

Insect Repellent Composition

[0001] The present invention relates to a composition that repels insects, in particular mosquitoes.

5 [0002] According to the WHO (2017), more than 17% of infectious diseases originate from vector-borne diseases, with more than one million deaths each year. Mosquitoes are the main vectors of these diseases, more specifically those of the genera *Aedes*, *Anopheles* and *Culex*, which transmit to humans: malaria, dengue, chikungunya virus fever, Zika virus fever, Rift Valley fever, yellow fever, West Nile fever, filariasis, as well as various
10 encephalitis. The number of people exposed to the risk of contracting dengue is estimated at more than 3.9 billion in over 129 countries, making it the most widespread viral infection, while malaria accounts for around 219 million cases worldwide and causes more than 400,000 deaths each year, most of them occurring in children under the age of five.

15 [0003] Although the majority of transmitted diseases occur in tropical and subtropical endemic regions, international travel, together with expanding urbanization and globalization, have increased their prevalence in territories that were previously unaffected. This is the case in Europe, which in recent years has seen the appearance on its territory of certain arbovirus-vector mosquitoes such as *Aedes albopictus*. This
20 mosquito currently represents a major risk in France, as it continues to spread into new regions. In addition to transmitting diseases, mosquitoes may also be a source of nuisance, disrupting outdoor activities. Their bites may furthermore lead to secondary infections, itching, irritation, allergic reactions, or pain.

[0004] Among the various means implemented to combat vector-borne diseases
25 transmitted by insects, in particular mosquitoes, protection by repellent effect constitutes a strategy of choice. Indeed, repellency prevents insect bites and thus the spread of the aforementioned diseases. Consequently, there is a constant need for improvement of repellent compositions against disease-vector insects.

[0005] Repellent compositions may be provided in various forms such as sprays, lotions,
30 wipes, and sticks for topical application in order to protect the skin from disease-carrying insects.

[0006] It is also known to impregnate textile materials (for example clothing, bedding, mosquito nets, upholstery fabrics) with repellent compositions in order to provide protection against disease-vector insects:

- either by wearing the treated garment,
- 5 - or by protecting one's environment with a treated mosquito net, bedding, or upholstery fabric.

[0007] Therefore, various treatments for textile materials have been developed to confer repellent properties against disease-vector insects. These treatments consist of impregnating the textile material with a repellent composition, which may, for example,
10 be provided in the form of a spray containing repellent active agents.

[0008] Furthermore, repellent compositions may also be used for aerial diffusion via suitable devices enabling their evaporation or atomization.

[0009] With regard to repellent active agents for combating mosquitoes, synthetic insecticides are intensively used. The most effective molecule for repelling mosquitoes is
15 N,N-diethyl-m-toluamide (hereinafter abbreviated "DEET"), either for cutaneous use or for spatial diffusion (spray). Other compounds used as insecticides include pyrethroids (permethrin and δ -permethrin). These synthetic compounds (amides, imides, piperidines, phthalates, and permethrins) induce toxic effects of varying severity on the central nervous system. The immediate toxicity of most of these chemical products is
20 generally low, but their use may, in the long term, seriously harm public health, particularly in relation to fertility and cancer.

[0010] While pyrethroids are less toxic to humans than DEET, which is not recommended for children under 12 years of age, mosquito resistance to these products has also been reported in 27 sub-Saharan countries. Intensive use of chemical insecticides has led to
25 the development of resistance. The major problem posed by mosquitoes is that they inexorably adapt to the insecticides placed on the market, mainly due to prolonged exposure times and the high doses used.

[0011] The development of such insecticide resistance among various mosquito strains makes it imperative to devise alternative, less toxic methods. Research is being
30 conducted into natural repellents, which could provide interesting solutions in mosquito control. Pyrethroids, which are the most widely used insecticides today, were originally

natural molecules derived from pyrethrum, itself extracted from chrysanthemum flowers, before chemists succeeded in producing the stabilized molecules that are used today.

[0012] The harmful effects of synthetic products have rekindled the need to search for alternatives for the control of harmful and disease-vector mosquitoes. In this respect, plant extracts—particularly tropical plants, which have a long history as important components in traditional medicine and human nutrition—may be considered.

[0013] Patent application BR 0 103 766 A describes a repellent composition comprising *Carapa guianensis* vegetable oil, *Eucalyptus citriodora* essential oil, and a solvent.

[0014] Thus, there is a real need to provide insect repellent compositions, in particular against mosquitoes, that comprise natural constituents, for example plant extracts, and that exhibit the longest possible protection time, at least several hours.

[0015] The inventor of the present invention has quite surprisingly discovered a synergistic effect between an oil and a mixture comprising p-menthane-3,8-diol (hereinafter abbreviated “PMD”) or an essential oil selected from *Lemon eucalyptus* essential oil and *Eucalyptus globulus* essential oil, together with a repellent agent selected from beta-caryophyllene and eucalyptol, to obtain a novel insect repellent composition exhibiting a total protection time significantly improved compared with what would normally be expected from the constituents used in this repellent composition.

[0016] The inventor has thus found that the combination of an oil with a mixture containing PMD and/or an essential oil selected from *Lemon eucalyptus* essential oil and *Eucalyptus globulus* essential oil, and a repellent agent selected from beta-caryophyllene and eucalyptol, makes it possible to obtain a repellent composition whose total protection time is very high compared to repellent compositions known to date and currently available on the market. The repellent composition according to the invention is therefore highly effective in terms of protection against insects, in particular against mosquitoes.

[0017] A first object of the invention is an insect repellent composition comprising at least:

- PMD and/or at least one essential oil selected from *Lemon eucalyptus* essential oil and *Eucalyptus globulus* essential oil,
- at least one repellent agent selected from beta-caryophyllene and eucalyptol,

- a solvent,
said repellent composition being characterized in that it further comprises at least one oil.

[0018] The plant *Hyptis suaveolens* originates from tropical America and is widely distributed in Africa, tropical Asia, and Australia. The main volatile compounds contained in the leaves of this plant are beta-caryophyllene, eucalyptol, sabinene, bergamotene, terpinolene, humulene, and limonene.

[0019] The originality of the repellent composition according to the invention lies in the inclusion of *Hyptis suaveolens* essential oil. The repellent composition according to the invention is distinguished in particular from the repellent composition described in patent application BR 0 103 766 A mentioned above in that it further contains *Hyptis suaveolens* essential oil. The inventor has surprisingly discovered a synergistic effect of *Hyptis suaveolens* essential oil with the other constituents of the repellent composition according to the invention. During the experiments detailed below, better total protection times were obtained with repellent compositions according to the invention compared with those obtained with comparative compositions similar to that described in patent application BR 0 103 766 A. In other words, the repellent composition according to the invention proved to be more effective than comparative compositions similar to that described in patent application BR 0 103 766 A.

[0020] Beta-caryophyllene is one of the most abundant terpenes in nature. It is found notably in clove, black pepper, cultivated hemp, basil, oregano, lavender, rosemary, black cumin, and cinnamon. It is considered safe by the European Food Safety Authority as a food additive, flavor enhancer, cosmetic additive, and aromatic additive.

[0021] PMD is a monoterpene-type organic compound present in very small amounts in the essential oil of *Lemon eucalyptus* leaves (*Corymbia citriodora* or *Eucalyptus citriodora*).

[0022] The repellent composition according to the invention has the advantage of being able to comprise only natural constituents.

[0023] The oil may be selected from vegetable oils, synthetic oils, and semi-synthetic oils. By “semi-synthetic oil” is meant a vegetable oil that has been functionalized to obtain desired properties.

[0024] The oil may be selected from mineral white oils, vegetable oils (derived from flowers, fruits, vegetables, trees, cereals, oilseeds, etc.), animal oils, synthetic oils, silicone oils, and fluorinated oils.

[0025] The vegetable oil may be a fat derived from oilseed grains or fruits.

5 [0026] When it is a vegetable oil, it may, for example, be selected from sweet almond oil, coconut oil, copra oil, castor oil, jojoba oil, olive oil, rapeseed oil, peanut oil, sunflower oil, wheat germ oil, corn germ oil, soybean oil, cottonseed oil, alfalfa oil, poppy seed oil, pumpkin seed oil, evening primrose oil, millet oil, barley oil, rye oil, safflower oil, bancoul nut oil, passionflower oil, hazelnut oil, palm oil, shea butter, apricot kernel oil, camellia
10 seed oil, calophyllum oil, sisymbrium oil, avocado oil, calendula oil, and oils derived from flowers or vegetables.

[0027] The oil may also be selected from esterified vegetable oils.

[0028] The oil may be selected from animal-derived oils, such as squalene and squalane.

[0029] The oil may be selected from mineral oils, such as paraffin oil, vaseline oil, and
15 isoparaffins.

[0030] The oil may be selected from synthetic oils, in particular from fatty acid esters such as butyl myristate, propyl myristate, cetyl myristate, isopropyl palmitate, butyl stearate, hexadecyl stearate, isopropyl stearate, octyl stearate, isocetyl stearate, dodecyl oleate, hexyl laurate, propylene glycol dicaprylate, hexyldecanol, hexyldecanol laurate, or from
20 esters derived from lanolin acid such as isopropyl lanolate, isocetyl lanolate, as well as monoglycerides, diglycerides, and triglycerides of fatty acids such as glyceryl triheptanoate, alkyl benzoates, polyalphaolefins, polyolefins such as polyisobutene, synthetic isoalkanes such as isohexadecane and isododecane, perfluorinated oils, and silicone oils. Among the latter, particular mention may be made of
25 dimethylpolysiloxanes, methylphenylpolysiloxanes, amine-modified silicones, fatty acid-modified silicones, alcohol-modified silicones, alcohol- and fatty acid-modified silicones, polyether-modified silicones, epoxy-modified silicones, fluorinated silicones, cyclic silicones, and alkyl-modified silicones.

[0031] Preferably, the oil is selected from *Carapa procera* oil, shea butter, palm kernel/coco
30 glucoside, coco-caprylate/caprate, plant-derived squalane extracted from olive, coconut oil, copra oil, castor oil, peanut oil, and sunflower oil, taken alone or in mixtures thereof.

[0032] In this regard, it is recalled that shea butter is an edible vegetable oil extracted from shea nuts.

[0033] Most advantageously, the oil is selected from *Carapa procera* oil, *Carapa guianensis* oil, and coco-caprylate/caprate, taken alone or in mixtures thereof.

5 [0034] The solvent is preferably water or an alcohol. More specifically, the alcohol may be selected from ethanol, isopropanol, and propanol.

[0035] The repellent composition may be in the form of a spray. In this embodiment of the invention, the solvent is an alcohol, preferably an alcohol selected from those described above.

10 [0036] The repellent composition may be in the form of a lotion, a cream, or a body milk. In these embodiments of the invention, the solvent is water.

[0037] In one embodiment of the invention, the repellent composition comprises a mixture of *Lemon eucalyptus* essential oil and *Eucalyptus globulus* essential oil.

[0038] In one embodiment of the invention, the repellent composition comprises:

- 15
- PMD,
 - at least one repellent agent selected from beta-caryophyllene and eucalyptol,
 - at least one oil, preferably an oil selected from those described above,
 - a solvent, preferably a solvent selected from those described above,
 - *Hyptis suaveolens* essential oil.

20 [0039] In one embodiment of the invention, the repellent composition comprises:

- at least one essential oil selected from *Lemon eucalyptus* essential oil and *Eucalyptus globulus* essential oil,
- at least one repellent agent selected from beta-caryophyllene and eucalyptol,
- at least one oil, preferably an oil selected from those described above,
- 25 - a solvent, preferably a solvent selected from those described above,
- *Hyptis suaveolens* essential oil.

[0040] In one embodiment of the invention, the repellent composition comprises:

- *Lemon eucalyptus* essential oil,
- beta-caryophyllene,
- 30 - at least one oil selected from *Carapa procera* oil, *Carapa guianensis* oil, and coco-caprylate/caprate,
- a solvent, preferably a solvent selected from those described above,

- *Hyptis suaveolens* essential oil.

[0041] The repellent composition according to the invention may further comprise at least one additional constituent selected from emulsifiers, surfactants, thickeners, film-forming agents, gelling agents, opacifiers, emulsion stabilizers, humectants, antioxidants, preservatives, fragrances, and ultraviolet filters, taken alone or in mixtures thereof.

[0042] The emulsifier may be selected from fatty alcohols and esters, fatty acids and esters, ethoxylated fatty alcohols, emulsifying polysaccharides (for example carrageenan), natural gums (for example acacia gum, guar gum, and xanthan gum), polyol esters (for example polysorbates), and emulsifying polymers (for example celluloses and carbomers), taken alone or in mixtures thereof.

[0043] Preferably, it is cetyl alcohol.

[0044] The surfactant may be selected from anionic, cationic, amphoteric, or non-ionic surfactants that are topically acceptable and commonly used in the field of dermocosmetics.

[0045] Among the anionic surfactants usable in the repellent compositions according to the invention, mention may be made of sulfonate, carboxylate, and phosphate salts such as potassium cetyl phosphate, glyceryl stearate citrate, glyceryl monooleate, and diethylhexyl sulfosuccinate.

[0046] Among the cationic surfactants usable in the repellent compositions according to the invention, mention may be made of quaternary ammonium compounds (for example benzethonium chloride, cetrimide, cetylpyridinium chloride), lauric acid, and myristyl alcohol.

[0047] Among the amphoteric surfactants usable in the repellent compositions according to the invention, mention may be made of betaines, amino acid derivatives, and imidazole derivatives such as lauramidopropyl betaine, coco betaine, and cocoyl hydroxyethyl imidazoline.

[0048] Among the non-ionic surfactants that may be used, mention may be made of polyoxyethylenes, alkanolamides, and oligopeptides such as polysorbate, sorbitan monostearate, coco glucoside, and sucrose laurate.

[0049] The thickener may be selected from carrageenans, alginates, silicates, and natural, synthetic, or semi-synthetic homopolymers or copolymers having thickening properties,

such as xanthan gum, karaya gum, cellulose, hydroxyethylcellulose, and pectin, taken alone or in mixtures thereof.

[0050] The film-forming agent may be selected from natural, synthetic, and semi-synthetic homopolymers or copolymers that are film-forming (for example polyols or fatty alcohols such as guar gum, hydroxyethylcellulose, polyglyceryl methacrylate, fructose, gelatin, glycerin, maltodextrin, methylcellulose, paraffin), taken alone or in combination.

[0051] The gelling agent may be selected from gelling polyols and polymers (for example carbomers, sodium carboxymethylcellulose, carrageenan, and chitosan), taken alone or in combination.

[0052] The opacifier may be selected from calcium silicates, colorants, ethylene glycol palmitostearate, octyldodecanol, titanium oxide, and zinc stearate, taken alone or in combination.

[0053] The emulsion stabilizer may be selected from natural, synthetic, and semi-synthetic polymers (fatty alcohols, cellulose, polysaccharides, such as cetyl stearyl alcohol, sodium carboxymethylcellulose, carrageenan), taken alone or in combination.

[0054] The humectant may be selected from butylene glycol, propylene glycol, polyethylene glycol, ammonium alginate, butylene glycol, cyclomethicone, glycerin, polydextrose, propylene glycol, sodium hyaluronate, sodium lactate, sorbitol, tagatose, trehalose, triacetin, and triethanolamine, taken alone or in combination.

[0055] The antioxidant may be selected from derivatives of vitamins, minerals, thiols, and polyphenols (for example tocopherols, sodium sulfite, sodium thiosulfate, propyl gallate), taken alone or in combination.

[0056] The preservative may be selected from mineral and organic derivatives (for example sorbic acid, parabens, nitrites, sulfites), taken alone or in combination.

[0057] The fragrance may be selected from vanillin, any natural plant extract, or any plant

[0058] The ultraviolet filter may be selected from titanium dioxide and zinc oxide, diethylamino hydroxybenzoyl hexyl benzoate, ethylhexyl triazone, phenylbenzimidazole sulfonic acid dioxide, bis-ethylhexyloxyphenol methoxyphenyl triazine, taken alone or in combination.

[0059] The repellent composition according to the invention may comprise, in weight percentages relative to the total weight of said composition:

- between 5% and 30% of PMD and/or at least one essential oil selected from *Lemon eucalyptus* essential oil and *Eucalyptus globulus* essential oil,
- between 5% and 30% of at least one repellent agent selected from beta-caryophyllene and eucalyptol,
- 5 - between 5% and 30% of at least one oil, preferably an oil selected from those described above,
- q.s. solvent, preferably a solvent selected from those described above.

[0060] "Q.s." stands for "quantum satis," meaning that the weight percentage of solvent in the repellent composition is such that, when added to the percentages of all the other
 10 constituents of said repellent composition, the total equals 100%.

[0061] The repellent composition according to the invention may further comprise at least one additional constituent (preferably an additional constituent such as described above), the weight percentage of which may range from 0.1% to 5%. When the repellent composition comprises several additional constituents, the total of the weight
 15 percentages of the additional constituents may advantageously range from 0.2% to 30%.

[0062] In one embodiment of the invention, the repellent composition according to the invention comprises, in weight percentages relative to the total weight of said composition:

- between 5% and 30% of PMD and/or at least one essential oil selected from *Lemon eucalyptus* essential oil and *Eucalyptus globulus* essential oil,
- 20 - between 5% and 30% of at least one repellent agent selected from beta-caryophyllene and eucalyptol,
- between 5% and 30% of at least one oil, preferably an oil selected from those described above,
- optionally between 0.5% and 10% of *Hyptis suaveolens* essential oil,
- 25 - optionally between 0.1% and 30% of at least one additional constituent, preferably an additional constituent selected from those described above,
- q.s. solvent, preferably a solvent selected from those described above.

[0063] In one embodiment of the invention, the repellent composition according to the invention comprises, in weight percentages relative to the total weight of said composition:

- 30 - between 5% and 30% of PMD and/or at least one essential oil selected from *Lemon eucalyptus* essential oil and *Eucalyptus globulus* essential oil,

- between 5% and 30% of at least one repellent agent selected from beta-caryophyllene and eucalyptol,
- between 5% and 30% of at least one oil, preferably an oil selected from *Carapa procera* oil, shea butter, palm kernel/coco glucoside, coco-caprylate/caprates, plant-derived squalane extracted from olive, coconut oil, copra oil, castor oil, peanut oil, and sunflower oil, taken alone or in mixtures thereof,
- optionally between 0.5% and 10% of *Hyptis suaveolens* essential oil,
- optionally between 0.1% and 30% of at least one additional constituent,
- q.s. solvent, preferably water or an alcohol.

10 [0064] In one embodiment of the invention, the repellent composition according to the invention comprises, in weight percentages relative to the total weight of said composition:

- between 5% and 30% of PMD,
- between 5% and 30% of at least one repellent agent selected from beta-caryophyllene and eucalyptol,
- between 5% and 30% of at least one oil, preferably an oil selected from those described above,
- optionally between 0.5% and 10% of *Hyptis suaveolens* essential oil,
- optionally between 0.1% and 30% of at least one additional constituent, preferably an additional constituent selected from those described above,
- q.s. solvent, preferably a solvent selected from those described above.

[0065] In one embodiment of the invention, the repellent composition according to the invention comprises, in weight percentages relative to the total weight of said composition:

- between 5% and 30% of at least one essential oil selected from *Lemon eucalyptus* essential oil and *Eucalyptus globulus* essential oil,
- between 5% and 30% of at least one repellent agent selected from beta-caryophyllene and eucalyptol,
- between 5% and 30% of at least one oil, preferably an oil selected from those described above,
- optionally between 0.5% and 10% of *Hyptis suaveolens* essential oil,
- optionally between 0.1% and 30% of at least one additional constituent, preferably an additional constituent selected from those described above,
- q.s. solvent, preferably a solvent selected from those described above.

[0066] In one embodiment of the invention, the repellent composition comprises:

- between 5% and 30% of *Lemon eucalyptus* essential oil,
- between 5% and 30% of beta-caryophyllene,
- between 5% and 30% of *Carapa procera* oil and/or coco-caprylate/caprate,
- 5 - optionally between 0.5% and 10% of *Hyptis suaveolens* essential oil,
- optionally between 0.1% and 30% of at least one additional constituent, preferably an additional constituent selected from those described above,
- q.s. solvent, preferably a solvent selected from those described above.

[0067] The present invention also relates to a process for manufacturing the repellent

10 composition as described above. The manufacturing process comprises at least the following steps:

1) an active base is prepared by carrying out steps a) and b):

a) PMD and/or at least one essential oil selected from *Lemon eucalyptus* essential oil and *Eucalyptus globulus* essential oil is mixed with at least one repellent agent
15 selected from beta-caryophyllene and eucalyptol, and optionally *Hyptis suaveolens* essential oil,

b) to the mixture from step a) is added at least one oil, preferably an oil selected from those described above, so as to obtain the active base,

2) the repellent composition is finalized as follows:

20 2a) when the solvent is water:

- the optional additional lipophilic constituents are added to the active base,
- an aqueous phase is prepared by adding to the water the optional additional hydrophilic constituents,
- said aqueous phase is mixed with the active base to which the optional lipophilic
25 additional constituents may have been added, so as to obtain the repellent composition in the form of an oil-in-water emulsion,

2b) when the solvent is alcohol:

- the active base is mixed with alcohol and the optional additional constituents so as to obtain the repellent composition in a sprayable form.

30 [0068] At the end of step b), the active base is in the form of oily microdroplets. More specifically, PMD and/or at least one essential oil selected from *Lemon eucalyptus*

essential oil and *Eucalyptus globulus* essential oil, at least one repellent agent selected from beta-caryophyllene and eucalyptol, and *Hyptis suaveolens* essential oil constitute the core of these microdroplets, which is surrounded by at least one oil.

[0069] It is entirely within the competence of a person skilled in the art to determine

5 whether the optional additional constituents are lipophilic or hydrophilic and whether they should therefore be added to the active base, to the water, or to the alcohol.

[0070] When the solvent is alcohol, the constituents of the active base readily mix with the alcohol. There is no phase separation problem.

[0071] Moreover, in this embodiment of the invention, once sprayed onto the skin, the

10 repellent composition provides a film-forming effect on the skin, which may additionally yield an efficiency gain of 13.3% through simple friction.

[0072] When the solvent is water, the repellent composition is in the form of an oil-in-water emulsion. The repellent composition comprises microparticles containing the active base, which are dispersed in the continuous aqueous phase. These microparticles spread

15 easily over the skin, and the constituents of the active base are released more slowly than when the repellent composition contains alcohol as a solvent.

[0073] Therefore, the total protection times are longer when the repellent composition comprises water as the solvent and is thus in the form of an oil-in-water emulsion, compared to when the repellent composition comprises alcohol as the solvent.

20 [0074] Preferably, steps a) and b) are carried out at a temperature between 25°C and 60°C. For example, the temperature is 45°C. A water bath may be used for this purpose.

[0075] Steps a) and b) are advantageously carried out with a dispersion and homogenization device, for example an Ultra-Turrax® device.

[0076] During step a), the mixing speed may range from 1,500 revolutions per minute to

25 7,000 revolutions per minute. In one embodiment of the invention, it is 5,000 revolutions per minute.

[0077] During step b), the mixing speed may range from 1,500 revolutions per minute to 18,000 revolutions per minute. In one embodiment of the invention, it is 13,000 revolutions per minute.

30 [0078] The duration of step a) may range from 1 minute to 10 minutes. In one embodiment of the invention, it is 3 minutes.

[0079] The duration of step b) may range from 1 minute to 10 minutes. In one embodiment of the invention, it is 7 minutes.

[0080] When the solvent is water, the optional additional lipophilic constituents are added to the active base by subjecting the mixture to a mixing speed ranging from 1,500 revolutions per minute to 18,000 revolutions per minute, for a duration of 1 to 10 minutes, and at a temperature between 25°C and 60°C. In one embodiment of the invention, the mixing speed is 13,000 revolutions per minute, the duration of this step is 3 minutes, and the temperature of the mixture is 45°C (obtained using a water bath). This step is advantageously carried out with a dispersion and homogenization device, for example an Ultra-Turrax® device.

[0081] The optional hydrophilic additional constituents are added to the water by subjecting the mixture to a mixing speed ranging from 1,500 revolutions per minute to 18,000 revolutions per minute, for a duration of 1 to 10 minutes, and at a temperature between 25°C and 60°C. In one embodiment of the invention, the mixing speed is 14,000 revolutions per minute, the duration of this step is 5 minutes, and the temperature of the mixture is 45°C (obtained using a water bath). This step is advantageously carried out with a dispersion and homogenization device, for example an Ultra-Turrax® device.

[0082] Finally, said aqueous phase is mixed with the active base, to which the optional lipophilic additional constituents may have been added, by subjecting the mixture to a mixing speed ranging from 1,500 revolutions per minute to 18,000 revolutions per minute, for a duration of 1 to 10 minutes, and at a temperature between 25°C and 60°C. In one embodiment of the invention, the mixing speed is 13,000 revolutions per minute, the duration of this step is 3 minutes, and the temperature of the mixture is 45°C (obtained using a water bath). This step is advantageously carried out with a dispersion and homogenization device, for example an Ultra-Turrax® device.

[0083] When the solvent is alcohol, the active base is mixed with alcohol by subjecting the mixture to a mixing speed ranging from 1,500 revolutions per minute to 10,000 revolutions per minute, for a duration of 1 to 10 minutes, and at a temperature between 20°C and 35°C. In one embodiment of the invention, the mixing speed is 5,000 revolutions per minute, the duration of this step is 3 minutes, and the temperature of the mixture is ambient temperature (about 20°C). This step is advantageously carried out with a dispersion and homogenization device, for example an Ultra-Turrax® device.

[0084] The repellent composition according to the invention may also be manufactured using an ultrasound device (or other mechanical stirring devices). This device makes it possible to stir the constituents of the mixtures in the different steps of the manufacturing process.

5 [0085] The repellent composition according to the invention is preferably repellent against mosquitoes. For example, it may concern the following mosquito species: *Aedes aegypti*, *Culex pipiens*, and *Anopheles gambiae*.

[0086] The repellent composition may be applied directly to the skin.

[0087] In another embodiment of the invention, the repellent composition according to the
10 invention may be diffused into the air using a suitable device (for example a device plugged into an electrical outlet).

[0088] The present invention also relates to a method for repellent treatment against insects (preferably mosquitoes) of a textile material, characterized in that at least one repellent composition according to the invention as described above is sprayed onto at
15 least a portion of said textile material.

[0089] The textile material may be selected from natural textile materials such as cotton, feather, down; synthetic textile materials such as polyesters, nylon, acrylics; or mixed textile materials.

[0090] Within the scope of the present invention, the term "textile material" refers to any
20 textile material selected, for example, from:

- non-woven textiles (for example felts),
 - woven textiles (for example warp and weft fabrics), or
 - knitted textiles (for example knits),
- which are composed of fibers, filaments, or yarns, taken alone or in mixtures thereof, of
25 natural and/or synthetic origin.

[0091] The fibers may be spun, carded, or twisted. The natural fibers, filaments, or yarns may be of plant or animal origin and thus selected from cotton, wool, silk, jute, linen, hemp, and viscose. The synthetic fibers, filaments, or yarns may also be synthetic in origin and selected from polyamides, aramids, polyesters, polyacrylonitriles, aramids,
30 polybenzimidazole, polyether-ether-ketone, polyphenylene sulfides, polyacrylics, chlorofibers, polyolefins such as polypropylene or polyethylene.

[0092] The textile material treated with the repellent composition according to the invention may be used in various fields such as:

- bedding (quilts, duvets, pillows, sheets, pillowcases, blankets);

clothing;

5 - furnishings (mosquito nets, carpets, curtains);

- storage (packaging covers for clothing, bedding items such as quilts and blankets, or furnishings).

[0093] In one embodiment of the invention, between 0.01 and 50 g/m², preferably between 0.01 and 20 g/m², of repellent composition according to the invention is sprayed onto
10 said textile material.

[0094] Spraying may be carried out manually or automatically, for example with a mechanical, pneumatic, electrical, or compressed-air sprayer.

[0095] The repellent compositions according to the invention may be ready-to-use or diluted in a suitable excipient before being sprayed onto the textile. It is within the competence
15 of a person skilled in the art to determine any dilutions to be carried out before spraying the repellent composition according to the invention onto the textile.

[0096] The repellent treatment process according to the invention may consist of domestic use. For example, the user sprays the repellent composition onto a garment, a bedding or furnishing item, a storage cover, or a mosquito net to be protected from insects (for
20 example mosquitoes).

[0097] In another embodiment, the repellent treatment process according to the invention is implemented on an industrial line. The repellent composition according to the invention may thus be sprayed onto a textile material during an industrial process, for example an industrial process for manufacturing clothing, bedding or furnishing items, storage covers, or mosquito nets, so as to treat them before their use.
25

[0098] The textile material may be selected from clothing, bedding or furnishing items, storage covers, or mosquito nets.

[0099] The present invention therefore also relates to a textile material that has been treated by spraying a repellent composition according to the invention as described
30 above. The textile material may be a textile material as described above.

[0100] The present invention also relates to a product that has been treated by spraying a repellent composition according to the invention as described above, preferably in the amounts described above. The product may be a product as described above, for example a garment, a bedding or furnishing item, a storage cover, or a mosquito net.

5 [0101] The invention will now be described using the following non-limiting examples.

[0102] EXPERIMENTAL PART:

[0103] Experiments were carried out to measure the total protection time obtained with test compositions, namely repellent compositions according to the invention and comparative compositions, after their application to the skin and exposure to
10 mosquitoes.

[0104] During these experiments, mosquitoes of the species *Anopheles gambiae* and *Aedes aegypti* were used. The mosquito colony was maintained in a chamber at a temperature of 27°C with a humidity rate of 80% and a photoperiod of 12 hours of light and 12 hours of darkness. The mosquito larvae were fed with fish food. The emerged adults were
15 placed in cubic cages measuring 45 cm per side and fed with a 10% sugar solution. The females used during the experiments came from batches of mosquitoes aged 4 to 7 days post-emergence.

[0105] The experimental protocol implemented was that described in the *Guidelines for efficacy testing of mosquito repellents on human skin*
20 (WHO/HTM/NTD/WHOPES/2009.4), WHO, 2009.

[0106] This was the “arm-in-cage” test. Volunteers (men and women aged 20 to 45 years) who had applied a test composition to their forearms (i.e., the area extending from the wrist to the elbow, approximately 600 cm² of skin) successively placed their arms into the mosquito cage.

25 [0107] The total protection time corresponded to the time between the application of the tested composition on the skin and the first mosquito bite and/or the landing and maintenance on the skin of two mosquitoes probing without biting.

[0108] Example 1: Synergistic effect of the combination of beta-caryophyllene, *Lemon eucalyptus* essential oil, with coco-caprylate/caprate and *Hyptis suaveolens* essential oil:

30 [0109] Table 1 below details the weight percentages of the constituents of a first repellent composition according to the invention (“IQ-1”), of a first comparative repellent composition (“C1A”), and of a second comparative repellent composition (“C1B”)

corresponding to the repellent composition according to the invention IQ-1;
the total protection times of these three compositions IQ-1, C1A, and C1B.

[0110] [Table 1]

Tested Repellent Compositions (Weight Percentages and Total Protection Time)

Constituents (% w/w)	IQ-1	C1A	C1B
Water (qs to 100%)	qs	qs	qs
Xanthan gum	1%	1%	1%
Hexyl decanol	3%	3%	3%
Hexyldecyl laurate	3%	3%	3%
Sucrose laurate	2%	2%	2%
Cetearyl alcohol	1%	1%	1%
<i>Carapa procera</i> oil	10%	10%	0%
<i>Lemon eucalyptus</i> essential oil (<i>Eucalyptus citriodora</i>)	20%	20%	0%
Tocopherol	1%	1%	1%
Sorbic acid	2%	2%	2%
Vanillin powder	5%	5%	5%
<i>Hyptis suaveolens</i> essential oil	2%	0%	2%
Beta-caryophyllene	5%	5%	0%
Total protection time	10.5 hours	3.8 hours	0 hours

5 Table 1 detailing the constituents of compositions IQ-1, C1A and C1B and their total protection time.

[0111] The total protection time of the first repellent composition according to the invention (“IQ-1”) was 10.5 hours. Such a total protection time of more than 10 hours is highly remarkable for a repellent composition. Such a duration of total protection has never
10 been achieved with repellent compositions known from the prior art.

[0112] The first comparative composition (“C1A”) was a composition identical to composition IQ-1 except that it was devoid of *Hyptis suaveolens* essential oil. The total protection time of this first comparative composition “C1A” was 3.8 hours.

[0113] The 2nd comparative composition (“C1B”) was a composition identical to
15 composition IQ-1, except that it was devoid of beta-caryophyllene, *Lemon eucalyptus* essential oil, and *Carapa procera* oil. The total protection time of the 2nd comparative composition “C1B” was 0 hours.

[0114] In view of the different protection times detailed in Table 1 above, it is observed that the addition of *Hyptis suaveolens* essential oil to the repellent composition according to the invention IQ-1 significantly improved its total protection time compared with the total protection time of the comparative composition C1A (10.5 hours versus 3.8 hours).

Furthermore, the zero total protection time of comparative composition C1B demonstrates that *Hyptis suaveolens* essential oil does not exhibit an effect on its own in a repellent composition. It must be combined with other constituents, namely *Lemon eucalyptus* essential oil, beta-caryophyllene, and *Carapa procera* oil, in order to produce a synergistic effect and thereby achieve a very high total protection time.

[0115] The synergy between the active constituents, namely:

- the mixture of *Lemon eucalyptus* essential oil, beta-caryophyllene, and *Carapa procera* oil on the one hand, and
- *Hyptis suaveolens* essential oil on the other hand,

was calculated by comparing the total protection time results of composition IQ-1 and the comparative compositions C1A and C1B.

[0116] In order to use Colby's formula, which is based on efficacy percentages, and thus to enable comparison between the efficacies of the tested repellent compositions, an efficacy percentage was determined as a function of the total protection time of each repellent composition as follows:

- a total protection time of 0 hours corresponded to 0% efficacy;
- a total protection time of 1 hour corresponded to 10% efficacy;
- a total protection time of 1.5 hours corresponded to 15% efficacy;
- a total protection time of 8 hours corresponded to 80% efficacy.

[0117] The total protection time of composition IQ-1 was 10.5 hours, corresponding to an observed efficacy of 105%. The total protection time of the first comparative composition C1A was 3.8 hours, corresponding to an observed efficacy of 38%. The total protection time of the second comparative composition C1B was 0 hours, corresponding to an observed efficacy of 0%.

[0118] According to Colby's formula (1) below (S. R. Colby, *Calculating synergistic and antagonistic responses of herbicide combinations*, Weeds, 1967, 15, pages 20–22):

$$[0119] \text{ Expected \% efficacy} = X + Y - (X \times Y) / 100 \quad (1)$$

[0120] The expected % efficacy of the 1st composition according to the invention IQ-1 was 38%, versus 105%, which is the observed efficacy percentage of said composition IQ-1.

[0121] This 1st example demonstrates the synergistic effect between the mixture of *Lemon eucalyptus* essential oil and beta-caryophyllene, *Carapa procera* oil, and *Hyptis*

5 *suaveolens* essential oil. In other words, the combination of *Hyptis suaveolens* essential oil with *Carapa procera* oil and a mixture containing *Lemon eucalyptus* essential oil and beta-caryophyllene makes it possible to significantly improve the total protection time of the repellent composition.

[0122] Example 2: Synergistic effect of the combination of beta-caryophyllene, *Lemon eucalyptus* essential oil, *Carapa guianensis* oil, and *Hyptis suaveolens* essential oil.

10

[0123] In Example 2, *Carapa procera* oil was replaced with *Carapa guianensis* oil. In other words, *Carapa procera* oil was replaced with another species belonging to the *Carapa* genus.

[0124] Table 2 below details:

- 15 - the weight percentages of the constituents of a second repellent composition according to the invention ("IQ-2"),
- a first comparative repellent composition ("C2A"), and
- a second comparative repellent composition ("C2B") corresponding to the second repellent composition according to the invention IQ-2;
- 20 - the total protection times of these three compositions IQ-2, C2A and C2B.

[0125]

Table 2 — Tested Repellent Compositions (Weight Percentages and Total Protection Time)

Constituents (% w/w)	IQ-2	C2A	C2B
Water (qs to 100%)	qs	qs	qs
Xanthan gum	1%	1%	1%
Hexyl decanol	3%	3%	3%
Hexyldecyl laurate	3%	3%	3%
Sucrose laurate	2%	2%	2%
Cetearyl alcohol	1%	1%	1%
<i>Carapa guianensis</i> oil	10%	10%	0%
<i>Lemon eucalyptus</i> essential oil (<i>Eucalyptus citriodora</i>)	20%	20%	0%
Tocopherol	1%	1%	1%
Sorbic acid	2%	2%	2%

Constituents (% w/w)	IQ-2	C2A	C2B
Vanillin powder	5%	5%	5%
<i>Hyptis suaveolens</i> essential oil	2%	0%	2%
Beta-caryophyllene	5%	5%	0%
Total protection time	10 hours	6.5 hours	0 minutes

Table 2 detailing the constituents of compositions IQ-2, C2A and C2B and their total protection time.

[0126] The 1st comparative composition ("C2A") was a composition identical to composition IQ-2 except that it was devoid of *Hyptis suaveolens* essential oil.

[0127] The 2nd comparative composition ("C2B") was a composition identical to composition IQ-2, except that it was devoid of beta-caryophyllene, *Lemon eucalyptus* essential oil, and *Carapa guianensis* oil.

[0128] In view of the different protection times detailed in Table 2 above, it is observed that the addition of *Hyptis suaveolens* essential oil to the repellent composition according to the invention IQ-2 improved its total protection time compared with the total protection time of comparative composition C2A (10 hours versus 6.5 hours). Furthermore, the zero total protection time of comparative composition C2B demonstrates that *Hyptis suaveolens* essential oil does not exhibit an effect on its own in a repellent composition. It must be combined with other constituents, namely *Lemon eucalyptus* essential oil, beta-caryophyllene, and *Carapa guianensis* oil, in order to produce a synergistic effect and thereby achieve a very high total protection time.

[0129] This Example 2, implemented with *Carapa guianensis* oil, shows that a repellent composition according to the invention is more effective than a repellent composition as described in patent application BR 0 103 766 A mentioned above, which, it should be recalled, is devoid of *Hyptis suaveolens* essential oil. This Example 2 demonstrates the full benefit of the presence of *Hyptis suaveolens* essential oil in the repellent composition according to the invention.

[0130] The synergy between the active constituents, namely:

- the mixture of *Lemon eucalyptus* essential oil, beta-caryophyllene, and *Carapa guianensis* oil on the one hand, and
- *Hyptis suaveolens* essential oil on the other hand,

was calculated by comparing the total protection time results of composition IQ-2 and the comparative compositions C2A and C2B.

[0131] The total protection time of composition IQ-2 was 10 hours, corresponding to an observed efficacy of 100%. The total protection time of the 1st comparative composition C2A was 6.5 hours, corresponding to an observed efficacy of 65%. The total protection time of the 2nd comparative composition C2B was 0 hours, corresponding to an observed efficacy of 0%.

[0132] According to Colby's formula (1), the expected % efficacy of the 2nd composition according to the invention IQ-2 was 65%, versus 100%, which is the observed efficacy percentage of said composition IQ-2.

[0133] This 2nd example also demonstrates the synergistic effect between the mixture of *Lemon eucalyptus* essential oil and beta-caryophyllene, *Carapa guianensis* oil (namely an oil different from that of Example 1, which was *Carapa procera* oil), and *Hyptis suaveolens* essential oil. In other words, the combination of *Hyptis suaveolens* essential oil with *Carapa guianensis* oil and a mixture containing *Lemon eucalyptus* essential oil and beta-caryophyllene makes it possible to significantly improve the total protection time of the repellent composition.

[0134] Example 3: Synergistic effect of the combination of beta-caryophyllene, *Lemon eucalyptus* essential oil, *Carapa guianensis* oil, and *Hyptis suaveolens* essential oil.

[0135] Table 3 below details:

- the weight percentages of the constituents of a 3rd repellent composition according to the invention ("IQ-3"), a 1st comparative repellent composition ("C3A"), and a 2nd comparative repellent composition ("C3B") corresponding to the third repellent composition according to the invention IQ-3;
- the total protection times of these three compositions IQ-3, C3A and C3B.

[0136]

Table 3 — Tested Repellent Compositions (Weight Percentages and Total Protection Time)

Constituents (% w/w)	IQ-3	C3A	C3B
Water (qs to 100%)	qs	qs	qs
Xanthan gum	1%	1%	1%
Hexyl decanol	3%	3%	3%

Constituents (% w/w)	IQ-3	C3A	C3B
Hexyldecyl laurate	3%	3%	3%
Sucrose laurate	2%	2%	2%
Cetearyl alcohol	1%	1%	1%
<i>Carapa guianensis</i> oil	10%	10%	0%
<i>Lemon eucalyptus</i> essential oil (<i>Eucalyptus citriodora</i>)	20%	20%	0%
Tocopherol	1%	1%	1%
Sorbic acid	2%	2%	2%
Vanillin powder	5%	5%	5%
<i>Hyptis suaveolens</i> essential oil	1%	0%	1%
Beta-caryophyllene	5%	5%	0%
Total protection time	8 hours	6.5 hours	0 hours

[0137] The 1st comparative composition ("C3A") was a composition identical to composition IQ-3 except that it was devoid of *Hyptis suaveolens* essential oil.

[0138] The 2nd comparative composition ("C3B") was a composition identical to composition IQ-3, except that it was devoid of beta-caryophyllene, *Lemon eucalyptus* essential oil, and *Carapa guianensis* oil.

[0139] The synergy between the active constituents, namely:

- the mixture of *Lemon eucalyptus* essential oil, beta-caryophyllene, and *Carapa guianensis* oil on the one hand, and
 - *Hyptis suaveolens* essential oil on the other hand,
- was calculated by comparing the total protection time results of composition IQ-3 and the comparative compositions C3A and C3B.

[0140] The total protection time of composition IQ-3 was 8 hours, corresponding to an observed efficacy of 80%. The total protection time of the 1st comparative composition C3A was 6.5 hours, corresponding to an observed efficacy of 65%. The total protection time of the second comparative composition C3B was 0 hours, corresponding to an observed efficacy of 0%.

[0141] According to Colby's formula (1), the expected % efficacy of the third composition according to the invention IQ-3 was 65%, versus 80%, which is the observed efficacy percentage of said composition IQ-3.

[0142] This 3rd example also demonstrates the synergistic effect between the mixture of *Lemon eucalyptus* essential oil and beta-caryophyllene, *Carapa guianensis* oil, and *Hyptis suaveolens* essential oil. In other words, the combination of *Hyptis suaveolens* essential oil with *Carapa guianensis* oil and a mixture containing *Lemon eucalyptus* essential oil and beta-caryophyllene makes it possible to improve the total protection time of the repellent composition. This Example 3 demonstrates the full benefit of the presence of *Hyptis suaveolens* essential oil in the repellent composition according to the invention.

[0143] Example 4: Synergistic effect of the combination of beta-caryophyllene, *Lemon eucalyptus* essential oil, *Carapa guianensis* oil, and *Hyptis suaveolens* essential oil.

[0144] Table 4 below details:

- the weight percentages of the constituents of a 4th repellent composition according to the invention ("IQ-4"), a 1st comparative repellent composition ("C4A"), and a 2nd comparative repellent composition ("C4B") corresponding to the 4th repellent composition according to the invention IQ-4;
- the total protection times of these three compositions IQ-4, C4A and C4B.

[0145]

Components (%)	IQ-4	C4A	C4B
water	qs	qs	qs
xanthan gum	1%	1%	1%
hexyl decanol	3%	3%	3%
hexyldecyl laurate	3%	3%	3%
sucrose laurate	2%	2%	2%
cetyl stearyl alcohol	1%	1%	1%
<i>Carapa guianensis</i> oil	10%	10%	0%
<i>Lemon eucalyptus</i> essential oil	10%	10%	0%
tocopherol	1%	1%	1%
sorbic acid	2%	2%	2%
vanillin powder	5%	5%	5%
<i>Hyptis suaveolens</i> essential oil	2%	0%	2%
beta-caryophyllene	10%	10%	0%
Total protection time	8.5 hours	5.5 hours	0 hour

Table 4 – Composition of IQ-4, C4A and C4B repellent formulations and their total protection time

[0146] The 1st comparative composition ("C4A") was a composition identical to composition IQ-4 except that it did not contain *Hyptis suaveolens* essential oil.

[0147] The 2nd comparative composition ("C4B") was a composition identical to composition IQ-4 except that it did not contain beta-caryophyllene, *Lemon eucalyptus*

5 essential oil, or *Carapa guianensis* oil.

[0148] The synergy between the active constituents, namely:

- the mixture of *Lemon eucalyptus* essential oil, *beta-caryophyllene*, and *Carapa guianensis* oil on the one hand, and
 - *Hyptis suaveolens* essential oil on the other hand, was calculated by comparing the total
- 10 protection time results of composition IQ-4 with those of the comparative compositions C4A and C4B.

[0149] The total protection time of composition IQ-4 was 8.5 hours, corresponding to an observed efficacy of 85%. The total protection time of the 1st comparative composition C4A was 5.5 hours, corresponding to an observed efficacy of 55%. The total protection time of

15 the 2nd comparative composition C4B was 0 hours, corresponding to an observed efficacy of 0%.

[0150] According to Colby's formula (1), the expected % efficacy of the fourth composition according to the invention IQ-4 was 55%, versus 85%, which is the observed efficacy percentage of said composition IQ-4.

20 [0151] This 4th example also demonstrates the synergistic effect between the mixture of *Lemon eucalyptus* essential oil and beta-caryophyllene, *Carapa guianensis* oil, and *Hyptis suaveolens* essential oil. In other words, the combination of *Hyptis suaveolens* essential oil with *Carapa guianensis* oil and a mixture containing *Lemon eucalyptus* essential oil and beta-caryophyllene makes it possible to improve the total protection time of the

25 repellent composition. This Example 4 demonstrates the full benefit of the presence of *Hyptis suaveolens* essential oil in the repellent composition according to the invention.

[0152] Example 5: Synergistic effect of the association of beta-caryophyllene, *Lemon eucalyptus* essential oil, *Carapa procera* oil and *Hyptis suaveolens* essential oil

[0153] Table 5 below details:

- 30 - the mass percentages of the constituents of a fifth repellent composition according to the invention ("IQ-5"), a first comparative repellent composition ("C5A"), and a second

comparative repellent composition (“C5B”) of the repellent composition according to the invention IQ-5;

- the total protection times of these three compositions IQ-5, C5A and C5B.

5 [0154]

Constituents (%)	IQ-5	C5A	C5B
Ethyl alcohol 95°	Q.S. to 100%	Q.S. to 100%	Q.S. to 100%
<i>Lemon eucalyptus</i> essential oil	20%	20%	0%
<i>Carapa procera</i> oil	10%	10%	0%
Vanillin powder	5%	5%	5%
Beta-caryophyllene	5%	5%	0%
<i>Hyptis suaveolens</i> essential oil	1%	0%	1%
Total protection time	6 hours	3.5 hours	0 hours

Table 5 – Constituents of compositions IQ-5, C5A and C5B and their total protection times

[0155] The 1st comparative composition (“C5A”) was a composition identical to composition IQ-5, except that it was devoid of *Hyptis suaveolens* essential oil.

10 [0156] The 2nd comparative composition (“C5B”) was a composition identical to composition IQ-5, except that it was devoid of beta-caryophyllene, *Lemon eucalyptus* essential oil, and *Carapa procera* oil.

[0157] The synergy between the active constituents, namely:

- the mixture of *Lemon eucalyptus* essential oil, beta-caryophyllene and *Carapa procera* oil on the one hand, and
- *Hyptis suaveolens* essential oil on the other hand, was calculated by comparing the total protection time results of composition IQ-5 with those of comparative compositions C5A and C5B.

20 [0158] The total protection time of composition IQ-5 was 6 hours, corresponding to an observed efficacy of 60%. The total protection time of the 1st comparative composition C5A was 3.5 hours, corresponding to an observed efficacy of 35%. The total protection time of the second comparative composition C5B was 0 hours, corresponding to an observed efficacy of 0%.

[0159] According to Colby's formula (1), the expected efficacy percentage of the 5th composition according to the invention IQ-5 was 35%, compared with 60%, which is the observed efficacy percentage of said composition IQ-5.

[0160] This 5th example also demonstrates the synergistic effect between the mixture of

5 *Lemon eucalyptus* essential oil and beta-caryophyllene, *Carapa procera* oil, and *Hyptis suaveolens* essential oil. In other words, the combination of *Hyptis suaveolens* essential oil with *Carapa procera* oil and a mixture comprising *Lemon eucalyptus* essential oil and beta-caryophyllene makes it possible to improve the total protection time of the repellent composition. This Example 5 demonstrates the significant advantage of the presence of

10 *Hyptis suaveolens* essential oil in the repellent composition according to the invention.

[0161] Example 6: Synergistic effect of the combination of beta-caryophyllene, *Lemon eucalyptus* essential oil, *Carapa guianensis* oil, and *Hyptis suaveolens* essential oil.

[0162] Table 6 below details:

– the mass percentages of the constituents of a 6th repellent composition according to the invention ("IQ-6"), a 1st comparative repellent composition ("C6A"), and a 2nd comparative repellent composition ("C6B") of the 6th repellent composition according to the invention IQ-6;

– the total protection times of these three compositions IQ-6, C6A, and C6B.

[0163]

Constituents (%)	IQ-6	C6A	C6B
Ethyl alcohol 95°	Q.S. to 100%	Q.S. to 100%	Q.S. to 100%
<i>Lemon eucalyptus</i> essential oil	20%	20%	0%
<i>Carapa guianensis</i> oil	10%	10%	0%
Vanillin powder	5%	5%	5%
Beta-caryophyllene	5%	5%	0%
<i>Hyptis suaveolens</i> essential oil	1%	0%	1%
Total protection time	5.5 hours	3.5 hours	0 hours

20 Table 6 – Constituents of compositions IQ-6, C6A and C6B and their total protection times

[0164] The 1st comparative composition ("C6A") was a composition identical to composition IQ-6, except that it was devoid of *Hyptis suaveolens* essential oil.

[0165] The 2nd comparative composition ("C6B") was a composition identical to composition IQ-6, except that it was devoid of beta-caryophyllene, *Lemon eucalyptus* essential oil, and *Carapa guianensis* oil.

[0166] The synergy between the active constituents, namely:

- 5 – the mixture of *Lemon eucalyptus* essential oil, beta-caryophyllene and *Carapa guianensis* oil on the one hand, and

- *Hyptis suaveolens* essential oil on the other hand,

was calculated by comparing the total protection time results of composition IQ-6 with those of comparative compositions C6A and C6B.

- 10 [0167] The total protection time of composition IQ-6 was 5.5 hours, corresponding to an observed efficacy of 55%. The total protection time of the 1st comparative composition C6A was 3.5 hours, corresponding to an observed efficacy of 35%. The total protection time of the 2nd comparative composition C6B was 0 hours, corresponding to an observed efficacy of 0%.

- 15 [0168] According to Colby's formula (1), the expected efficacy percentage of the 6th composition according to the invention IQ-6 was 35%, compared with 55%, which is the observed efficacy percentage of said composition IQ-6.

[0169] This 6th example also demonstrates the synergistic effect between the mixture of *Lemon eucalyptus* essential oil and beta-caryophyllene, *Carapa guianensis* oil and *Hyptis*

- 20 *suaveolens* essential oil. In other words, the combination of *Hyptis suaveolens* essential oil with *Carapa guianensis* oil and a mixture containing *Lemon eucalyptus* essential oil and beta-caryophyllene makes it possible to improve the total protection time of the repellent composition. This Example 6 demonstrates the significant advantage of including *Hyptis suaveolens* essential oil in the repellent composition according to the invention.

- 25 [0170] Example 7: Synergistic effect of the combination of beta-caryophyllene, *Lemon eucalyptus* essential oil, *Carapa guianensis* oil and *Hyptis suaveolens* essential oil.

[0171] Table 7 below details:

- the mass percentages of the constituents of a 7th repellent composition according to the invention ("IQ-7"), a 1st comparative repellent composition ("C7A"), and a 2nd comparative repellent composition ("C7B") of the 7th repellent composition according to the invention IQ-7;
- 30 – the total protection times of these 3 compositions IQ-7, C7A and C7B.

[0172]

Constituents (%)	IQ-7	C7A	C7B
Ethyl alcohol 95°	Q.S. to 100%	Q.S. to 100%	Q.S. to 100%
<i>Lemon eucalyptus</i> essential oil	20%	20%	0%
<i>Carapa guianensis</i> oil	10%	10%	0%
Vanillin powder	5%	5%	5%
Beta-caryophyllene	5%	5%	0%
<i>Hyptis suaveolens</i> essential oil	2%	0%	2%
Total protection time	6.5 hours	3.5 hours	0 hours

Table 7 – Constituents of compositions IQ-7, C7A and C7B and their total protection times

[0173] The 1st comparative composition (“C7A”) was a composition identical to composition IQ-7, except that it was devoid of *Hyptis suaveolens* essential oil.

[0174] The 2nd comparative composition (“C7B”) was a composition identical to composition IQ-7, except that it was devoid of beta-caryophyllene, *Lemon eucalyptus* essential oil, and *Carapa guianensis* oil.

[0175] The synergy between the active constituents, namely:

– the mixture of *Lemon eucalyptus* essential oil, beta-caryophyllene and *Carapa guianensis* oil on the one hand, and

– *Hyptis suaveolens* essential oil on the other hand,

was calculated by comparing the total protection time results of composition IQ-7 with those of comparative compositions C7A and C7B.

[0176] The total protection time of composition IQ-7 was 6.5 hours, corresponding to an observed efficacy of 65%. The total protection time of the 1st comparative composition C7A was 3.5 hours, corresponding to an observed efficacy of 35%. The total protection time of the 2nd comparative composition C7B was 0 hours, corresponding to an observed efficacy of 0%.

[0177] According to Colby’s formula (1), the expected efficacy percentage of the 7th composition according to the invention IQ-7 was 35%, compared with 65%, which is the observed efficacy percentage of said composition IQ-7.

[0178] This seventh example also demonstrates the synergistic effect between the mixture of *Lemon eucalyptus* essential oil and beta-caryophyllene, *Carapa guianensis* oil and *Hyptis suaveolens* essential oil. In other words, the combination of *Hyptis suaveolens* essential oil

with *Carapa guianensis* oil and a mixture containing *Lemon eucalyptus* essential oil and beta-caryophyllene makes it possible to improve the total protection time of the repellent composition. This Example 7 demonstrates the significant advantage of including *Hyptis suaveolens* essential oil in the repellent composition according to the invention.

5 [0179] Example 8: Synergistic effect of the combination of beta-caryophyllene, *Lemon eucalyptus* essential oil, *Carapa guianensis* oil and *Hyptis suaveolens* essential oil.

[0180] Table 8 below details:

- the mass percentages of the constituents of an 8th repellent composition according to the invention (“IQ-8”), a 1st comparative repellent composition (“C8A”), and a 2nd comparative repellent composition (“C8B”) of the 8th repellent composition according to the invention IQ-8;
- the total protection times of these 3 compositions IQ-8, C8A and C8B.

[0181]

Constituents (%)	IQ-8	C8A	C8B
Ethyl alcohol 95°	Qs to 100%	Qs to 100%	Qs to 100%
<i>Lemon eucalyptus</i> essential oil	15%	15%	0%
<i>Carapa guianensis</i> oil	15%	15%	0%
Vanillin powder	5%	5%	5%
Beta-caryophyllene	5%	5%	0%
<i>Hyptis suaveolens</i> essential oil	1%	0%	1%
Total protection time	5.5 hours	3 hours	0 hour

15 Table 8 — Composition of tested repellent formulations IQ-8, C8A and C8B and their total protection time

[0182] The 1st comparative composition (“C8A”) was a composition identical to composition IQ-8, except that it was devoid of *Hyptis suaveolens* essential oil.

20 [0183] The 2nd comparative composition (“C8B”) was a composition identical to composition IQ-8, except that it was devoid of beta-caryophyllene, *Lemon eucalyptus* essential oil, and *Carapa guianensis* oil.

[0184] The synergy between the active constituents, namely:

- the mixture of *Lemon eucalyptus* essential oil, beta-caryophyllene and *Carapa guianensis*

oil on the one hand, and

– *Hyptis suaveolens* essential oil on the other hand,

was calculated by comparing the total protection time results of composition IQ-8 with those of comparative compositions C8A and C8B.

5 [0185] The total protection time of composition IQ-8 was 5.5 hours, corresponding to an observed efficacy of 55%. The total protection time of the 1st comparative composition C8A was 3 hours, corresponding to an observed efficacy of 30%. The total protection time of the 2nd comparative composition C8B was 0 hours, corresponding to an observed efficacy of 0%.

[0186] According to Colby's formula (1), the expected efficacy percentage of the 8th
10 composition according to the invention IQ-8 was 30%, compared with 55%, which is the observed efficacy percentage of said composition IQ-8.

[0187] This 8th example also demonstrates the synergistic effect between the mixture of *Lemon eucalyptus* essential oil and beta-caryophyllene, *Carapa guianensis* oil and *Hyptis suaveolens* essential oil. In other words, the combination of *Hyptis suaveolens* essential oil
15 with *Carapa guianensis* oil and a mixture containing *Lemon eucalyptus* essential oil and beta-caryophyllene makes it possible to improve the total protection time of the repellent composition. This Example 8 demonstrates the significant advantage of including *Hyptis suaveolens* essential oil in the repellent composition according to the invention.

[0188] Example 9: Synergistic effect of the combination of beta-caryophyllene, *Lemon eucalyptus* essential oil, *Carapa procera* oil, and *Hyptis suaveolens* essential oil
20

[0189] Table 9 below details:

- the mass percentages of the constituents of a 9th repellent composition according to the invention ("IQ-9"), a 1st comparative repellent composition ("C9A"), and a 2nd comparative repellent composition ("C9B") of the 9th repellent composition according
25 to the invention IQ-9;
- the total protection times of these three compositions IQ-9, C9A and C9B.

[0190]

Constituents (%)	IQ-9	C9A	C9B
Ethyl alcohol 95°	Q.S. to 100%	Q.S. to 100%	Q.S. to 100%
<i>Lemon eucalyptus</i> essential oil	20%	20%	0%
<i>Carapa procera</i> oil	10%	10%	0%
Vanillin powder	5%	5%	5%

Constituents (%)	IQ-9	C9A	C9B
Beta-caryophyllene	5%	5%	0%
<i>Hyptis suaveolens</i> essential oil	3%	0%	3%
Total protection time	8.5 hours	3.5 hours	0 hours

Table 9 – Constituents of compositions IQ-9, C9A and C9B and their total protection times

[0191] The 1st comparative composition (“C9A”) was a composition identical to composition IQ-9 except that it was devoid of essential oil of *Hyptis suaveolens*.

[0192] The 2nd comparative composition (“C9B”) was a composition identical to

5 composition IQ-9, except that it was devoid of beta-caryophyllene, essential oil of *Lemon eucalyptus*, and *Carapa procera* oil.

[0193] The synergy between the active constituents, namely:

- the mixture of *Lemon eucalyptus* essential oil, beta-caryophyllene, and *Carapa procera* oil on the one hand, and
 - 10 - the essential oil of *Hyptis suaveolens* on the other hand,
- was calculated by comparison of the total protection time results of composition IQ-9 and comparative compositions C9A and C9B.

[0194] The total protection time of composition IQ-9 was 8.5 hours, corresponding to an observed efficacy of 85%. The total protection time of the 1st comparative composition

15 C9A was 3.5 hours, corresponding to an observed efficacy of 35%. The total protection time of the 2nd comparative composition C9B was 0 hour, corresponding to an observed efficacy of 0%.

[0195] According to Colby formula (1), the expected efficacy percentage of the composition according to the invention IQ-9 was 35% versus 85%, which is the observed efficacy

20 percentage of said composition IQ-9.

[0196] This 9th example also demonstrates the synergistic effect between the mixture of *Lemon eucalyptus* essential oil and beta-caryophyllene, *Carapa procera* oil, and *Hyptis suaveolens* essential oil. In other words, the combination of *Hyptis suaveolens* essential oil with *Carapa procera* oil and a mixture containing *Lemon eucalyptus* essential oil and

25 beta-caryophyllene makes it possible to improve the total protection time of the repellent composition. This Example 9 demonstrates the significant benefit of the

presence of *Hyptis suaveolens* essential oil in the repellent composition according to the invention.

[0197] Example 10: Synergistic effect of the combination of beta-caryophyllene, *Lemon eucalyptus* essential oil, *Carapa guianensis* oil, and *Hyptis suaveolens* essential oil.

5 [0198] Table 10 below details:

- the mass percentages of the constituents of a tenth repellent composition according to the invention ("IQ-10"), of a 1st comparative repellent composition ("C10A"), and of a 2nd comparative repellent composition ("C10B") corresponding to the repellent composition IQ-10 according to the invention;
- 10 - the total protection times of these three compositions IQ-10, C10A and C10B.

[0199]

Constituents (%)	IQ-10	C10A	C10B
Ethyl alcohol 95°	q.s.	q.s.	q.s.
<i>Lemon eucalyptus</i> essential oil	20%	20%	0%
<i>Carapa guianensis</i> oil	10%	10%	0%
Vanillin powder	5%	5%	5%
Beta-caryophyllene	5%	5%	0%
<i>Hyptis suaveolens</i> essential oil	3%	0%	3%
Total protection time	7 hours	4 hours	0 hour

Table 10 — Constituents of compositions IQ-10, C10A and C10B and their total protection time

[0200] The 1st comparative composition ("C10A") was a composition identical to composition IQ-10, except that it was devoid of essential oil of *Hyptis suaveolens*.

[0201] The 2nd comparative composition ("C10B") was a composition identical to composition IQ-10, except that it was devoid of beta-caryophyllene, *Lemon eucalyptus* essential oil, and *Carapa guianensis* oil.

[0202] The synergy between the active constituents, namely:

- 20 - the mixture of *Lemon eucalyptus* essential oil, beta-caryophyllene, and *Carapa guianensis* oil on the one hand, and
- *Hyptis suaveolens* essential oil on the other hand,

was calculated by comparing the total protection time results of composition IQ-10 with those of the comparative compositions C10A and C10B.

[0203] The total protection time of composition IQ-10 was 7 hours, corresponding to an observed efficacy of 70%. The total protection time of the 1st comparative composition C10A was 4 hours, corresponding to an observed efficacy of 40%. The total protection time of the 2nd comparative composition C10B was 0 hour, corresponding to an observed efficacy of 0%.

[0204] According to Colby's formula (1), the expected % efficacy of the 4th composition according to the invention IQ-10 was 40% versus 70%, which represents the observed efficacy percentage of said composition IQ-10.

[0205] This 10th example also demonstrates the synergistic effect between the mixture of *Lemon eucalyptus* essential oil and beta-caryophyllene, *Carapa guianensis* oil, and *Hyptis suaveolens* essential oil. In other words, the combination of *Hyptis suaveolens* essential oil with *Carapa guianensis* oil and a mixture containing *Lemon eucalyptus* essential oil and beta-caryophyllene makes it possible to improve the total protection time of the repellent composition. This Example 10 demonstrates the full benefit of the presence of *Hyptis suaveolens* essential oil in the repellent composition according to the invention.

[0206] Example 11: Synergistic effect of the combination of beta-caryophyllene, *Lemon eucalyptus* essential oil, *Carapa guianensis* oil, and *Hyptis suaveolens* essential oil.

[0207] Table 11 below details:

- the mass percentages of the constituents of a 5th repellent composition according to the invention ("IQ-11"), a 1st comparative repellent composition ("C11A") and a 2nd comparative repellent composition ("C11B") of the 11th repellent composition according to the invention IQ-11;
- the total protection times of these 3 compositions IQ-11, C11A and C11B.

[0208]

Constituents (%)	IQ-11	C11A	C11B
Ethyl alcohol 95°	q.s.	q.s.	q.s.
<i>Lemon eucalyptus</i> essential oil	20%	20%	0%
<i>Carapa guianensis</i> oil	10%	10%	0%
Vanillin powder	5%	5%	5%
Beta-caryophyllene	5%	5%	0%
<i>Hyptis suaveolens</i> essential oil	4%	0%	4%

Constituents (%)	IQ-11	C11A	C11B
Total protection time	7 hours	3.5 hours	0 hour

Table 11 — Detailing the constituents of compositions IQ-11, C11A and C11B and their total protection times

[0209] The 1st comparative composition (“C11A”) was a composition identical to composition IQ-11, except that it was devoid of *Hyptis suaveolens* essential oil.

5 [0210] The 2nd comparative composition (“C11B”) was a composition identical to composition IQ-11, except that it was devoid of beta-caryophyllene, *Lemon eucalyptus* essential oil, and *Carapa guianensis* oil.

[0211] The synergy between the active constituents, namely:

- the mixture of *Lemon eucalyptus* essential oil, beta-caryophyllene, and *Carapa* 10 *guianensis* oil on the one hand, and
 - the essential oil of *Hyptis suaveolens* on the other hand,
- was calculated by comparison of the total protection time results of composition IQ-11 and comparative compositions C11A and C11B.

[0212] The total protection time of composition IQ-11 was 7 hours, corresponding to an 15 observed efficacy of 70%. The total protection time of the 1st comparative composition C11A was 3.5 hours, corresponding to an observed efficacy of 35%. The total protection time of the 2nd comparative composition C11B was 0 hour, corresponding to an observed efficacy of 0%.

[0213] According to the Colby formula (1) below, the expected % efficacy of the composition 20 according to the invention IQ-11 was 35%, compared with 70%, which is the observed efficacy percentage of said composition IQ-11.

[0214] This 11th example also demonstrates the synergistic effect between the mixture of *Lemon eucalyptus* essential oil and beta-caryophyllene, *Carapa guianensis* oil, and *Hyptis* 25 *suaveolens* essential oil. In other words, the combination of *Hyptis suaveolens* essential oil with *Carapa guianensis* oil and a mixture containing *Lemon eucalyptus* essential oil and beta-caryophyllene makes it possible to improve the total protection time of the repellent composition. This example 11 demonstrates the full benefit of the presence of *Hyptis suaveolens* essential oil in the repellent composition according to the invention.

[0215] Example 12: Synergistic effect of the combination of beta-caryophyllene, *Lemon eucalyptus* essential oil, *Carapa guianensis* oil, and *Hyptis suaveolens* essential oil.

[0216] Table 12 below details:

- the mass percentages of the constituents of a twelfth repellent composition according to the invention ("IQ-12"), of a first comparative repellent composition ("C12A"), and of a second comparative repellent composition ("C12B") corresponding to the twelfth repellent composition according to the invention IQ-12;
- the total protection times of these three compositions IQ-12, C12A, and C12B.

[0217]

Constituents (%)	IQ-12	C12A	C12B
Ethyl alcohol 95°	Q.S.	Q.S.	Q.S.
<i>Lemon eucalyptus</i> essential oil	10%	10%	0%
<i>Carapa guianensis</i> oil	10%	10%	0%
Vanillin powder	5%	5%	5%
Beta-caryophyllene	15%	15%	0%
<i>Hyptis suaveolens</i> essential oil	3%	0%	3%
Total protection time	5.5 hours	3 hours	0 hour

Table 12 detailing the constituents of compositions IQ-12, C12A and C12B and their total protection time

[0218] The 1st comparative composition ("C12A") was a composition identical to composition IQ-12 except that it did not contain *Hyptis suaveolens* essential oil.

[0219] The 2nd comparative composition ("C12B") was a composition identical to composition IQ-12, except that it did not contain beta-caryophyllene, *Lemon eucalyptus* essential oil, and *Carapa guianensis* oil.

[0220] The synergy between the active constituents, namely:

- the mixture of *Lemon eucalyptus* essential oil, beta-caryophyllene, and *Carapa guianensis* oil on the one hand, and
- *Hyptis suaveolens* essential oil on the other hand,

was calculated by comparing the total protection time results of composition IQ-12 with those of comparative compositions C12A and C12B.

[0221] The total protection time of composition IQ-12 was 5.5 hours, corresponding to an observed efficacy of 55%. The total protection time of the 1st comparative composition C12A was 3 hours, corresponding to an observed efficacy of 30%. The total protection time of the 2nd comparative composition C12B was 0 hours, corresponding to an observed efficacy of 0%.

[0222] According to Colby formula (1), the expected % efficacy of the 12th composition according to the invention IQ-12 was 30% versus 55%, which is the observed efficacy percentage of said composition IQ-12.

[0223] This 12th example also demonstrates the synergistic effect between the mixture of *Lemon eucalyptus* essential oil and beta-caryophyllene, *Carapa guianensis* oil, and *Hyptis suaveolens* essential oil. In other words, the combination of *Hyptis suaveolens* essential oil with *Carapa guianensis* oil and a mixture containing *Lemon eucalyptus* essential oil and beta-caryophyllene makes it possible to improve the total protection time of the repellent composition. This Example 12 demonstrates the full benefit of the presence of *Hyptis suaveolens* essential oil in the repellent composition according to the invention.

[0224] Example 13:

[0225] Table 13 below details the mass percentages of the constituents of a thirteenth repellent composition according to the invention ("IQ-13").

IQ-13	Weight percentages (%)
Water	Q.S. (quantity sufficient)
Xanthan gum	1%
Hexyl decanol	3%
Hexyldecyl laurate	3%
Sucrose laurate	2%
Cetyl stearyl alcohol	1%
<i>Carapa procera</i> oil	10%
<i>Lemon eucalyptus</i> essential oil	15%
Tocopherol	1%
Sorbic acid	2%
Vanillin powder	5%
<i>Hyptis suaveolens</i> essential oil	1%
Beta-caryophyllene	20%

Table 13 detailing the constituents of composition IQ-13

[0226] The total protection time of the 13th repellent composition according to the invention, "IQ-13", was 10.5 hours. Such a total protection duration has never been achieved with repellent compositions known in the prior art.

CLAIMS

1. An insect repellent composition comprising at least:

- p-menthane-3,8-diol (hereinafter abbreviated as "PMD") and/or at least one essential oil selected from *Lemon eucalyptus* essential oil and *Eucalyptus globulus* essential oil,
- at least one repellent agent selected from beta-caryophyllene and eucalyptol,
- a solvent,
- at least one oil selected from vegetable oils, synthetic oils, semi-synthetic oils, animal-derived oils, mineral oils, silicone oils, and fluorinated oils,

characterized in that it further comprises *Hyptis suaveolens* essential oil.

2. The repellent composition according to claim 1, wherein the oil is selected from *Carapa procera* oil, *Carapa guianensis* oil, shea butter, Palm Kernel/Coco glucoside, coco-caprylate/caprate, plant-derived squalane extracted from olive, coconut oil, copra oil, castor oil, peanut oil, and sunflower oil, alone or in mixtures thereof.

3. The repellent composition according to claim 2, wherein the oil is selected from *Carapa procera* oil, *Carapa guianensis* oil, and coco-caprylate/caprate, alone or in mixtures thereof.

4. The repellent composition according to claim 3, comprising:

- *Lemon eucalyptus* essential oil,
- beta-caryophyllene,
- at least one oil selected from *Carapa procera* oil, *Carapa guianensis* oil, and coco-caprylate/caprate,
- *Hyptis suaveolens* essential oil,
- a solvent.

5. The repellent composition according to any one of claims 1 to 4, wherein the solvent is water or an alcohol.

6. The repellent composition according to any one of claims 1 to 5, further comprising at least one additional component selected from emulsifiers, surfactants, thickeners, film-forming agents, gelling agents, opacifying agents, emulsion stabilizers, humectants, antioxidants, preservatives, fragrances, and ultraviolet filters, alone or in mixtures thereof.

5

7. The repellent composition according to claim 6, comprising, in mass percentages relative to the total mass of the composition:

- between 5% and 30% PMD and/or at least one essential oil selected from *Lemon eucalyptus* essential oil and *Eucalyptus globulus* essential oil,
- 10 - between 5% and 30% of at least one repellent agent selected from beta-caryophyllene and eucalyptol,
- between 5% and 30% of at least one oil selected from *Carapa procera* oil, *Carapa guianensis* oil, shea butter, Palm Kernel/Coco glucoside, coco-caprylate/caprate, plant-derived squalane extracted from olive, coconut oil, copra oil, castor oil, peanut
- 15 oil, and sunflower oil, alone or in mixtures thereof,
- between 0.5% and 10% *Hyptis suaveolens* essential oil,
- optionally between 0.1% and 30% of at least one additional component,
- q.s. of solvent, preferably water or alcohol.

20 8. The repellent composition according to claim 7, comprising, in mass percentages relative to the total mass of the composition:

- between 5% and 30% *Lemon eucalyptus* essential oil,
- between 5% and 30% beta-caryophyllene,
- between 5% and 30% of at least one oil selected from *Carapa procera* oil, *Carapa*
- 25 *guianensis* oil, and coco-caprylate/caprate,
- between 0.5% and 10% *Hyptis suaveolens* essential oil,
- optionally between 0.1% and 30% of at least one additional component,
- q.s. of solvent, preferably water or alcohol.

30 9. A method for insect-repellent treatment of a textile material, characterized in that at least one repellent composition according to any one of claims 1 to 8 is sprayed onto at least part of said textile material.