the total weight of the composition, or matrix layer.

In order to enhance the ability of the composition, or matrix layer, to adhere to the surface of skin, it may optionally contain a tackifier (or tacking agent). Tack can be controlled by combining adhesives of varying hardnesses (glass temperature or T_g). Typically, a tackifier is a polymer which is insoluble in water and composed of a monomer which contains partly or wholly a (meth)acrylic alkyl ester. Such types of polymers include, but are not limited to, acrylic, N-butyl-methacrylic copolymer (Primal™ N580NF, sold by Japan Acrylic Chemical Company, Ltd.), acrylic methyl, acrylic 2-ethylhexyl copolymer (Nikasol™ TS-6520, sold by Nippon Carbide Industries Company, Ltd), polyacrylic acid (Jurymer™ AC-IOLPH, sold by Nihon Junyaku Company, Ltd), methacrylic copolymer L (Plastoid™ L50, sold by Rohm Pharma GmbH), and aminoalkylmethacrylate copolymer E (Plastoid™ E35L, Plastoid™ E35M, Plastoid™ E35H, all sold by Rohm Pharma GmbH). Other non-limiting examples include rosin esters, hydrogenated rosins, dipropylene glycol dibenzoate, and/or mixed hydrocarbons, and acrylic copolymers (e.g. Flexbond™ 150 adhesive by Air Products).

Plasticizers are additives that increase the plasticity or fluidity of the material to which they are added. Plasticizers may be used in the present invention to soften the final product increasing its flexibility and making it less brittle. Suitable plasticizers include phthalates, esters of polycarboxylic acids with linear or branched aliphatic alcohols of moderate chain length, acetylated monoglycerides, alkyl citrates, triethyl citrate (TEC), acetyl triethyl citrate (ATEC), tributyl citrate (TBC), acetyl tributyl citrate (ATBC), trioctyl citrate (TOC), acetyl trioctyl citrate (ATOC), trihexyl citrate (THC), acetyl trihexyl citrate (ATHC), butyryl trihexyl citrate (BTHC, trihexyl o-butyryl citrate), trimethyl citrate (TMC), methyl laurate, lauric acid, lauryl lactate, lauryl alcohol, alkyl sulphonic acid phenyl ester, diethylene glycol monoethyl ether, bis(2-ethylhexyl) phthalate (DEHP), diisooctyl phthalate (DIOP), bis(n-butyl)phthalate (DnBP, DBP), diisobutyl phthalate (DIBP), bis(2-ethylhexyl)adipate (DEHA), dimethyl adipate (DMAD), monomethyl adipate (MMAD), dioctyl adipate (DOA), ethyl oleate, sorbitan monooleate, glycerol monooleate, dibutyl sebacate (DBS), dibutyl maleate (DBM), diisobutyl maleate (DIBM), benzoates, epoxidized vegetable oils, tris(tromethamine), N-ethyl toluene sulfonamide (o/p ETSA), N-(2-hydroxypropyl) benzene sulfonamide (HP BSA), N-(n-butyl) benzene sulfonamide (BBSA-NBBS), tricresyl phosphate (TCP), tributyl phosphate (TBP), triethylene glycol dihexanoate (3G6, 3GH), tetraethylene glycol diheptanoate (4G7), 1,3-butyleneglycol, dipropylene glycol, PEG400, Span 80, and polyvinylpyrrolidone. Dibutyl sebacate (DBS), sorbitan monooleate, methyl laurate and lauric acid are preferred plasticizers.

Inert carrier components may be present in an amount within the range of about 0.001%w/w to about 50%w/w, within the range of about 0.001%w/w to about 40%w/w, within the range of about 0.001%w/w to about 30%w/w, of the total weight of the composition, or matrix layer. In one

embodiment, the composition, or matrix layer comprises an anti-tacking agent (such as succinic acid) and a plasticizer (such as dibutyl sebacate) in a total amount of about 35%w/w of the total weight of the composition, or matrix layer.

The amount of polymer carrier and optional inert carrier components present in the composition, or matrix layer will depend on the specific biologically active compound to be administered. Generally, however, these components may be present in an amount within the range of about 50%w/w to about 99%w/w, within the range of about 80%w/w to about 98%w/w, within the range of about 90%w/w to about 98%w/w, of the total weight of the composition, or matrix layer. In one embodiment, the composition, or matrix layer, comprises these components in the amount of about 95%w/w of the total weight of the composition, or matrix layer.

It should be noted that, in some instances herein, the term "polymer carrier" could be used collectively to refer to the polymer carrier and the inert carrier components.

The composition, or matrix layer, may also optionally further comprise one or more excipients (in addition to the inert carrier components discussed above).

A person skilled in the art of the invention would appreciate what are suitable excipients for inclusion in the composition, or matrix layer, of the invention. Some examples include, but are not limited to, solvents, thickeners or gelling agents, preservatives, surfactants, stabilizers, buffers, emollients, colours, fragrances, and appearance modifiers. It will be appreciated that any excipients which have been approved for use in pharmaceutical products by the regulatory bodies may be employed in the composition, or matrix layer, of the present invention. The amount of a particular excipient or excipients to be used in a composition, or matrix layer, of the present invention would also be appreciated by a person skilled in the art.

Biologically active compounds

The composition, or matrix layer, may form part of a transdermal delivery matrix patch. It has been surprisingly found that a transdermal delivery patch comprising this composition, or matrix layer, can effectively administer biologically active compounds.

The term "biologically active compound" refers to any chemical substance that has a biological effect in humans or animals for medical, therapeutic, cosmetic and veterinary purposes, and encompasses pharmaceuticals including drugs, cosmeceuticals, nutraceuticals, and nutritional agents. It will be appreciated that some of biologically active compounds can be classified in more than one of these classes.

A wide range of biologically active compounds may be delivered with the transdermal delivery patch of the present invention. Examples include, but are not limited to, cardiovascular drugs, in particular antihypertensive agents (e.g. calcium channel blockers or calcium antagonists) and antiarrhythmic agents; congestive heart-failure pharmaceuticals; inotropic agents; vasodilators; ACE inhibitors; diuretics; carbonic anhydrase inhibitors; cardiac glycosides; phosphodiesterase inhibitors; α blockers; β-blockers; sodium channel blockers; potassium channel blockers; β-adrenergic agonists; platelet inhibitors; angiotensin II antagonists; anticoagulants; thrombolytic agents; treatments for bleeding; treatments for anaemia; thrombin inhibitors; antiparasitic agents; antibacterial agents; insulin; human growth hormone and peptides; vaccines; antiinflammatory agents, in particular non-

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steroidal antiinflammatory agents (NSAIDs), more particularly COX-2 inhibitors; steroidal antiinflammatory agents; prophylactic antiinflammatory agents; antiglaucoma agents; mast cell stabilisers; mydriatics; agents affecting the respiratory system; allergic rhinitis pharmaceuticals; alpha-adrenergic agonists; corticosteroids; chronic obstructive pulmonary disease pharmaceuticals; xanthine-oxidase inhibitors; antiarthritis agents; gout treatments; autacoids and autacoid antagonists; antimycobacterial agents; antifungal agents; antiprotozoal agents; anthelmintic agents; antiviral agents especially for respiratory , herpes, cyto-megalovirus, human immunodeficiency virus and hepatitis infections; treatments for leukemia and kaposi's sarcoma; pain management agents in particular opioids, anaesthetics and analgesics; neuroleptics; sympathomimetic pharmaceuticals; adrenergic agonists; drugs affecting neurotransmitter uptake or release; anticholinergic pharmaceuticals; antihaemorrhoid treatments; agents to prevent or treat radiation or chemotherapeutic effects; liopgenisis drugs; fat reducing treatments; anti-obesity peptides; antiobesity agents such as lipase inhibitors; sympathomimetic agents; treatments for gastric ulcers and inflammation such as proton pump inhibitors; prostaglandins; VEGF inhibitors; antihyperlipidemic agents, in particular statins; drugs that affect the central nervous system (CNS) such as antipsychotic, antiepileptic and antiseizure drugs (anticonvulsants), psychoactive drugs, stimulants, antianxiety and hypnotic drugs, antidepressant drugs; antiparkinson's pharmaceuticals; hormones and fragments thereof such as sex hormones; growth hormone antagonists; gonadotropin releasing hormones and analogues thereof; steroid hormones and their antagonists; selective estrogen modulators; growth factors; antidiabetic pharmaceuticals such as insulin, insulin fragments, insulin analogues, glucagon-like peptides and hypoglycaemic agents; H1, H2, H3 and H4 antihistamines; peptide, protein, polypeptide, nucleic acids and oligonucleotide pharmaceuticals; analogues, fragments and varients of natural proteins, polypeptides, oligonucleaotides and nucleic acids and such like compounds; agents used to treat migraine headaches; asthma pharmaceuticals; cholinergic antagonists; glucocorticoids; androgens; antiandrogens; inhibitors of adrenocorticoid biosynthesis; osteoporosis treatments such as biphosphonates; antithyroid pharmaceuticals; suncreens, sun protectants and filters; cytokine agonists; cytokine antagonists; anticancer drugs; antialzheimer drugs; HMGCoA reductase inhibitors; fibrates; cholesterol absorption inhibitors; HDL cholesterol elevating agents; triglyceride reducing agents; antiageing or antiwrinkle agents; precursor molcules for the generation of hormones; proteins such as collagen and elastin; antibacterial agents; anti acne agents; antioxidants; hair treatments and skin whitening agents; suncreens, sun protectants and filters; variants of human apolipoprotein; precursor molecules for generation of hormones; proteins and peptides thereof; amino acids; plant extracts such as grape seed extract; DHEA; isoflavones; nutritional agents including vitamins, phytosterols and iridoid gylcosides, sesquiterpene lactones, terpenes, phenolic glycosides, triterpenes, hydroquinone derivatives, phenylalkanones; antioxidants such as retinol and other retinoids including retinoic acid and co enzyme Q10; omega-3-fatty acids; glucosamine; nucleic acids, oligonucleotides, antisense pharmaceuticals; enzymes; cytokines; cytokine analogues; cytokine agonists; cytokine antagonists; immunoglobulins; antibodies; antibody pharmaceuticals; gene therapies; lipoproteins; erythropoietin; vaccines; small and large molecule therapeutic agents for the treatment, or prevention of human and animal diseases such as allergy/asthma, arthritis, cancer, diabetes, growth impairment, cardiovascular diseases, inflammation, immunological disorders,

baldness, pain, ophthalmological diseases, epilepsy, gynaecological disorders, CNS diseases, viral infections, bacterial infections, parasitic infections, GI diseases, obesity, and haemological diseases.

Some specific non-limiting examples of suitable biologically active compounds include:

anaesthetics:

including amino-ester and amino-amide anaesthetics such as benzocaine, chloroprocaine, cocaine, reserpine, guanethidine, cyclomethycaine, dimethocaine/larocaine, propoxycaine, procaine/novocaine, proparacaine, tetracaine/amethocaine; articaine, bupivacaine, carticaine, cinchocaine/dibucaine, etidocaine, levobupivacaine, lidocaine/lignocaine, mepivacaine, piperocaine, prilocaine, ropivacaine, trimecaine, propofol, halothane, enflurane barbiturates, benzodiazepines, neostigmine and ketamine

alkylating agents:

including carmustine, cyclophosphamide, ifosfamide, streptozotocin and mechlorethamine

calcium channel blockers:

including amlodipine, aranidipine, azelnidipine, barnidipine, benidipine, cilnidipine, clevidipine, cronidipine, darodipine, dexniguldipine, efonidipine, elnadipine, elgodipine, felodipine, flordipine, furnidipine, iganidipine, isradipine, lacidipine, lemildipine, lercanidipine, manidipine, mesuldipine, nicardipine, nifedipine, niludipine, nilvadipine, nimodipine, nisoldipine, nitrendipine, olradipine, oxodipine, palonidipine, pranidipine, sagandipine, sornidipine, teludipine, tiamdipine, trombodipine, watanidipine, verapamil, gallopamil, benzothiazepine, diltiazem, mibefradil, bepridil, fluspirilene and fendiline

antiarrhythmic and antiangina agents:

including amiodarone, disopyramide, flecainide acetate, quinidine sulphate, nitroglycerine, ranolazine, amiodarone, isosorbide and alteplase

antibacterial, antibiotic and antiacne agents:

including amoxicillin, ampicillin, azithromycin, benethamine penicillin, bleomycin, benzoyl peroxide, cinoxacin, chloramphenicol, daunorubicin, plicamycin, fluoroquinolones, ciprofloxacin, clarithromycin, clindamycin, clindesse, clofazimine, chlorohexidine gluconate, cloxacillin, demeclocycline, doxycycline, erythromycin, ethionamide, imipenem, indomethacin, lymocycline, minocycline, nalidixic acid, nitrofurantoin, penicillin, rifampicin, spiramycin, sodium sulfacetamide, sulphabenzamide, sulphadoxine, sulphamerazine, sulphacetamide, sulphadiazine, sulphafurazole, sulphamethoxazole, sulphapyridine, tetracycline, cephalexin, cefdinir, triclosan, ofloxacin, vancocin, glyburide, mupirocin, cefprozil, cefuroxime axetil, norfloxacin, isoniazid, lupulone, D-penicillamine, levofloxacin, gatifoxacin, and trimethoprim

anticancer:

including doxorubicin, 6-thioguanine, paclitaxel, docetaxel, camptothecin, megestrol acetate, navelbine, cytarabine, fludarabine, 6-mercaptopurine, 5-fluorouracil, teniposide, vinblastine, vincristine, cisplatin, colchicine, carboplatin, procarbazine and etopside

antidepressants, antipsychotics and antianxiety:

including alprazolam, amoxapine, bentazepam, bromazepam, clorazipine, clobazam, clotiazepam, diazepam, lorazepam, flunitrazepam, flurazepam, lormetazepam, medazepam, nitrazepam, oxazepam, temazepam, maprotiline, mianserin, nortriptyline, risperidone, sertraline,

trazodone, baloperidol, trimipramine maleate fluoxetine, ondansetron, midazolam, chlorpromazine, haloperidol, triazolam, clozapine, fluopromazine, fluphenazine decanoate, fluanisone, perphenazine, pimozide, prochlorperazine, sulpiride, thioridazine, paroxitine, citalopram, bupropion, phenelzine, olanzapine, divalproex sodium and venlafaxine

tricyclics:

including azothiopine, amitriptyline, famotidine, promethazine, paroxatine, oxcarbazapine and mertazapine

antidiabetics:

including acetohexamide, chlorpropamide, glibenclaraide, gliclazide, glipizide, metformin, tolazamide, glyburide, glimepiride and tolbutamide

antiepileptics:

including beclamide, carbamazepine, gapapentin, tiagabine, vigabatrin, topiramate, clonazepam, ethotoin, methoin, methsuximide, methylphenobarbitone, oxcarbazepine, paramethadione, phenacemide, phenobarbitone, phenyloin, phensuximide, primidone, sulthiamine, phenytoin sodium, nirofurantoin monohydrate, gabapentin, lamotrigine, zonisamide, ethosuximide and valproic acid

hypnotics/sedatives and muscle relaxants:

including zolpidem tartrate, amylobarbitone, barbitone, butobarbitone, pentobarbitone, brotizolam, carbromal, chlordiazepoxide, chlormethiazole, ethinamate, meprobamate, methaqualome, cyclobenzaprene, cyclobenzaprine, tizanidine, baclofen, butalbital, zopiclone, atracurium, tubocurarine and Phenobarbital

antifungal, antiprotazoal and antiparasitic agents:

including amphotericin, butoconazole nitrate, clotrimazole, econazole nitrate, fluconazole, flucytosine, griseofulvin, itraconazole, ketoconazole, miconazole, natamycin, nystatin, sulconazole nitrate, terconazole, tioconazole and undecenoic acid; benznidazole, clioquinol, decoquinate, diiodohydroxyquinoline, diloxanide furoate, dinitolmide, furzolidone, metronidazole, nimorazole, nitrofurazone, ornidazole, terbinafine, clotrimazole, chloroquine, mefloquine, itraconazole, pyrimethamine, praziquantel, quinacrine, mebendazole and tinidazole

antihypertensive and cardiac therapeutic agents:

including candesartan, hydralazine, clonidine, triamterene, felodipine, gemfibrozil, fenofibrate, nifedical, prazosin, mecamylamine, doxazosin, dobutamine and cilexetil

antimigraine agents:

including dihydroergotamine mesylate, ergotamine tartrate, methysergide maleate, pizotifen maleate and sumatriptan succinate

antimuscarinic agents:

including atropine, benzhexol, biperiden, ethopropazine, hyoscyamine, mepenzolate bromide, oxybutynin, oxyphencylcimine and tropicamide

antineoplastic agents (or immunosuppressants):

including aminoglutethimide, amsacrine, azathioprine, busulphan, chlorambucil, cyclosporin, dacarbazine, estramustine, etoposide, lomustine, melphalan, mercaptopurine, methotrexate,

mitomycin, mitotane, mitozantrone, procarbazine, tamoxifen citrate, testolactone, tacrolimus, mercaptopurine and sirolimus

antiparkinsonian agents:

including bromocriptine mesylate, levodopa, tolcapone, ropinirole, bromocriptine, hypoglycaemic agents such as sulfonylureas, biguanides, α-glucosidase inhibitors, thaiazolidinediones, cabergoline, carbidopa and lysuride maleate

antithyroid agents:

including carbimazole and propylthiouracil

antiviral drugs:

including amantadine, retinovir, cidofovir, acyclovir, famciclovir, ribavirin, amprenavir, indinavirm, rimantadine and efavirenz, penciclovir, ganciclovir, vidarabine, abacavir, adefovir, apmrenavir, delavirdine, didanosine, stavudine, zalcitabine, zidovudine, enfuvirtide and interferon

cardiac inotropic agents:

including amrinone, milrinone, digitoxin, digoxin, enoximone, lanatoside C and medigoxin

hypo and hyper lipidemic agents:

including fenofibrate, clofibrate, probucol, ezetimibe and torcetrapib

antiinflammatory:

including meoxicam, triamcinolone, cromolyn, nedocromil, hydroxychloroquine, montelukast, zileuton, zafirlukast and meloxicam

antihistamine:

including fexofenadine, chloral hydrate, hydroxyzine, promethazine, cetirazine, cimetidine, clyclizine, meclizine, dimenhydrinate, loratadine, nizatadine and promethazine

antiulcer:

including omeprazole, lansoprazole, pantoprazole and ranitidine

diuretics:

including hydrochlorothiazide, amiloride, acetazolamide, furosemide and torsemide

opioids:

including natural opiates which are alkaloids contained in the resin of the opium poppy such as morphine, codeine and thebaine; semi-synthetic opioids created from natural opiates such as hydromorphone, hydrocodone, oxycodone, oxymorphone, desomorphine, diacetylmorphine (heroin), nicomorphine, dipropanoylmorphine, benzylmorphine and ethylmorphine; fully synthetic opioids such as fentanyl, pethidine, methadone, tramadol and dextropropoxyphene; and, endogenous opioid peptides, produced naturally in the body, such as endorphins, enkephalins, dynorphins, and endomorphins; opioid analgesics including opioid receptor agonists, opioid receptor partial agonists, opioid antagonist or opioid receptor mixed agonist-antagonists; opioid receptor agonists including morphine, depomorphine, etorphine, heroin, hydromorphone, oxymorphone, levorphanol, methadone, levomethadyl, meperidine, fentanyl, sufentanyl, alfentanil, codeine, hydrocodone, oxycodone, and mixtures of the foregoing; opioid receptor antagonists including naloxone and naltrexone; opioid receptor mixed agonist-antagonist which has mixed opioid agonist/antagonist activities, or one that exhibits only partial agonist activity, including buprenorphine, nalbuphine, butorphanol, pentazocine,

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and mixtures of such compounds; opioids which exhibit partial agonist activity, including ethylketocyclazocine; opium alkaloids including phenanthrenes which are naturally occurring in opium such as codeine, morphine, thebaine and oripavine (the active metabolite of thebaine); synthetic derivatives such as diacetylmorphine (heroin), dihydrocodeine, hydrocodone, hydromorphone, nicomorphine, desmorphine, ethylmorphine, dipropanoylmorphine, oxycodone and oxymorphone; synthetic opioids including anilidopiperidines such as fentanyl, alphamethylfentanyl, alfentanil, sufentanil, remifentanil, carfentanyl and ohmefentanyl, Phenylpiperidines such as pethidine (meperidine), ketobemidone, MPPP, allylprodine, prodine and PEPAP; diphenylpropylamine derivatives such as propoxyphene, dextropropoxyphene, dextromoramide, bezitramide, piritramide, methadone, dipipanone, levomethadyl acetate (LAAM), difenoxin, diphenoxylate and loperamide; benzomorphan derivatives such as dezocine, pentazocine and phenazocine; oripavine derivatives such as buprenorphine, dihydroetorphine and etorphine; morphinan derivatives such as butorphanol, nalbuphine, levorphanol and levomethorphan, and others such as lefetamine, meptazinol, tilidine, tramadol and tapentadol; opioid receptor antagonists including nalmefene, naloxone and naltrexone

NSAIDs:

including arylalkanoic acid sub-group of class which includes diclofenac, aceclofenac, acemetacin, alclofenac, bromfenac, etodolac, indometacin, indometacin farnesil, nabumetone, oxametacin, proglumetacin, sulindac and tolmetin; 2-arylpropionic acid (profens) sub-group of class which includes alminoprofen, benoxaprofen, carprofen, dexibuprofen, dexketoprofen, fenbufen, fenoprofen, flunoxaprofen, flurbiprofen, ibuprofen, ibuproxam, indoprofen, ketoprofen, ketorolac, loxoprofen, miroprofen, naproxen, oxaprozin, pirprofen, suprofen, tarenflurbil and tiaprofenic acid; and *N*-arylanthranilic acid (fenamic acid) sub-group of class which includes flufenamic acid, meclofenamic acid, mefenamic acid and tolfenamic acid; tromethamine, celecoxib, nepafenac, aspirin, rofecoxib, naproxen, sulindac, piroxicam, pheylbutazone, tolmetin, indomethacin, acetominophen (paracetamol), tramadol and propoxyphene

retinoids:

including first generation retinoids such as retinol, retinal, tretinoin (retinoic acid, Retin-A), isotretinoin and alitretinoin; second generation retinoids such as etretinate and its metabolite acitretin; third generation retinoids such as tazarotene, bexarotene and adapalene

hormones and steroids:

including adrenocorticotrophic hormone (ACTH), antidiruetic hormone (vasopressin), atrial-nartreuretic factor (ANF), atrial-nartreuretic peptide (ANP), beclomethasone, cortisone, scopolamine, dopamine, epinephrine, catecholamines, cholecystokinin, clomiphene citrate, danazol, dexamethasone, diethylstilbestrol (DES), ethinyl estradiol, fludrocortison, finasteride, follicle stimulating hormone, gastrin, hydroxyprogesterone, growth hormone, insulin, leptin, luteinizing hormone, medroxyprogesterone acetate, mestranol, quinestrol, methyltestosterone, nandrolone, norethindrone, norethisterone, norgestrel, estradiol, conjugated oestrogens, oxandrolone, oxytocin, prednisone, progesterone, prolactin, protogalndins, somatostatin, stanozolol, stibestrol, thyroxine, prednisolone phosphate, triamcinolone, mifepristone acetonide, budesonide, levothyroxine, testosterone, testosterone cypionate, fluoxymesterone, flutamide, mometasone furoate, cyproterone, fluromethalone, goserelin, leuprolide, calcitonin, halobetasol, hydrocortisol and tibolone

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statins and derivatives:

including atorvastatin, fluvastatin, lovastatin, nystatin, rosuvastatin, pravastatin, orlistat and simvastatin

stimulants:

including amphetamine, phentermine, tyramine, ephedrine, metaraminol, phenylephrine, dexamphetamine, dexfenfluramine, fenfluramine, nicotine, caffeine and mazindol

vasocontrictors:

including desmopressin

vasodilitors:

including carvedilol, terazosin, phentolamine and menthol

antialzheimers:

including levetiracetam, levitiracetam and donepezil

ACE inhibitors:

including benzapril, enalapril, ramipril, fosinopril sodium, lisinopril, minoxidil, isosorbide, rampril and quinapril

beta adrenoreceptor antogonists:

including atenolol, timolol, pindolol, propanolol hydrochloride, bisoprolol, esmolol, metoprolol succinate, metoprolol and metoprolol tartrate

angiotensin II antagonists:

including losartan

platelet inhibitors:

including abciximab, clopidrogel, tirofiban and aspirin

alcohols and phenols:

including tramadol, tramadol hydrochloride, allopurinol, calcitriol, cilostazol, soltalol, urasodiol bromperidol, droperidol, flupenthixol decanoate, albuterol, albuterol sulphate, carisoprodol, chlobetasol, ropinirol, labetalol, and methocarbamol

ketones and esters:

including amioderone, fluticasone, spironolactone, prednisone, triazodone, desoximetasone, methyl prednisdone, benzonatate nabumetone and buspirone

antiemetics:

including metoclopramide

ocular treatments:

including dorzolamide, brimonidine, olopatadine, cyclopentolate, pilocarpine and echothiophate

anticoagulant and antithrombitic agents:

including warfarin, enoxaparin and lepirudin

treatments for gout:

including probenecid and sulfinpyrazone

COPD and asthma treatments:

including ipratropium

treatments for osteoporosis:

including raloxifene, pamidronate and risedronate

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cosmetic peptides:

including acetyl hexapeptide-3, acetyl hexapeptide-8, acetyl octapeptide and l-carnosine

vaccines:

including vaccines comprising toxoids (inactivated toxic compounds); proteins, protein subunits and polypeptides; polynucleotides such as DNA and RNA; conjugates; adjuvants such as saponins, virosomes, inorganic and organic adjuvants, for example zostavax

nutraceutical and cosmeceutical actives:

including coenzyme Q_{10} (or ubiquinone), ubiquinol or resveratrol; a carotenoid such as α, β, or γ-carotene, lycopene, lutein, zeaxanthin and astaxanthin; a phytonutrient, such as lycopene, lutein and seaxanthin; an unsaturated fatty acid such as linoleic acid, conjugated linoleic acid, linolenic acid, omega-3 fatty acids including but not limited to docosahexaenoic acid (DHA) and eicosapentaeonic acid (EPA) and their glycerol-esters; fat-soluble vitamins including vitamin D (D2, D3 and their derivatives), vitamin E (α, β, γ, δ-tocopherols, or α, β, γ, δ-tocotrienols), vitamin A (retinol, retinal, retinoic acid and derivatives), vitamin K (K_1, K_2, K_3 and their derivatives) capric/caprylic triglycerides, folic acid, iron, niacin, glyceryl linoleate, omega 6 fatty acids, vitamin F, selenium, cyanocobalamin, aloe vera, beta glucan, bisabolol, camellia thea (green tea) extract, capric/caprylic triglycerides, centella asiatica (gotu cola) extract, cetearyl olivate, chlorophyll, citrus sinensis (orange) oil, cocoyl proline, dicapryl ether, disodium lauriminodipropionate tocopheryl phosphates (vitamin E phosphates), glycerin, glyceryl oleate, glycyrrhiza glabra (licorice) root extract, hamamelis virgiana (witch hazel) extract, lactic acid, lecithin, lutein, macadamia integrifolia (macadamia) seed oil, matricaria chamomilla (chamomile) extract, oenothera biennis (evening primrose) oil, olea europaea (olive) leaf extract, rice bran oil, persea gratissima (avocado) oil, polygonum multiflorum extract, pomegranate sterols, resveratrol, rosa eglanteria (rose hip) oil, santalum spicatum (sandalwood) oil, titanium dioxide, folic acid, glycerin, glyceryl linoleate (omega 6 fatty acids vitamin F), vitamin A palmitate, vitis vinifera (grapeseed) oil, halobetasol, adenosine, adenosine triphosphate, alpha hydroxy acid, allantoin, hyaluronic acid and derivatives, isolutrol, tranexamic acid, glycolic acid, arginine, ascorbyl glucosamine, ascorbyl palmitate, salicylic acid, carnosic acid, alpha lipoic acid, gamma linolenic acid (GLA), panthenol, retinyl propionate, retinyl pamitate, furfuryladenine, retinaldehyde, copper pepetides, idebenone, dimethylaminoethanol (DMAE), niacinamide, beta-glucan, palmitoyl pentapeptide-4, palmitoyl oligopeptide/ tetrapetide-7, ethocyn, ceramides, phenylalanine, glucuronolactone, L-carnitine, hydroxylapetite, palmitoyl tripetide-3, forskolin, zinc oxide, α-bisabolol, eugenol, silybin, soy isoflavones, aucubin, catalpol, pseudoguaianolide from Arnica chamissonis, rosmarinic acid, rosmanol, salicylates for example salicin, saligenin and salicyclic acid, taxasterol, α-lactucerol, isolactucerol, taraxacoside, ceremides, arbutin, gingerols, shagaols, hypercin, elastin, collagen and peptides thereof.

Particularly preferred biologically active compounds include alprazolam, donepazil, rispiredone, lorazepam, nicotine, lidocaine, diclofenac, felodipine, insulin, ketoralac, prilocaine, halobetasol, hydrocortisol, opioids such as oxycodone or dihydrohydroxycodeinone (oxycodone base).

It is to be understood that pharmaceutically, nutraceutically or cosmeceutically acceptable derivatives of biologically active compounds are included within the scope of the present invention.

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The term "pharmaceutically, nutraceutically or cosmeceutically acceptable derivatives" includes, but is not limited to, pharmaceutically, nutraceutically or cosmeceutically acceptable salts, esters, salts of such esters, ethers, or any other derivative including prodrugs and metabolites, which upon administration to a subject (e.g. patient, human or animal) in need is capable of providing, directly or indirectly, a biologically active compound as otherwise described herein.

As used herein, the term "pharmaceutically, nutraceutically or cosmeceutically acceptable salt" refers to those salts which are, within the scope of sound medical judgment, suitable for use in contact with the tissues of humans and lower animals without undue toxicity, irritation, allergic response and the like, and are commensurate with a reasonable benefit/risk ratio. Pharmaceutically, nutraceutically or cosmeceutically acceptable salts are well known in the art. For example, S. M. Berge, *et al.* describe pharmaceutically, nutraceutically or cosmeceutically acceptable salts in detail in J. Pharmaceutical Sciences, 66:1-19, 1977. Examples of pharmaceutically, nutraceutically or cosmeceutically acceptable nontoxic acid addition salts are salts of an amino group formed with inorganic acids such as hydrochloric acid, hydrobromic acid, phosphoric acid, sulfuric acid and perchloric acid or with organic acids such as acetic acid, oxalic acid, maleic acid, tartaric acid, citric acid, succinic acid, or malonic acid or by using other methods used in the art such as ion exchange. Other pharmaceutically acceptable salts include adipate, alginate, ascorbate, aspartate, benzenesulfonate, benzoate, bisulfate, borate, butyrate, camphorate, camphorsulfonate, citrate, cyclopentanepropionate, digluconate, dodecylsulfate, ethanesulfonate, formate, fumarate, glucoheptonate, glycerophosphate, gluconate, hernisulfate, heptanoate, hexanoate, hydroiodide, 2-hydroxy-ethanesulfonate, lactobionate, lactate, laurate, lauryl sulfate, malate, maleate, malonate, methanesulfonate, 2-naphthalenesulfonate, nicotinate, nitrate, oleate, oxalate, palmitate, pamoate, pectinate, persulfate, 3-phenylpropionate, phosphate, picrate, pivalate, propionate, stearate, succinate, sulfate, tartrate, thiocyanate, p-toluenesulfonate, undecanoate, valerate salts, and the like. Representative alkali or alkaline earth metal salts include sodium, lithium, potassium, calcium, magnesium, and the like. Further pharmaceutically acceptable salts include, when appropriate, nontoxic ammonium, quaternary ammonium, and amine cations formed using counterions such as halide, hydroxide, carboxylate, sulfate, phosphate, nitrate, loweralkyl sulfonate, and aryl sulfonate.

The term "pharmaceutically, nutraceutically or cosmeceutically acceptable ester" refers to esters which are hydrolysed *in vivo* and include those that break down readily in the human body to leave the parent compound or a salt thereof. Suitable ester groups include, for example, those derived from pharmaceutically, nutraceutically or cosmeceutically acceptable aliphatic carboxylic acids, particularly alkanoic, alkenoic, cycloalkanoic and alkanedioic acids, in which each alkyl or alkenyl moiety advantageously has not more than 6 carbon atoms. Examples of particular esters include formates, acetates, propionates, butyrates, acrylates and ethylsuccinates.

The term "pharmaceutically, nutraceutically or cosmeceutically acceptable prodrugs" as used herein refers to those prodrugs of the biologically active compounds which are, within the scope of sound medical judgment, suitable for use in contact with the tissues of a subject with undue toxicity, irritation, allergic response, and the like, commensurate with a reasonable benefit/risk ratio, and effective for their intended use, as well as the zwitterionic forms, where possible, of the compounds of the invention. The term "prodrug" refers to compounds that are rapidly transformed *in vivo* to yield the

parent compound of the above formula, for example by hydrolysis in blood. A thorough discussion is provided in T. Higuchi and V. Stella, Pro-drugs as Novel Delivery Systems, Vol. 14 of the A.C.S. Symposium Series, and in Edward B. Roche, ed., Bioreversible Carriers in Drug Design, American Pharmaceutical Association and Pergamon Press, 1987.

The present invention is further not limited solely to the administration of one biologically active compound: more than one biologically active compound or other therapeutic compounds may be incorporated into the composition, or matrix layer.

The biologically active compound may be present in a therapeutically effective amount, that is, an amount necessary to achieve a desired therapeutic effect. Typically, the biologically active compound will be present in an amount within the range of about 0.1%w/w to about 30%w/w, within the range of about 0.1%w/w to about 20%w/w, within the range of about 0.1%w/w to about 10%w/w, of the total concentration of the composition, or matrix layer. In one embodiment, the matrix layer will have a biologically active compound concentration within the range of about 3.0%w/w to about 15.0%w/w of the total concentration of the composition, or matrix layer.

The ratio of biologically active compound:TP (%w/w) may be within the range of about 5:5 to about 5:0.5, with the most preferred value preferably being about 5:1. The polymer carrier:[biologically active compound and TP] may be within the range of about 1:1 to about 3:1, with preferred values preferably being within the range of about 7:6 to about 7:3.

Preparation of the transdermal delivery patch

The composition, or matrix layer, may form part of a transdermal delivery matrix patch. The transdermal delivery patch may be prepared by a variety of techniques.

One technique involves combining the polymer carrier and any inert carrier components such as an anti-tacking agent and/or plasticizer with a suitable solvent (e.g. 50% water, 50% ethanol). This is combined with a dispersion comprising the biologically active compound and the mixture of a mono-tocopheryl phosphate compound and a di-tocopheryl phosphate compound, and is stirred until complete homogenisation is achieved. In one embodiment, the composition may then be placed in a suitable mould and dried. In a preferred method, the composition may be dried by heating up to about 90°C, preferably for 0.5 to 24 hours. However, formulating and/or drying may be conducted at a temperature within the range of about 30°C to about 90°C. It has been found that formulating and/or drying at a temperature of about 75°C results in better delivery of the biologically active compound. In an alternate embodiment, the composition may be cast on a surface (e.g. a roller) and then dried under heat.

The composition comprising a mixture of a mono-tocopheryl phosphate compound and a di-tocopheryl phosphate compoundand a polymer carrier is suitable for use as a matrix layer. The matrix layer may be a solid or semi-solid layer.

The transdermal delivery patch usually would also comprise a backing layer. The backing layer acts as a support or substrate for the composition, or matrix layer. When preparing a transdermal delivery patch using a mould, the backing layer would be placed in the mould before addition of the composition, or matrix layer.

Accordingly, the composition, or matrix layer, essentially has two surfaces: a first surface and a second surface opposite the first surface, where the first surface is in contact with the backing layer and the second surface being adapted to be in diffusional contact with the skin of a subject. The subject may be a human or animal.

Preferably, the backing layer is occlusive or impermeable to protect the composition, or matrix layer, from the outer environment. However, a non-occlusive backing layer could also be used, so long as the packaging of the transdermal delivery patch is fully occlusive to prevent degradation of the composition, or matrix layer. An occlusive backing layer is preferred.

The backing layer may be of any thickness, however in the art, backing layers typically have a thickness of about 0.0005 inches to about 0.01 inches.

The transdermal delivery patch may further comprise a liner which is a removable protective or impermeable layer, usually but not necessarily rendered "non-stick" so as not to stick to the composition, or matrix layer. The liner, which may also be referred to as the release liner, protects the transdermal delivery patch during storage. During use, the release liner is to be removed.

The liner may be made from the same material as the backing layer, however it may also be a metal foil, Mylar (registered trademark), polyethylene terephthalate, siliconized polyester, fumed silica in silicone rubber, polytretrafluoroethylene, cellophane, siliconized paper, aluminized paper, polyvinyl chloride film, composite foils or films containing polyester such as polyester terephthalate, polyester or aluminized polyester, polytetrafluoroethylene, polyether block amide copolymers, polyethylene methyl methacrylate block copolymers, polyurethanes, polyvinylidene chloride, nylon, silicone elastomers, rubber-based polyisobutylene, styrene, styrene-butadiene, and styrene-isoprene copolymers, polyethylene, and polypropylene.

The release liner may be of any thickness, however in the art, release liners typically have a thickness of about 0.01mm to about 2mm.

The transdermal delivery patch may also comprise an adhesive layer. The adhesive layer may be an additional layer to the composition, or matrix layer, or may be included on the outer margin of the backing layer where the backing layer extends beyond the edges of the composition, or matrix layer. Polymeric adhesives useful for transdermal patches include polyacrylate polymers, rubber-based adhesives and polysiloxane adhesives. These types of materials, as well as others, are described by Van Norstrand (The Handbook of Pressure Sensitive Adhesive Technology Second Edition 1989). Examples of commercially available adhesives include, but are not limited to, polyacrylate adhesives sold under the trademarks DUROTAK (registered trademark) by National Starch and Chemical Corporation, Bridgewater, NJ, as well as GELVA-MULTIPOLYMER SOLUTION (registered trademark) by Cytek Surface Specialties, Smyrna, GA.

Advantages

It has surprisingly been found that biologically active compounds can be effectively administered using a transdermal delivery patch comprising a composition, or matrix layer, which

comprises a mixture of a mono-tocopheryl phosphate compound and a di-tocopheryl phosphate compoundand a polymer carrier.

Transdermal delivery options for include, for example, topical creams and gels, and skin patches.

Creams and gels may present difficulties with compliance and dosage control, and may be considered messy or unpleasant by patients.

There are different forms of skin patches, including "reservoir" patches and "matrix" patches. Patches may also be single- or multi-layered. A "reservoir" patch essentially has a liquid or gel compartment containing the drug solution or suspension separated by a membrane and a layer of adhesive. In a "matrix" patch, the drug dispersion is present in a semi-solid or solid layer, which may or may not also comprise the adhesive material.

Reservoir patches overcome some of the dosage difficulties with topical creams and gels, however the delivery may be uneven or inconsistent, and there is some risk of perforation of the reservoir. An additional issue relates to delivery of prescribed drugs which may be addictive and subject to abuse. Gels, creams and reservoir patches provide limited barriers to extraction of the drug substance, whereas incorporation of the drug substance within a composition, or matrix layer, represents a significant, if not almost impossible barrier to extraction of the drug substance.

Delivery of an active orally or by injection typically results in a delivery profile which is non-linear. Transdermal delivery provides a non-invasive way of potentially achieving sustained steady state delivery.

Without wishing to be bound by theory, the presence of a mixture of a mono-tocopheryl phosphate compound and a di-tocopheryl phosphate compoundis considered to enhance the skin permeation of the biologically active compound. It has also been found that the components of the composition, or matrix layer, do not formulate well together without the presence of a mixture of a mono-tocopheryl phosphate compound and a di-tocopheryl phosphate compound. It has also been found that the presence of a phosphate compound of tocopherol will act to reduce skin irritation caused by many the biologically active compounds.

EXAMPLES

Various embodiments/aspects of the present invention will now be described with reference to the following non-limiting examples.

Example 1: Manufacture of transdermal delivery patch

Final composition, or matrix layer	
Components	Percentage by weight, after drying
A combination of mono-(tocopheryl) phosphate and di-(tocopheryl) phosphate in a ratio of 6:4	1.1%w/w
Oxycodone	5.5%w/w
Eudragit E100 (polymethyl methacrylate)	60.6%w/w
Dibutyl sebacate	27.3%w/w
Succinic acid	5.5%w/w

<u>Small scale laboratory manufacturing</u>

The components were dissolved in a solvent solution (acetone:isopropanol:ethyl alcohol 60:6.6:33.5 by %weight).

The resulting solution was then poured into individual casts (containing suitable backing layers) at room temperature and the solvent was allowed to evaporate at 75°C for 1.5 hours.

Large scale manufacturing

All composition, or matrix layer, components could be combined at a suitable temperature to produce a homogeneous molten mass. The molten mass can then be cast on a cold surface (for example, a rotating mill with a suitable backing layer, or sheet, thereon) and allowed to solidify. Individual transdermal delivery patches of varying sizes may then be cut.

In both methods, the composition, or matrix layer, would be relatively thin; however, the thickness of the composition, or matrix layer, can be varied depending on the desired properties of the transdermal delivery patch. Figure 1 shows an example of a transdermal delivery patch of one embodiment of the present invention.

Example 2: Alternate method for manufacture of transdermal delivery patch

Trandermal delivery patches were constructed by dissolving 20%w/w solid mixture of Eudragit E100 granules, dibutyl sebacate, succinic acid (the components other than TPM and oxycodone in the composition, or matrix layer, may collectively be referred to as the “polymer carrier”); a combination of mono-(tocopheryl) phosphate and di-(tocopheryl) phosphate in a ratio of 6:4 (TPM); and oxycodone base in 60:6.6:33.4 acetone/isopropyl alcohol/ethyl alcohol. The mixture was then transferred into 6cm^2 circular aluminium cast-lined on the underside with polyester backing (1.66mil, 3M Scotchpak™, 3M, MN) and the solvent evaporated in an oven at either 45°C overnight or 75°C for

1.5 hours. Where glue was used, the glue was DuroTak adhesive and in this example succinic acid was omitted from the formulation.

Table: Composition, excipient ratios and manufacture conditions of transdermal delivery patches

Patch	Ratio (PC:O:TPM)*	Oxycodone (mg)	Vol. stock (ml)	Dry temp./ time	Succinic acid	Glue
1	10:5:1	10	2	45°C overnight	Yes	No
2	14:5:1	10	2	45°C/ overnight	Yes	No
3	14:5:1	5	1	45°C/ overnight	Yes	No
4	14:5:1	5	1	75°C/1.5h	Yes	No
5	14:10:2	5	0.5	75°C/1.5h	No	Yes

** Refers to ratio of polymer carrier:oxycodone:TPM*

Example 3: Comparative testing for drying temperatures

Oxycodone transdermal delivery patches were made according to Example 1 (small scale), testing the variable of the two different heating regimes. The transdermal delivery patches were adhered to full thickness human skin applied to a Franz cell with PBS as the receiver solution. Time points were taken at 18, 22, 24, 42, 44, 68 and 75 hours and the receiver solution was tested by HPLC to determine the concentration of oxycodone which had passed through the skin.

Table: Parameters in the patches tested

Patch	Ratio (PC:O:TPM)*	Oxycodone (mg)	Vol. stock (ml)	Dry temp./ time	Succinic acid	Glue
A	14:5:1	10	2	45°C/overnight	Yes	No
B	14:5:1	10	2	75°C/1.5h	Yes	No

** Refers to ratio of polymer carrier:oxycodone:TPM*

The results outline in Figure 2 show that the transdermal delivery patch manufactured using the higher (accelerated) drying temperature has increased transdermal delivery properties compared with the transdermal delivery patch manufactured with drying at a lower temperature.

Example 4: Comparative testing to determine effect of an external glue layer

Transdermal delivery patches were manufactured and the receiver solution tested as in Example 3, with testing time points of 0.5, 1, 3, 4 and 20 hours.

Table: Parameters in the patches tested

Patch	Ratio (PC:O:TPM)*	Oxycodone (mg)	Vol. stock (ml)	Dry temp./ time	Succinic acid	Glue
C	14:5:1	10	2	75°C/1.5h	Yes	No
D	14:5:1	10	2	75°C/1.5h	No	Yes

** Refers to ratio of polymer carrier:oxycodone:TPM*

The results of this comparison outlined in Figure 3 clearly demonstrate that using a transdermal delivery patch which includes an adhesive layer results in reduced transdermal penetration of the oxycodone compared with the transdermal delivery patches formulated to be self-adhesive.

Example 5: Comparative testing to determine effect of an occlusive backing layer compared with no backing layer

The transdermal delivery patches were manufactured and the receiver solution tested as in Examples 3 and 4, at time points 1, 2, 3, 4 and 5 hours.

Table: Parameters in the patches tested

Patch	Ratio (PC:O:TPM)*	Oxycodone (mg)	Vol. stock (ml)	Dry temp./ time	Occlusive backing	Glue
E	14:5:1	10	2	75°C/1.5h	Yes	No
F	14:5:1	10	2	75°C/1.5h	No	No

** Refers to ratio of polymer carrier:oxycodone:TPM*

The results outlined in Figure 4 clearly show that penetration of the oxycodone transdermally is far superior when an occlusive backing layer is used with the patch compared with a patch without the adhesive backing layer.

Example 6: Pharmacokinetic testing

This example compares plasma PK parameters using Patch Nos. 1, 2, 4 and 5 from Example 2.

Transdermal delivery patches were cut from the polyester backing and adhered to the shaved and washed back of a 10-12 week old male Sprague-Dawley rat with a 6x7cm Tegaderm HP™ (3M, MN) adhesive dressing either with the backing layer in place or removed (see Table below). Tegaderm serves to hold the occlusive backing layer in place, or if the backing layer is absent, holds the transdermal delivery patch itself in place.

The day after the transdermal delivery patches were adhered to the shaved section, blood samples removed from the tail tip following ~1mm tip amputation at specified times.

The PK parameters quantified were:

C_{max}: the maximal observed plasma oxycodone concentration.

AUC_{0-4}: The area under the curve between 0 and 4 hours (the duration of the experiment was 4 hours) and is a measure of the total amount of drug delivered.

The results in Figure 5 and Table below demonstrate that the transdermal delivery patches of the present invention in various formulations are able to effectively deliver the oxycodone to the rats as demonstrated by the pharmacokinetic data.

Table: Estimated pharmacokinetic parameters of rats administered transdermal delivery patches

Patch	Oxycodone dose (mg/kg)	Occlusive	*n*	C_{max} (ng/mL)	AUC_{0-4} (ng.mL/min)
1	41.8 ± 0.4	No	17	93 ± 16	13681 ± 2367
2	45.0 ± 2.1	Yes	9	92 ± 27	11959 ± 2910
4	21.7 ± 0.1	Yes	5	144 ± 33	21637 ± 5189
5	18.1 ± 0.3	Yes	5	74 ± 29	11161 ± 4636

'n' = no. of animals

Example 7: Pharmacodynamic testing

Rats were prepared and dosed similar to Example 6 using Patch Nos. 1, 3 and 5 from Example 2.

The day after the transdermal delivery patches were adhered to the shaved section, antinociception of the hind-paw was assessed with a plantar analgesiometer with the IR source calibrated to 190Mu/cm^2.

The following PD parameters were assessed:

Maximum: The maximum time it took for the rat to remove its paw in response to the heat stimulus. The higher the number, the longer it took for the rat to respond and the deeper the oxycodone induced analgesia.

AUC: This is a measure of the total analgesia over the observation period as measured by the area under the curve between 0 and 4 hour, and is useful for comparing the response to different treatments.

The baseline response time is indicated in Figure 6 at t=(-0.5h) and t=0.

The results outlined in the Table below and Figure 6 demonstrate that analgesia was effectively administered to the rats using a variety of compositions of the present invention.

Table: Pharmacodynamic parameters from rats administered different transdermal delivery patches

Patch	Oxycodone dose (mg/kg)	*n*	Max (sec.)	AUC_{0-4} (sec/h)
1	41.0±0.8	5	20.7±3.5	57.6±9.1
3	21.8±0.6	5	22.3±3.3	76.8±13.1

5	21.6±0.5	4	20.5±2.3	64.0±6.4

'n' = no. of animals

Example 8: Alternate plasticisers

The following formulations were prepared as outlined in Example 2. Formulation 1 was cast onto a die and Formulation 2 was cast onto a plate. The percentages below reflect the composition when the patch is dry.

Formulation 1 (1%T80, dbs)	**%w/w**
Eudragit 100	60.59
DBS	26.28
Succinic acid	5.46
Oxycodone	5.56
Tocopheryl phosphate	0.67
Di-tocopheryl phosphate	0.44
Tween 80	1.00
	100.00

Formulation 2 (3%ML, 25%T)	**%w/w**
Eudragit 100	60.59
Transcutol	24.28
Succinic acid	5.46
Oxycodone	5.56
Tocopheryl phosphate	0.67
Di-tocopheryl phosphate	0.44
Methyl laurate	3.00
	100.00

The transdermal delivery patches were adhered to full thickness human skin applied to a Franz cell with PBS as the receiver solution. Time points were taken at 1, 2, and 4 hours and the receiver solution was tested by HPLC to determine the concentration of oxycodone which had passed through the skin.

The results are outlined in Figure 7 and demonstrate that delivery of oxycodone can be achieved using alternate plasticisers.

Example 9:

Alternate polymer carrier

The following formulations were prepared as in Example 1, however with the composition was cast onto a flat surface or plate instead of a die.

20% tran, 3% ML, 1% Span	**20% tran, 1% Lau, 1% Span**	**20% tran, 1% Span**	**3% ML**	**1% Span**
20%w/w transcutol	20%w/w transcutol	20%w/w transcutol	3%w/w Methyl laurate	1%w/w Span 80
3%w/w Methyl laurate	1% Lauric acid	1%w/w Span 80	DuroTak to 100%w/w	DuroTak to 100%w/w
1%w/w Span 80	1%w/w Span 80	DuroTak to 100%w/w	5.5%w/w Oxycodone	5.5%w/w Oxycodone
DuroTak to 100%w/w	DuroTak to 100%w/w	5.5%w/w Oxycodone	1.1%w/w TPM	1.1%w/w TPM
5.5%w/w Oxycodone	5.5%w/w Oxycodone	1.1%w/w TPM		
1.1%w/w TPM	1.1%w/w TPM			

The transdermal delivery patches were adhered to full thickness human skin applied to a Franz cell with PBS as the receiver solution. Time points were taken at 1, 2, and 4 hours and the receiver solution was tested by HPLC to determine the concentration of oxycodone which had passed through the skin.

The results are outlined in Figure 8 and demonstrate that oxycodone can be delivered transdermally using an alternate polymer carrier.

Example 10: Investigation into the pharmacodynamics of insulin formulated into transdermal delivery patches

PCT/AU2011/000358
Received 11/05/2012

Four transdermal delivery patches of the present invention were tested against a positive control gel.

The table below sets out the composition of the composition, or matrix layer, in each of the four transdermal delivery patches. The polyvinylpyrrolidone was found to provide the composition, or matrix layer, with sufficient "tackiness" to avoid the need to include any inert carrier components. The dry weight of each transdermal delivery patch was 60mg.

Patch	TPM	Polyvinylpyrrolidone	Insulin
1	1.2mg (2%w/w)	54.8mg (91.33%w/w)	4mg (6.67%w/w)
2	0.6mg (1%w/w)	55.4mg (92.33%w/w)	4mg (6.67%w/w)
3	0.6mg (1%w/w)	56.4mg (94.0%w/w)	3mg (5%w/w)
4	1.2mg (2%w/w)	50.8mg (84.6%w/w)	8mg (13.33%w/w)

The components of the composition, or matrix layer, were dissolved in a solvent solution (50% water, 50% ethanol). The resulting solution was then poured into individual casts (containing suitable backing layers) at room temperature and the solvent was allowed to evaporate at 75°C for 1.5 hours.

300mg of gel was used as the positive control, which comprised 2.25mg/ml insulin, 2% TPM (2:1), 30% ethanol, 1% carpobol 934 in water adjusted to pH=4.7.

Study design

The study was a cross-over design to test the effect of transdermal delivery patches of the present invention compared to the gel. In this design, each animal received four of the five treatments across the course of the study. The animals were male and 10-12 weeks of age. Each treatment group was 11 animals. All animals were >300g in weight, and had circulating glucose concentrations of >10mmol/L in the fasted state (mean fasted glucose concentration was 21.37±0.85mmol/L). The key endpoint of the study was blood glucose levels during a 5-hour insulin tolerance test, conducted as described below.

Streptozotocin administration

Diabetes was induced by the administration of a single intraperitoneal injection of streptozotocin (STZ) 50mg/kg (Sigma Chemicals) dissolved in sodium citrate buffer (0.1mol/L, pH 4.5) immediately before use. Rats were considered diabetic and included in the study if their blood glucose was greater than 16mmol/L 24 hours after the STZ injection. In all groups blood glucose measurements were made by obtaining a spot sample from tail tipping. Animals were left for 5 days following STZ administration prior to testing.

Treatment application

24 hours before the application of the gel and transdermal delivery patches the animals were anaesthetised and ~30cm^2 of fur was shaved from the back, avoiding any damage to the skin that could enhance absorption of the formulations. The gel was applied at a dose of 12mg/cm^2 across the shaved area. The transdermal delivery patches were adhered to the shaved area and protected with the application of a tegaderm dressing. The insulin tolerance tests were performed 24 hours after removing the fur. Following each treatment, the animals were allowed to recover for 3 days before the next treatment.

ITT (Insulin tolerance test)

Animals were fasted for 2 hours prior to the application of insulin or control formulations. Spot blood samples were taken from the tail at 0, 30, 60, 90, 120, 180, 240 and 300 minutes after the

application of the gel and transdermal delivery patches. Blood glucose levels were determined at the same time points using glucose sticks (AccuChek, Roche Diagnostics).

Results

The gel and the transdermal delivery patches caused significant reductions in blood glucose concentrations in the diabetic rats (see Figures 9 and 10). Blood glucose was significantly reduced ($p<0.05$) from starting values 30 min after application and remained lowered for the duration of the experiment. There was no statistically significant difference in the reduction of blood glucose between the patches and gel tested here, as demonstrated by the area under the curve (see Figure 10). The transdermal delivery patches appear efficacious for the delivery of insulin, however, a transdermal delivery patch provides the many advantages described herein over a gel or other methods of delivery.

Example 11: Diclofenac transdermal delivery patch

Diclofenac diethylamine transdermal delivery patches were prepared having the following composition:

200mg diclofenac diethylamine
20mg TPM (8:2)
168mg Eudragit

200mg diclofenac diethylamine
168mg Eudragit

The diclofenac diethylamine transdermal delivery patches had a surface area of $120cm^2$.

Manufacturing method

The components listed in the table above were dissolved in 30ml isopropanol:acetone mixture (1:1) at 45°C. The mixture was then casted over a 3M scotch pack, and dried for 90 minutes at 75°C.

In-vitro testing (Diffusion)

Transdermal delivery patches were cut into circular discs ($7cm^2$) and placed over rat skin. Receptor solution was 12ml and had an effective surface with the skin equal to about $1.76cm^2$. After the duration of the experiment, skin (about $7cm^2$) was removed, the surface cleaned (excess gel) and extracted with 10ml solvent.

Results

The results are reflected in Figures 11 and 12.

Diffusion	Dose: 2.92mg/$1.76cm^2$
Skin extraction	Dose: 11.78mg/$7.06cm^2$

Example 12: Lidocaine transdermal delivery patches

Lidocaine transdermal delivery patches were prepared having the following composition:

100mg lidocaine base
20mg TPM (8:2)
168mg Eudragit

100mg lidocaine base
168mg Eudragit

The lidocaine transdermal delivery patches had a surface area of $120cm^2$.

Manufacturing method

The components listed in the table above were dissolved in 30ml isopropanol:acetone mixture (1:1) at 45°C. The mixture was then casted over a 3M scotch pack, and dried for 90 minutes at 75°C.

In-vitro testing (Diffusion)

Transdermal delivery patches were cut into circular discs (7cm^2) and placed over rat skin. Receptor solution was 12ml and had an effective surface with the skin equal to about 1.76cm^2. After the duration of the experiment, skin (about 7cm^2) was removed, the surface cleaned (excess gel) and extracted with 10ml solvent.

Results

The results are reflected in Figure 13.

Diffusion	Dose: 1.46mg/1.76cm^2
Skin extraction	Dose: 5.89mg/7.06cm^2

In this specification, except where the context requires otherwise, the words "comprise", "comprises", and "comprising" mean "include", "includes", and "including" respectively, i.e. when the invention is described or defined as comprising specified features, various embodiments of the same invention may also include additional features.

Although this invention has been described by example and with reference to possible embodiment thereof, it is to be understood that modifications or improvements may be made thereto without departing from the scope of the invention.

CLAIMS

1. A matrix layer for use in a transdermal delivery patch for administration of a biologically active compound, the matrix layer comprising a mixture of a mono-tocopheryl phosphate compound and a di-tocopheryl phosphate compound and a polymer carrier wherein the polymer carrier is present in an amount within the range of about 30%w/w to about 95%w/w of the total concentration of the matrix layer.

2. The matrix layer of claim 1, wherein the mono-tocopheryl phosphate compound is selected from the group consisting of mono-(tocopheryl) phosphate, mono-(tocopheryl) phosphate monosodium salt, mono-(tocopheryl) phosphate disodium salt, mono-(tocopheryl) phosphate monopotassium salt and mono-(tocopheryl) phosphate dipotassium salt, and the di-tocopheryl phosphate compound is selected from the group consisting of di-(tocopheryl) phosphate, di-(tocopheryl) phosphate monosodium salt and di-(tocopheryl) phosphate monopotassium salt.

3. The matrix layer of claim 1, wherein the ratio (%w/w) of the mixture of the mono-tocopheryl phosphate compound and the di-tocopheryl phosphate compound is at least 2:1, within a range of about 4:1 to about 1:4, within a range of about 6:4 to about 8:2, about 2:1, about 6:4, or about 8:2.

4. The matrix layer of claim 1, wherein the mixture of the mono-tocopheryl phosphate compound and the di-tocopheryl phosphate compound is present in an amount within a range of about 0.01%w/w to about 10%w/w, within the range of about 0.1%w/w to about 5%w/w, within the range of about 0.1%w/w to about 3%w/w, within the range of about 0.1%w/w to about 2%w/w, within the range of about 0.1%w/w to about 1%w/w or within the range of about 0.1%w/w to about 0.5%w/w, of the total concentration of the matrix layer.

5. The matrix layer of claim 1, wherein the mixture of the mono-tocopheryl phosphate compound and the di-tocopheryl phosphate compound is present in an amount within a range of about 0.5%w/w to about 1.5%w/w, or in an amount of about 0.1%w/w, of the total concentration of the matrix layer.

6. The matrix layer of claim 1, wherein the polymer carrier comprises a natural or synthetic polymer, co-polymer, terpolymer, or combination thereof.

7. The matrix layer of claim 6, wherein the natural polymers are selected from the group consisting of rubbers, elastomers, polysaccharides including cellulose, natural resins including shellac and amber; and, the synthetic polymers are selected from the group

consisting of acrylates, polyacrylates, polyalkyl acrylates, polyamides, polyesters, polycarbonates, polyimides, polystyrenes, acrylonitrile butadiene styrene, polyacrylonitrile, polybutadiene, poly(butylene terephthalate), poly(ether sulphone), poly(ether)ketones, polyethylene, poly(ethylene glycol), poly(ethylene terphthalate), polypropylene, polytetratfluroethylene, styrene-acrylonitrile resin, poly(trimethylene terephthalate), polyurethanes, polyvinyl butyral, polyvinylchlorides, polyvinylidenedifluoride, povidones, poly(vinyl pyrrolidone), polychloroprene, fluoroelastomers, chloro-sulphonated rubbers, hypromellose, polyolefine elastomer, polyacrylamide, chlorinated polyethylene, polyethersulphone, nylon, liquid crystal polymers, polyethylene terephthalate (PET), polyphenylsulphone, polypthalaminepolyvinyl alcohol derivatives, polyethylene glycols, ethylene vinyl acetate, polymethyl methacrylate, cellulose derivatives such as ethyl cellulose, hydroxyl propyl methyl cellulose, sugar derivatives (gums) including derivatives of sorbitol and mannitol, silicone oil and silicone oil derivatives, polysiloxanes including amine-resistant polysiloxanes, and siloxanes.

8. The matrix layer of claim 6, wherein the polymer carrier is selected from the group consisting of acrylates, povidones, siloxanes, polyvinyl pyrrolidone, polysiloxanes, amine-resistant polysiloxanes, polyalkyl acrylates, and polymethyl methacrylates.

9. The matrix layer of any one of claims 1 to 8, wherein the polymer carrier is present in an amount within the range of about 30%w/w to about 80%w/w, or within the range of about 55%w/w to about 65%w/w, of the total weight of the matrix layer.

10. The matrix layer of any one of claims 1 to 8, wherein the polymer carrier is present in an amount within the range of about 85%w/w to about 95%w/w, or within the range of about 90%w/w to about 95%w/w, of the total weight of the matrix layer.

11. The matrix layer of any one of claims 1 to 10, wherein the polymer carrier further comprises inert carrier components selected from the group consisting of anti-tacking agents, tackifiers, and plasticizers.

12. The matrix layer of claim 11, wherein the anti-tacking agent is succinic acid.

13. The matrix layer of claim 11, wherein the anti-tacking agent is present in an amount of less than about 1%w/w, up to about 1%w/w, or up to about 5%w/w, of the total weight of the matrix layer.

14. The matrix layer of claim 11, wherein the tackifier is insoluble in water and composed of a monomer which contains partly or wholly a (meth)acrylic alkyl ester.

15. The matrix layer of claim 11, wherein the tackifier is selected from the group consisting of acrylic, N-butyl-methacrylic copolymer, acrylic methyl, acrylic 2-ethylhexyl copolymer, polyacrylic acid, methacrylic copolymer L, aminoalkylmethacrylate copolymer E, rosin esters, hydrogenated rosins, dipropylene glycol dibenzoate, mixed hydrocarbons, and acrylic copolymers.

16. The matrix layer of claim 11, wherein the plasticizer is selected from the group consisting of phthalates, esters of polycarboxylic acids with linear or branched aliphatic alcohols of moderate chain length, acetylated monoglycerides, alkyl citrates, triethyl citrate (TEC), acetyl triethyl citrate (ATEC), tributyl citrate (TBC), acetyl tributyl citrate (ATBC), trioctyl citrate (TOC), acetyl trioctyl citrate (ATOC), trihexyl citrate (THC), acetyl trihexyl citrate (ATHC), butyryl trihexyl citrate (BTHC, trihexyl o-butyryl citrate), trimethyl citrate (TMC), methyl laurate, lauric acid, lauryl lactate, lauryl alcohol, alkyl sulphonic acid phenyl ester, diethylene glycol monoethyl ether, bis(2-ethylhexyl) phthalate (DEHP), diisooctyl phthalate (DIOP), bis(n-butyl)phthalate (DnBP, DBP), diisobutyl phthalate (DIBP), bis(2-ethylhexyl)adipate (DEHA), dimethyl adipate (DMAD), monomethyl adipate (MMAD), dioctyl adipate (DOA), ethyl oleate, sorbitan monooleate, glycerol monooleate, dibutyl sebacate (DBS), dibutyl maleate (DBM), diisobutyl maleate (DIBM), benzoates, epoxidized vegetable oils, tris(tromethamine), N-ethyl toluene sulfonamide (o/p ETSA), N-(2-hydroxypropyl) benzene sulfonamide (HP BSA), N-(n-butyl) benzene sulfonamide (BBSA-NBBS), tricresyl phosphate (TCP), tributyl phosphate (TBP), triethylene glycol dihexanoate (3G6, 3GH), tetraethylene glycol diheptanoate (4G7), 1,3-butyleneglycol, dipropylene glycol, PEG400, Span 80, and polyvinylpyrrolidone.

17. The matrix layer of claim 11, wherein the inert carrier components are present in an amount within the range of 0.001%w/w to about 50%w/w, within the range of 0.001%w/w to about 40%w/w, or within the range of 0.001%w/w to about 30%w/w, of the total weight of the matrix layer.

18. The matrix layer of claim 1, wherein the matrix layer comprises an anti-tacking agent and a plasticizer in a total amount of about 35%w/w of the total weight of the matrix layer.

19. The matrix layer of claim 18, wherein the anti-tacking agent is succinic acid and the plasticizer is dibutyl sebacate.

20. The matrix layer of claim 1, wherein the polymer carrier and optional inert carrier components is present in an amount within the range of about 50%w/w to about 99%w/w, within the range of about 80%w/w to about 98%w/w, within the range of about 90%w/w to about 98%w/w, or in an amount of about 95%w/w, of the total weight of the matrix layer.

21. The matrix layer of claim 1, further comprising one or more excipients.

22. Use of a matrix layer as defined in any one of claims 1 to 21 in a transdermal delivery patch for administration of a biologically active compound.

23. A transdermal delivery patch for administration of a biologically active compound comprising a matrix layer as defined in any one of claims 1 to 21.

24. The transdermal delivery patch of claim 23, wherein the matrix layer is a solid or semi-solid layer.

25. The transdermal delivery patch of claim 23 or 24, further comprising one or more occlusive or impermeable layers, and/or one or more non-occulsive layers.

26. The transdermal delivery patch of claim 25, wherein an impermeable or occlusive layer is a backing layer.

27. The transdermal delivery patch of claim 25, wherein a non-occulsive layer is a backing layer.

28 The transdermal delivery patch of claim 26 or 27, wherein the thickness of the backing layer is about 0.0005 inches to about 0.01 inches.

29. The transdermal delivery patch of claim 25, wherein an impermeable layer is a removable release liner.

30. The transdermal delivery patch of claim 25, wherein the impermeable layers are made from metal foil, Mylar™, polyethylene terephthalate, siliconized polyester, fumed silica in silicone rubber, polytretrafluoroethylene, cellophane, siliconized paper, aluminized paper, polyvinyl chloride film, composite foils or films containing polyester such as polyester terephthalate, polyester or aluminized polyester, polytetrafluoroethylene, polyether block

amide copolymers, polyethylene methyl methacrylate block copolymers, polyurethanes, polyvinylidene chloride, nylon, silicone elastomers, rubber-based polyisobutylene, styrene, styrene-butadiene, and styrene-isoprene copolymers, polyethylene, polypropylene, or a combination thereof.

31. The transdermal delivery patch of claim 29 or 30, wherein the thickness of the release liner is about 0.01mm to about 2mm.

32. The transdermal delivery patch of any one of claims 23 to 31, further comprising an adhesive layer.

33. The transdermal delivery patch of claim 32, wherein the adhesive layer is a polymeric adhesive selected from the group consisting of polyacrylate polymers, rubber-based adhesives and polysiloxane adhesives; a commercially available adhesive selected from the group consisting of polyacrylate adhesives.

34. The transdermal delivery patch of any one of claims 23 to 33, wherein the biologically active compound is selected from the group of pharmaceuticals including drugs, cosmeceuticals, nutraceuticals, and nutritional agents.

35. The transdermal delivery patch of claim 34, wherein the biologically active compound is selected from the group consisting of cardiovascular drugs, antihypertensive agents and antiarrhythmic agents; congestive heart-failure pharmaceuticals; inotropic agents; vasodilators; ACE inhibitors; diuretics; carbonic anhydrase inhibitors; cardiac glycosides; phosphodiesterase inhibitors; α blockers; ß-blockers; sodium channel blockers; potassium channel blockers; ß-adrenergic agonists; platelet inhibitors; angiotensin II antagonists; anticoagulants; thrombolytic agents; treatments for bleeding; treatments for anaemia; thrombin inhibitors; antiparasitic agents; antibacterial agents; insulin; human growth hormone and peptides; vaccines; antiinflammatory agents; steroidal antiinflammatory agents; prophylactic antiinflammatory agents; antiglaucoma agents; mast cell stabilisers; mydriatics; agents affecting the respiratory system; allergic rhinitis pharmaceuticals; alpha-adrenergic agonists; corticosteroids; chronic obstructive pulmonary disease pharmaceuticals; xanthine-oxidase inhibitors; antiarthritis agents; gout treatments; autacoids and autacoid antagonists; antimycobacterial agents; antifungal agents; antiprotozoal agents; anthelmintic agents; antiviral agents, herpes, cyto-megalovirus, human immunodeficiency virus and hepatitis infections; treatments for leukemia and kaposi's sarcoma; pain management agents; neuroleptics; sympathomimetic pharmaceuticals; adrenergic agonists; drugs affecting

neurotransmitter uptake or release; anticholinergic pharmaceuticals; antihaemorrhoid treatments; agents to prevent or treat radiation or chemotherapeutic effects; liopgenisis drugs; fat reducing treatments; anti-obesity peptides; antiobesity agents; sympathomimetic agents; treatments for gastric ulcers and inflammation; prostaglandins; VEGF inhibitors; antihyperlipidemic agents; drugs that affect the central nervous system (CNS); antiparkinson's pharmaceuticals; hormones and fragments thereof; growth hormone antagonists; gonadotropin releasing hormones and analogues thereof; steroid hormones and their antagonists; selective estrogen modulators; growth factors; antidiabetic pharmaceuticals; H1, H2, H3 and H4 antihistamines; peptide, protein, polypeptide, nucleic acids and oligonucleotide pharmaceuticals; analogues, fragments and variants of natural proteins, polypeptides, oligonucleaotides and nucleic acids; agents used to treat migraine headaches; asthma pharmaceuticals; cholinergic antagonists; glucocorticoids; androgens; antiandrogens; inhibitors of adrenocorticoid biosynthesis; osteoporosis treatments; antithyroid pharmaceuticals; suncreens, sun protectants and filters; cytokine agonists; cytokine antagonists; anticancer drugs; antialzheimer drugs; HMGCoA reductase inhibitors; fibrates; cholesterol absorption inhibitors; HDL cholesterol elevating agents; triglyceride reducing agents; antiageing or antiwrinkle agents; precursor molecules for the generation of hormones; proteins; antibacterial agents; anti acne agents; antioxidants; hair treatments and skin whitening agents; suncreens, sun protectants and filters; variants of human apolipoprotein; precursor molecules for generation of hormones; proteins and peptides thereof; amino acids; plant extracts; DHEA; isoflavones; nutritional agents; antioxidants; omega-3-fatty acids; glucosamine; nucleic acids, oligonucleotides, antisense pharmaceuticals; enzymes; cytokines; cytokine analogues; cytokine agonists; cytokine antagonists; immunoglobulins; antibodies; antibody pharmaceuticals; gene therapies; lipoproteins; erythropoietin; vaccines; small and large molecule therapeutic agents for the treatment, or prevention of human and animal diseases.

36. The transdermal delivery patch of claim 35, wherein the biologically active compound is selected from the group consisting of alprazolam, donepazil, rispiredone, lorazepam, nicotine, lidocaine, diclofenac, felodipine, insulin, ketoralac, prilocaine, halobetasol, hydrocortisol, opioids including oxycodone, and dihydrohydroxycodeinone (oxycodone base).

37. The transdermal delivery patch of any one of claims 23 to 36, wherein the biologically active compound is present in an amount within the range of about 0.1%w/w to about 30%w/w, within the range of about 0.1%w/w to about 20%w/w, or within the range of about 0.1%w/w to about 10%w/w, of the total concentration of the matrix layer.

38. The transdermal delivery patch of claim 37, wherein the amount of biologically active compound is present in an amount within the range of about 3.0%w/w to about 15.0%w/w of the total concentration of the matrix layer.

39. The transdermal delivery patch of any one of claims 23 to 38, wherein the ratio (%w/w) of biologically active compound:TP is within the range of about 5:5 to about 5:0.5, or is about 5:1.

40. The transdermal delivery patch of any one of claims 23 to 38, wherein the ratio (%w/w) of polymer carrier:[biologically active compound and tocopheryl phosphate mixture] is within the range of about 1:1 to about 3:1, or within the range of about 7:6 to about 7:3.

41. A method for preparing a matrix layer for use in a transdermal delivery patch for administration of a biologically active compound comprising the steps of:

(i) combining a polymer carrier and optional inert carrier components with a suitable solvent;

(ii) combining (i) with a dispersion comprising a biologically active compound and a mixture of a mono-tocopheryl phosphate compound and a di-tocopheryl phosphate compound;

(iii) stirring (ii) until complete homogenisation is achieved;

(iv) placing the composition of (iii) in a suitable mould or casting the composition of (iii) on a surface; and

(v) drying the composition under heat;

wherein the polymer carrier is present in an amount within the range of about 30%w/w to about 95%w/w of the total concentration of the matrix layer.

42. The method of claim 41, wherein drying is conducted at a temperature of up to about 90°C, within the range of about 30°C to about 90°C, or at about 75°C.

43. The method of claim 42, wherein drying is conducted for about 0.5 to about 24 hours.

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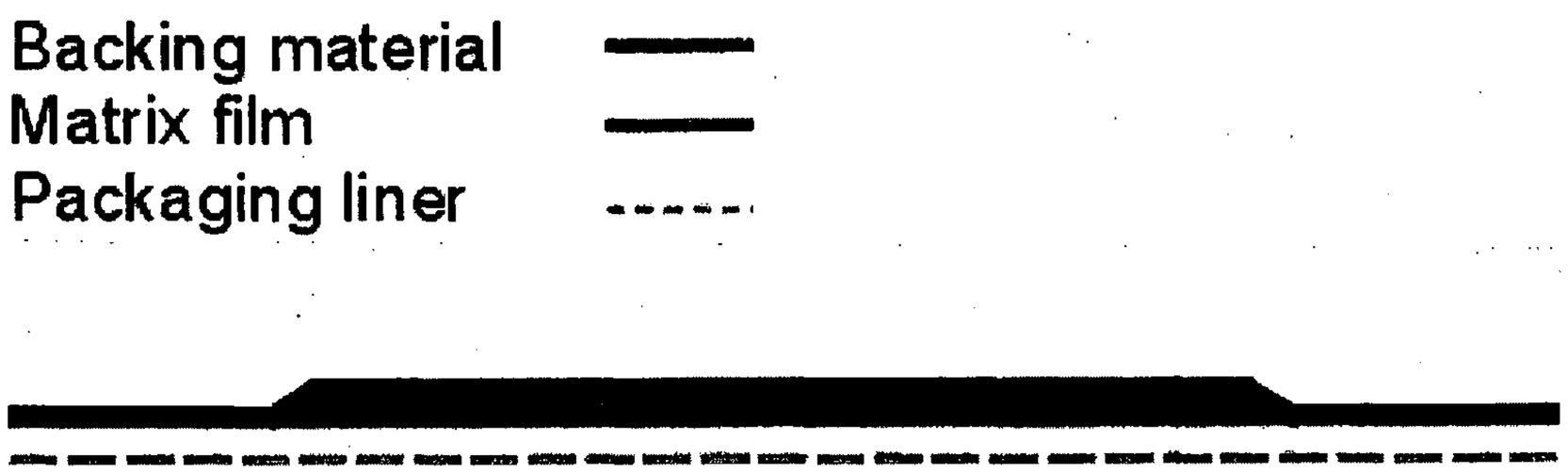


Figure 1

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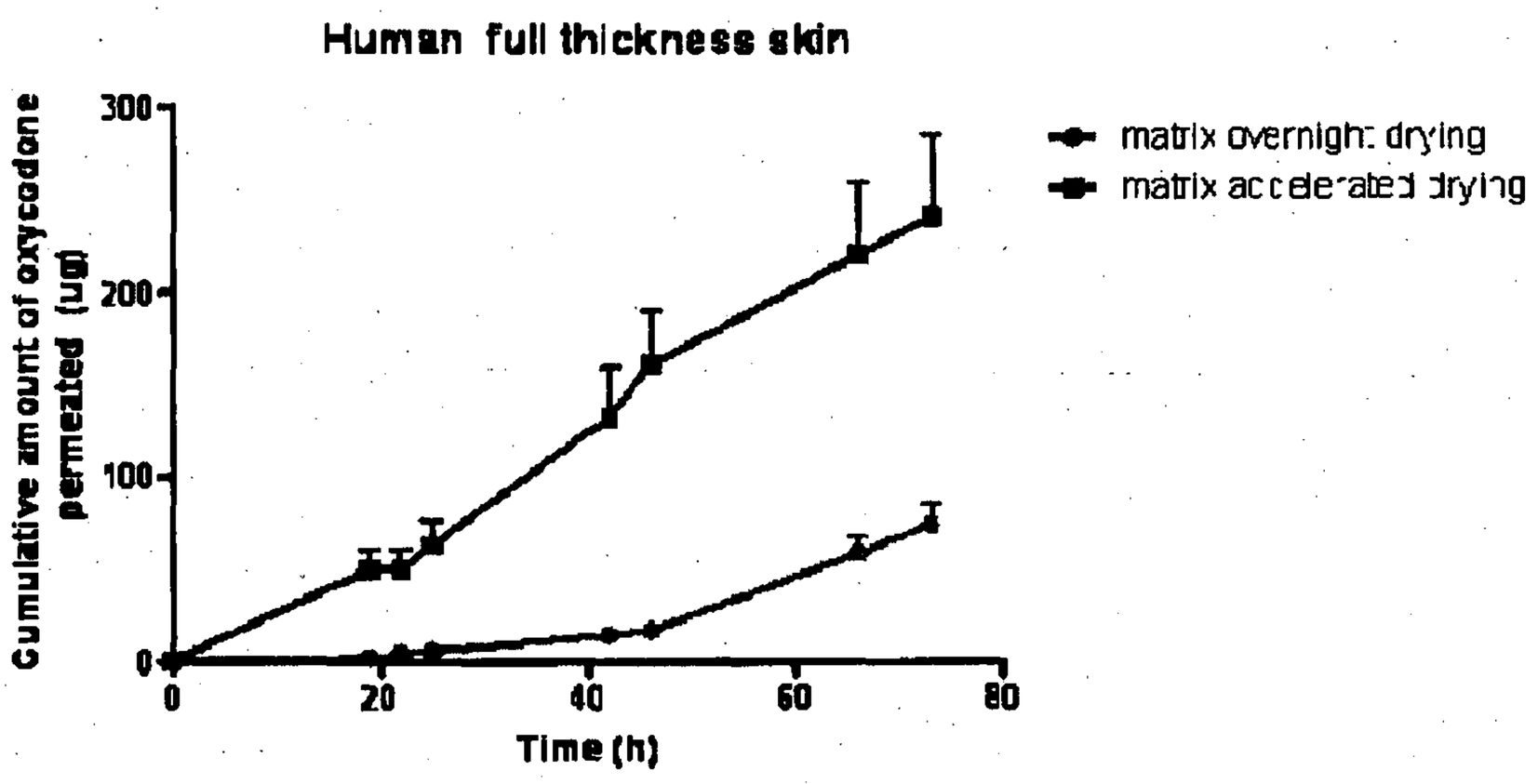


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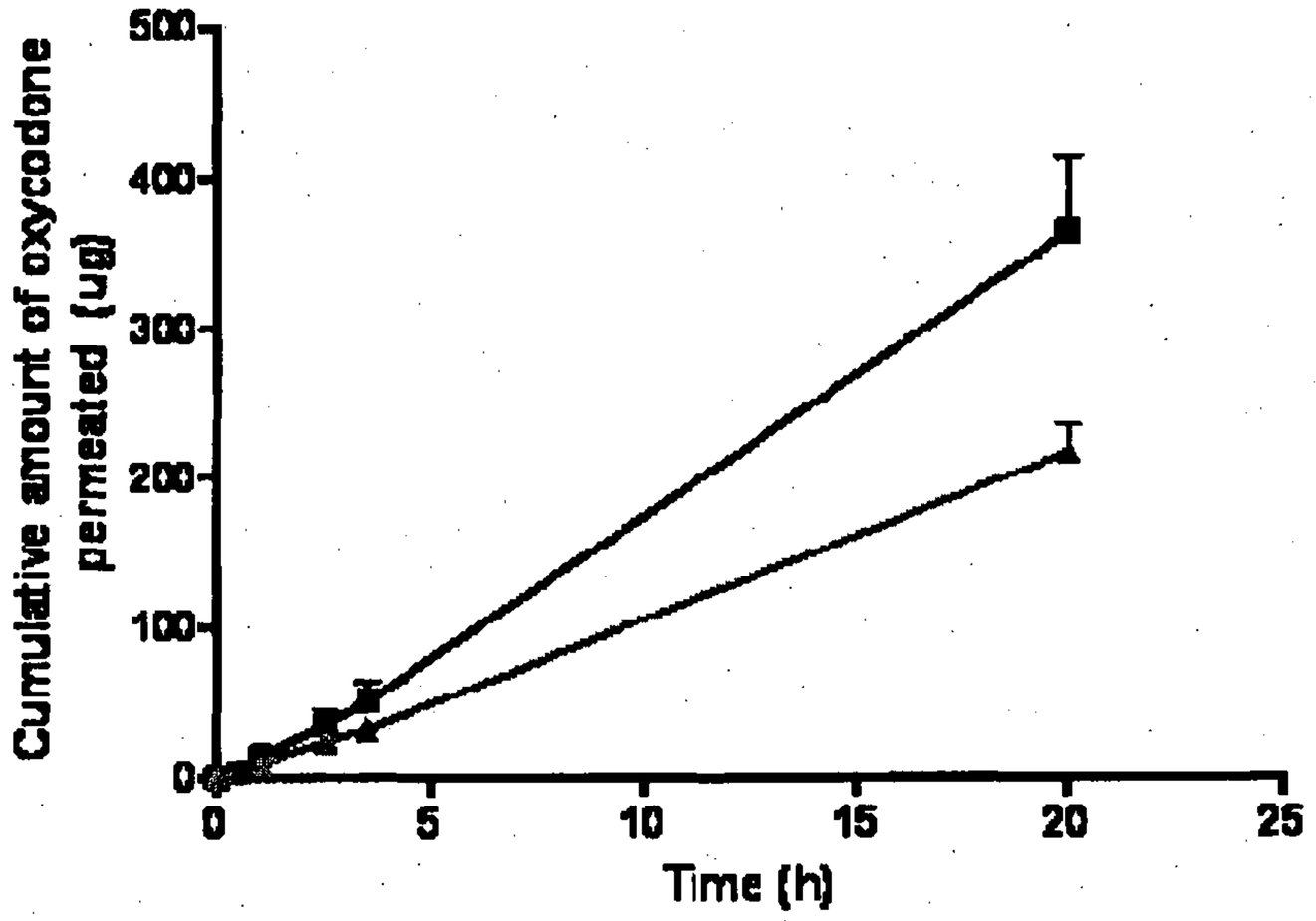


Figure 3

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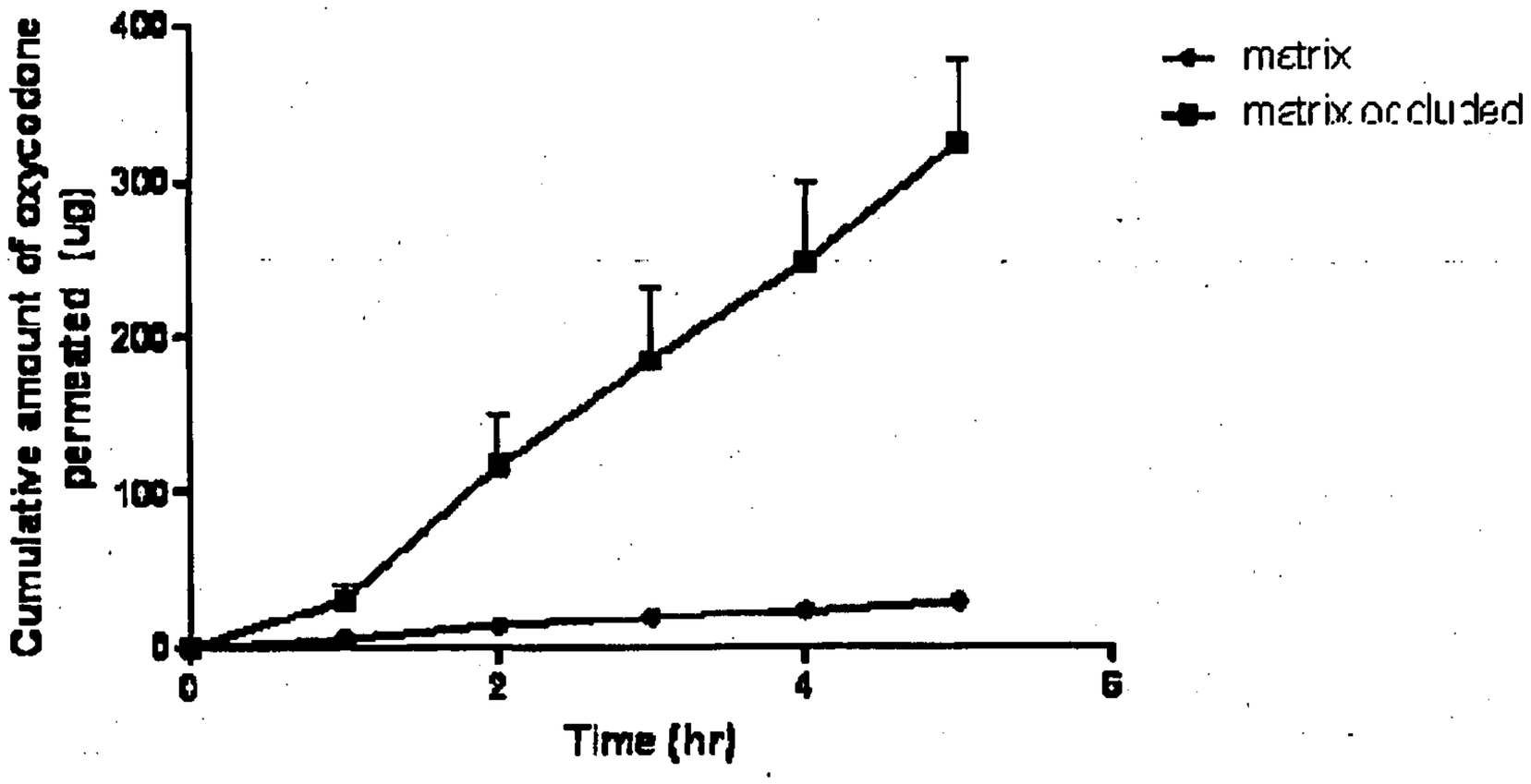


Figure 4

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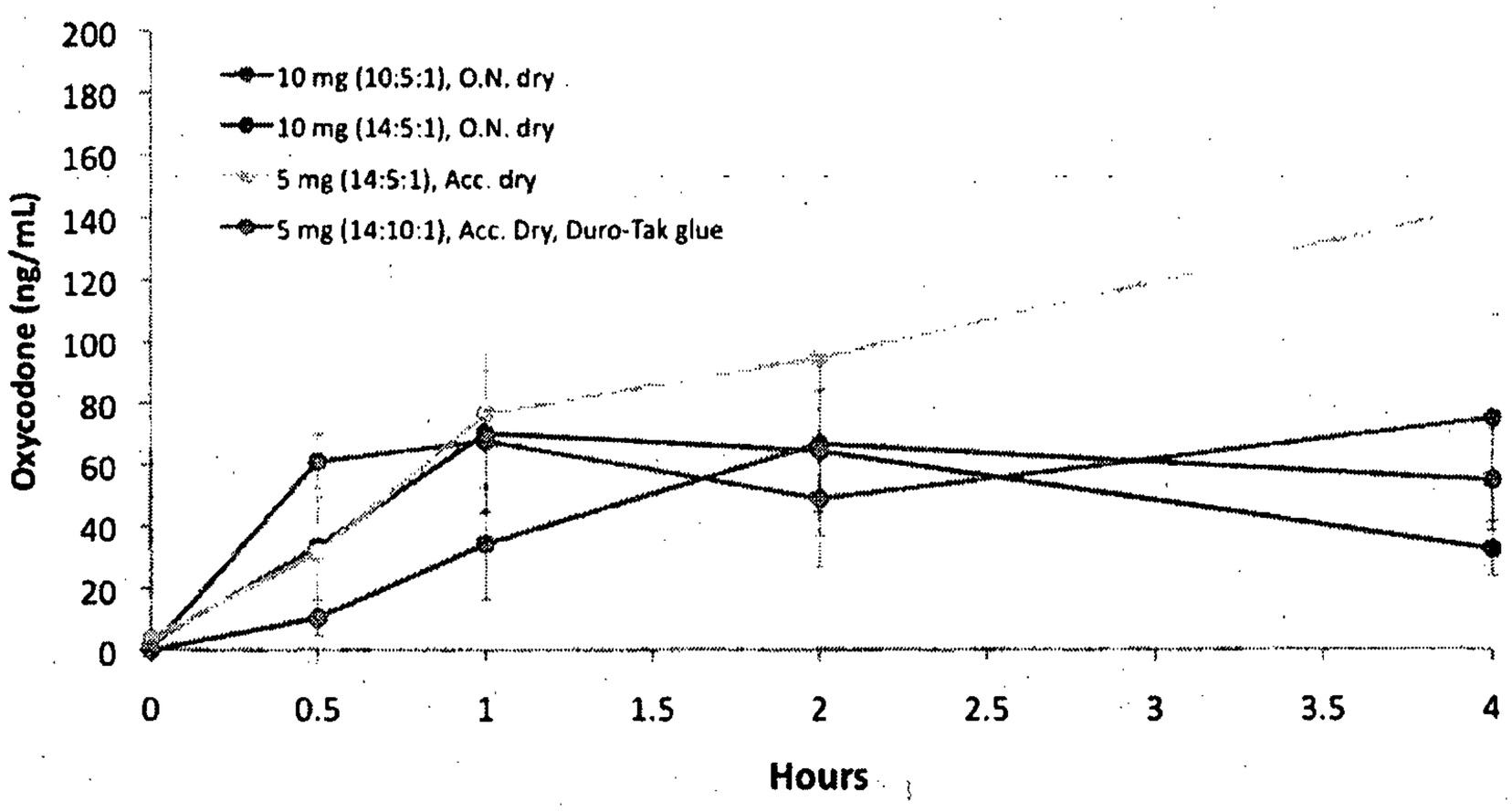


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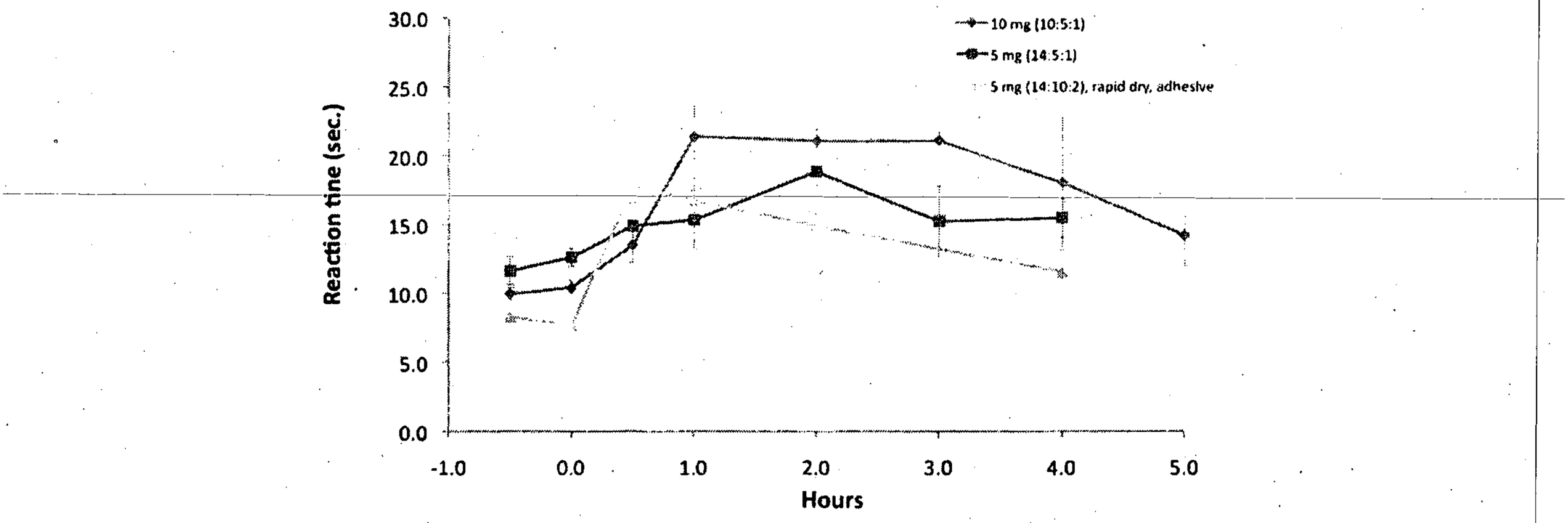


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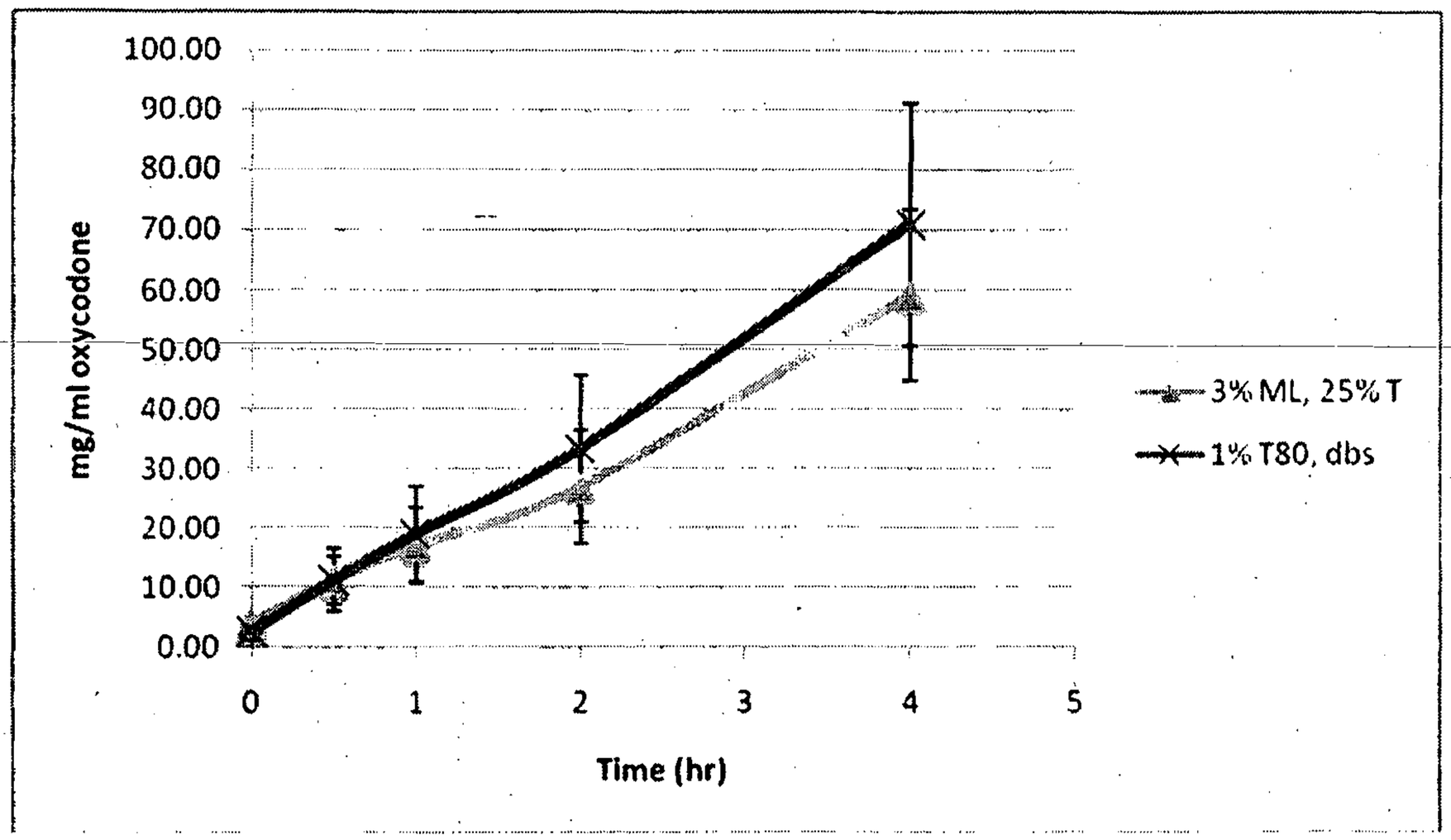


Figure 7

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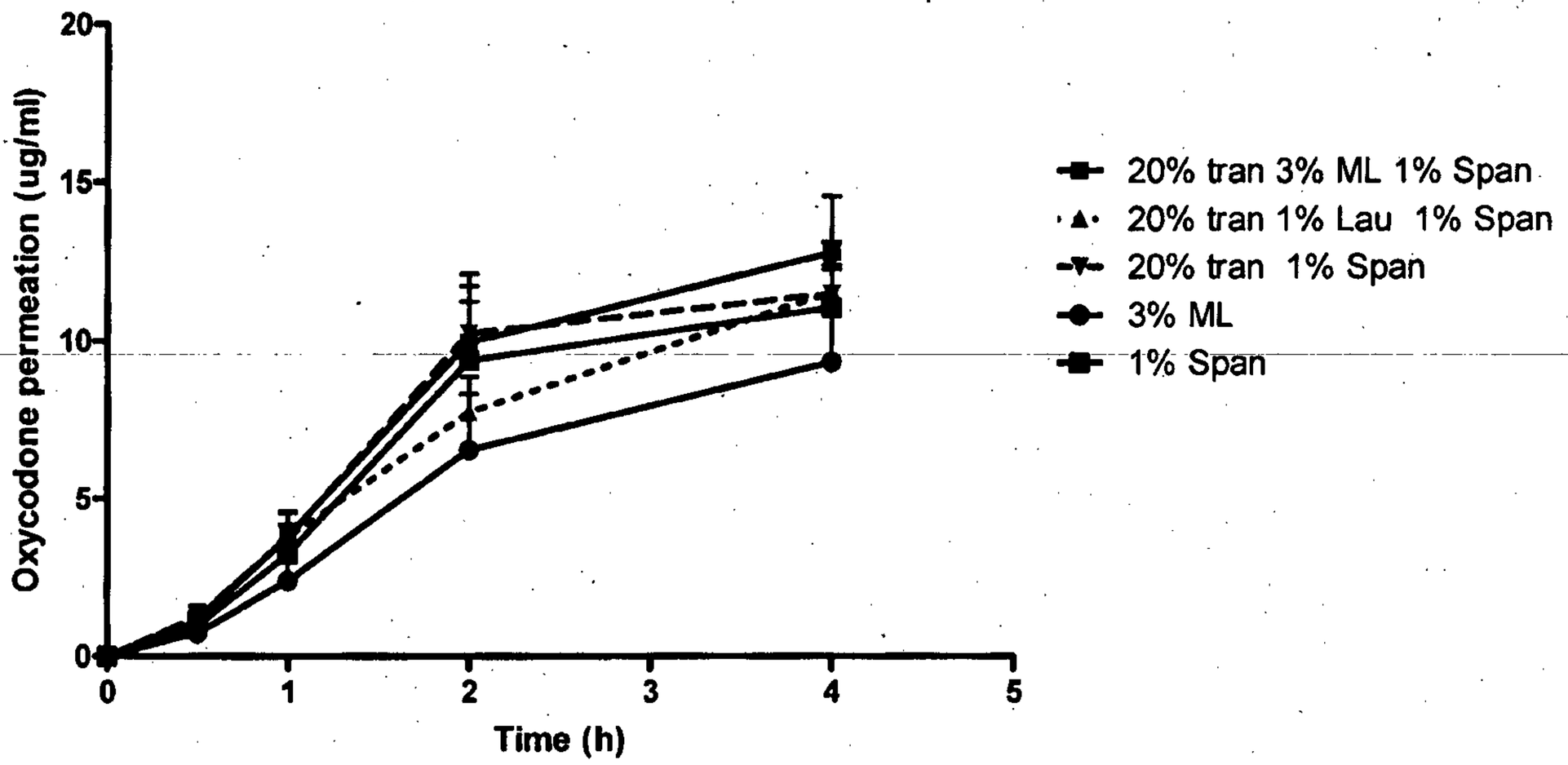


Figure 8

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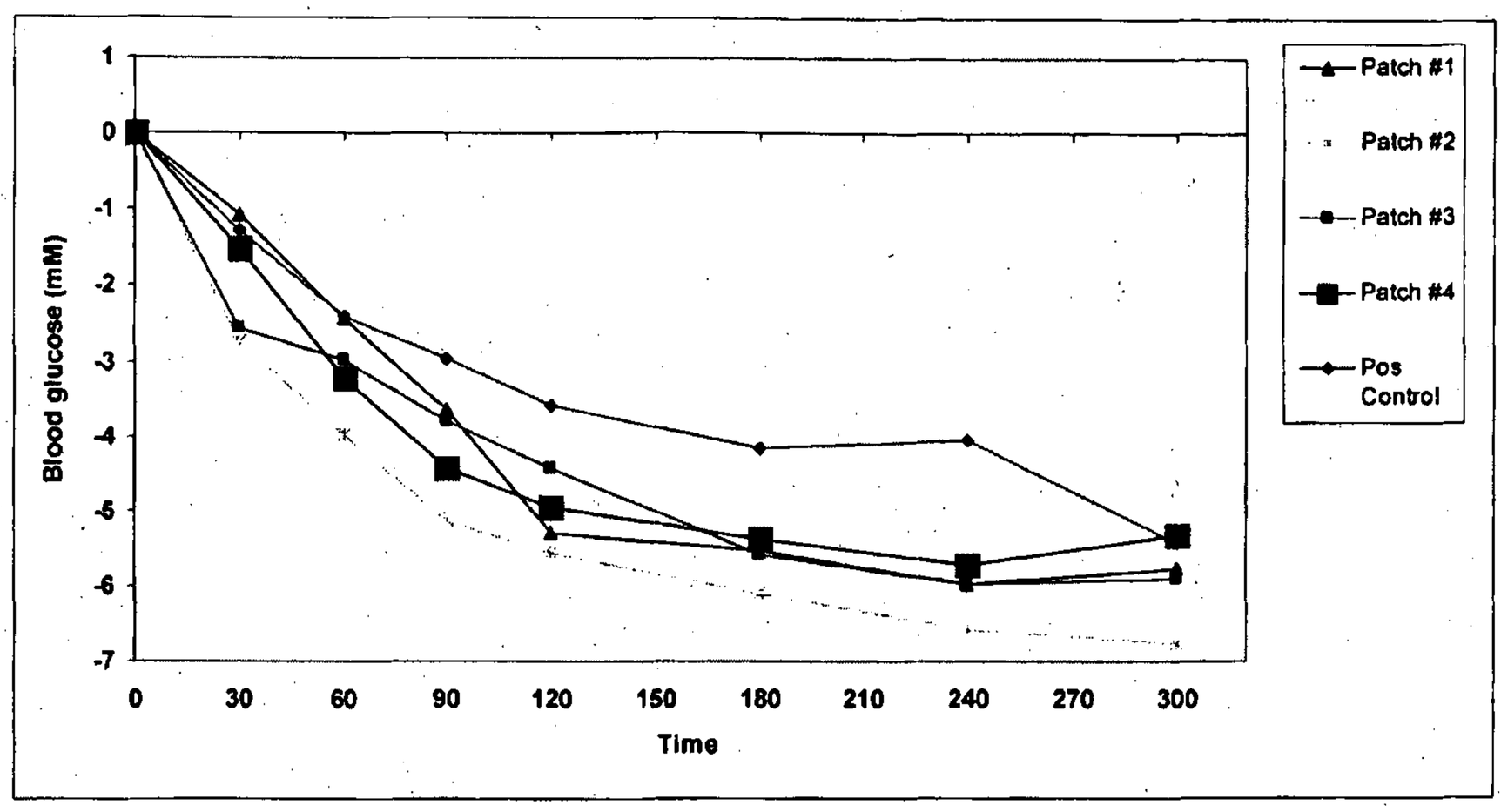


Figure 9

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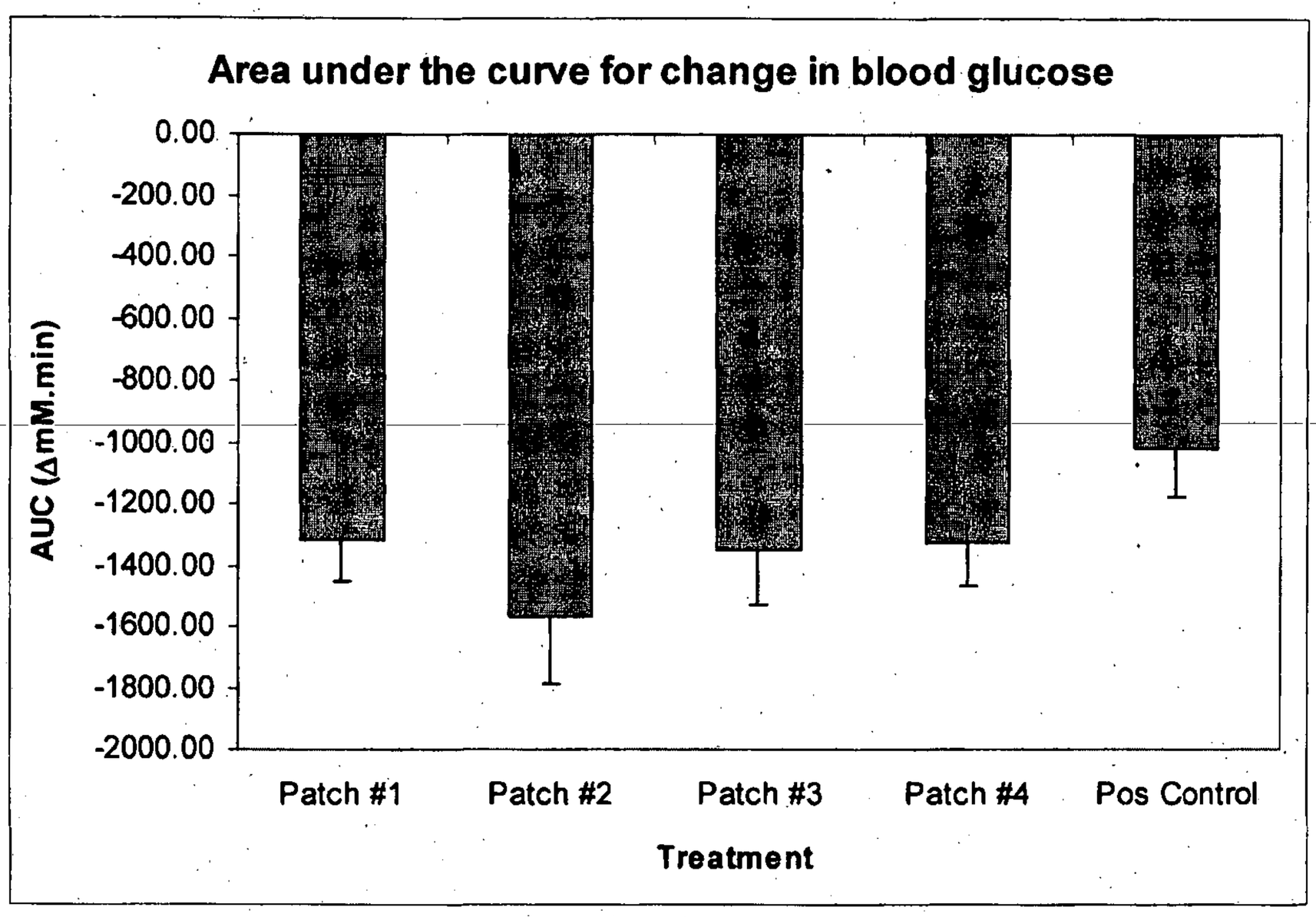


Figure 10

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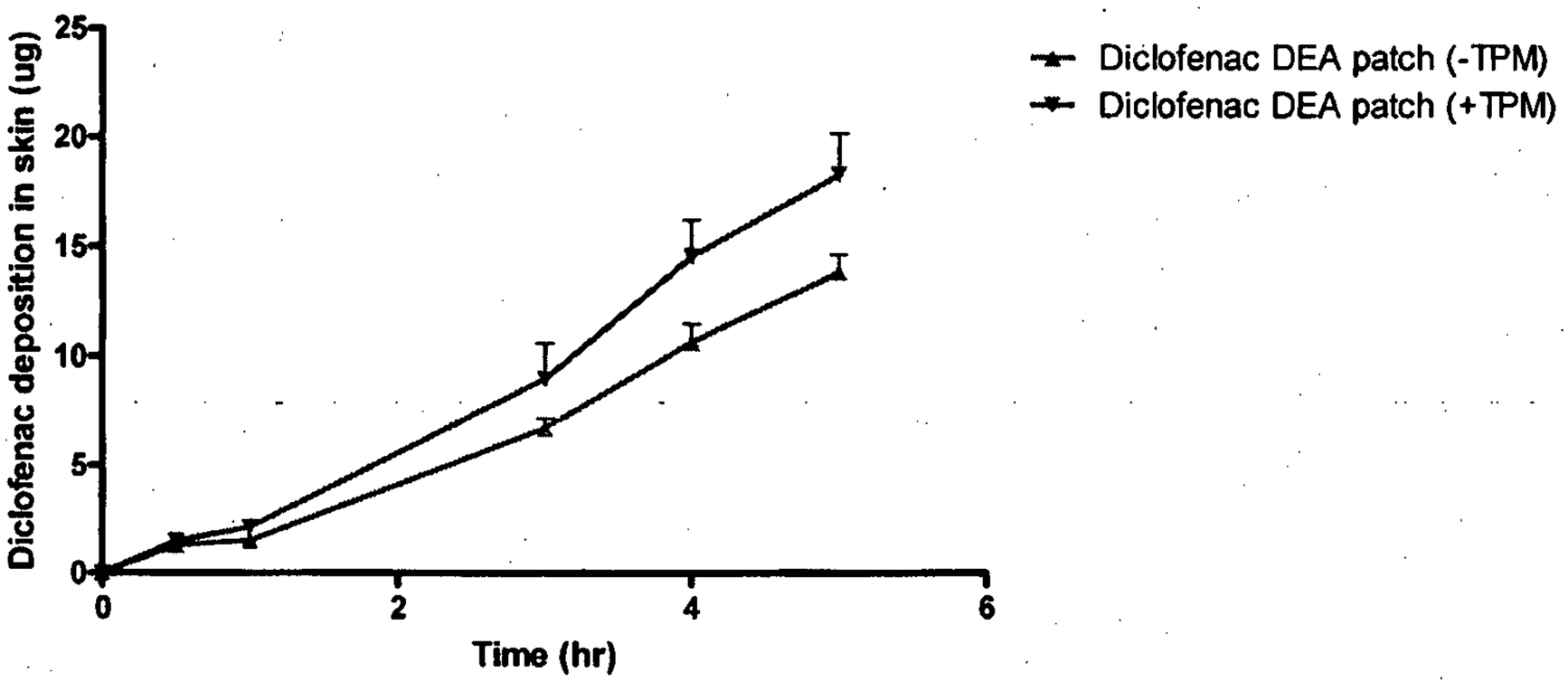


Figure 11

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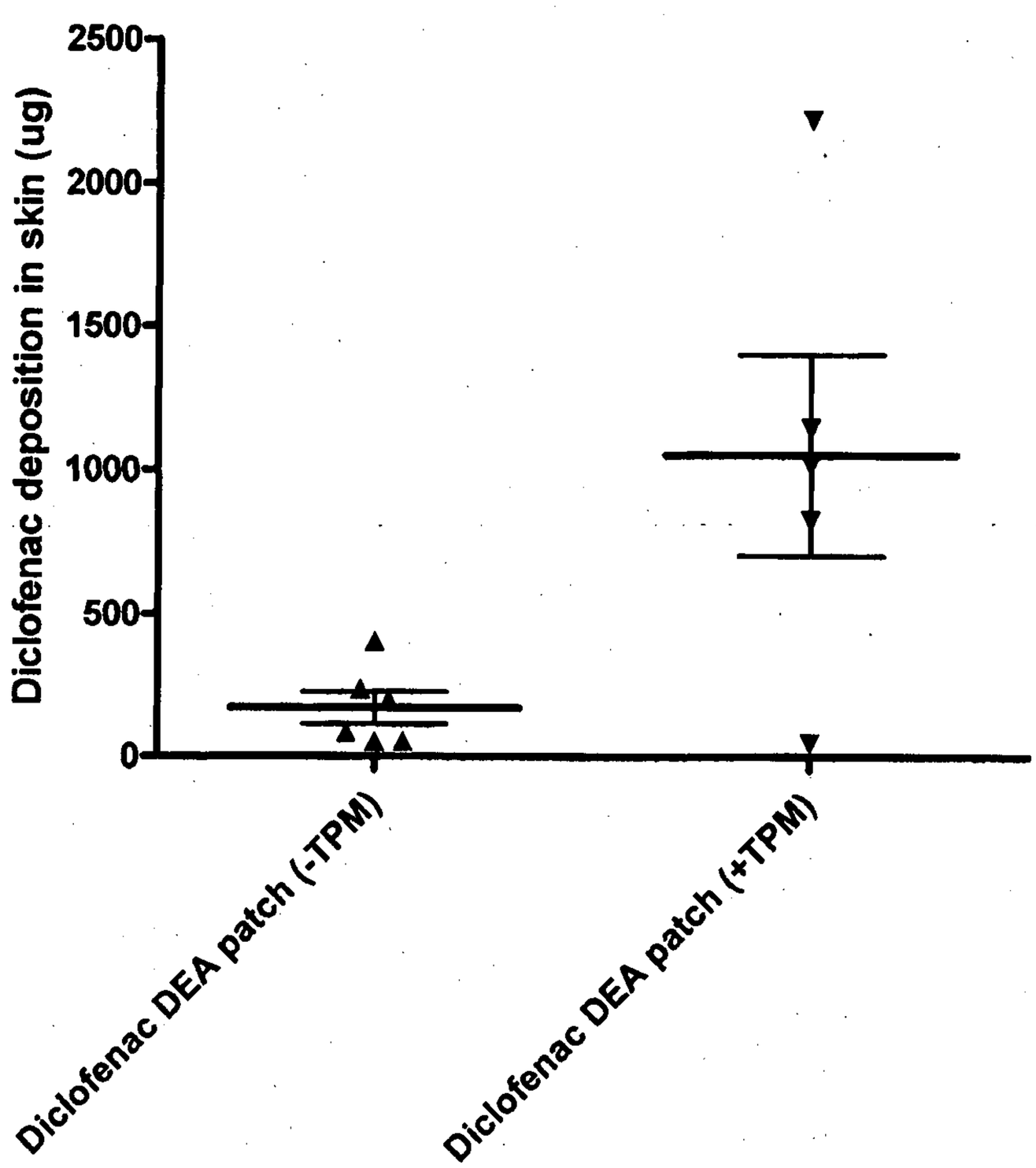


Figure 12

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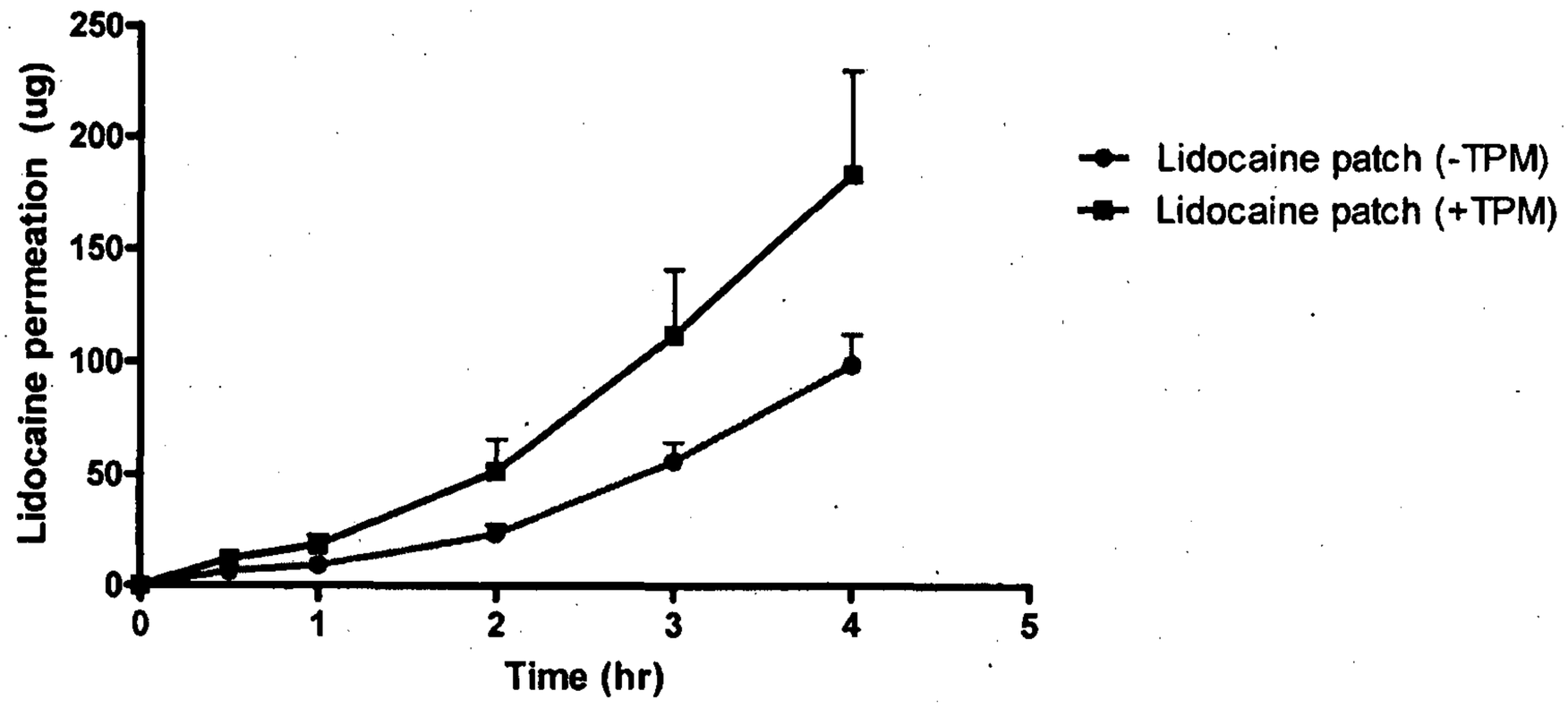


Figure 13

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Backing material

Matrix film

Packaging liner

