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Short review



RIFM fragrance ingredient safety assessment, 3,4,4a,5,8,8a(Or 3,4,4a,7,8,8a)-hexahydro-3,3,6,7-tetramethyl-1H-2-benzopyran, CAS Registry Number 72429-08-4

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Skin Sensitization
Phototoxicity/Photoallergenicity
Local Respiratory Toxicity
Environmental Safety

ABSTRACT

The existing information supports the use of this material as described in this safety assessment. 3,4,4a,5,8,8a (Or 3,4,4a,7,8,8a)-Hexahydro-3,3,6,7-tetramethyl-1H-2-benzopyran was evaluated for genotoxicity, repeated dose toxicity, reproductive toxicity, local respiratory toxicity, phototoxicity/photoallergenicity, skin sensitization, and environmental safety. Data show that 3,4,4a, 5,8,8a (Or 3,4,4a, 7,8,8a)-hexahydro-3,3,6,7-tetramethyl-1H-2-benzopyran is not genotoxic. The repeated dose, reproductive, and local respiratory toxicity endpoints were evaluated using the threshold of toxicological concern (TTC) for a Cramer Class III material, and the exposure to 3,4,4a, 5,8,8a (Or 3,4,4a, 7,8,8a)-hexahydro-3,3,6,7-tetramethyl-1H-2-benzopyran is below the TTC (0.0015 mg/kg/day, 0.0015 mg/kg/day, and 0.47 mg/day, respectively). The skin sensitization endpoint was completed using the dermal sensitization threshold (DST) for non-reactive materials (900 µg/cm²); exposure is below the DST. The phototoxicity/photoallergenicity endpoints were evaluated based on ultraviolet (UV) spectra; 3,4,4a, 5,8,8a (Or 3,4,4a,7,8,8a)-hexahydro-3,3,6,7-tetramethyl-1H-2-benzopyran is not expected to be phototoxic/photoallergenic. The environmental endpoints were evaluated; 3,4,4a, 5,8,8a (Or 3,4,4a, 7,8,8a)-hexahydro-3,3,6,7-tetramethyl-1H-2-benzopyran was found not to be persistent, bioaccumulative, and toxic (PBT) as per the International Fragrance Association (IFRA) Environmental Standards, and its risk quotients, based on its

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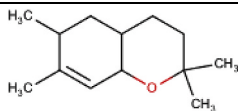
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current volume of use in Europe and North America (i.e., Predicted Environmental Concentration/Predicted No Effect Concentration [PEC/PNEC]), are <1.

Version: 101220. This version replaces any previous versions.

Name: 3,4,4a,5,8,8a (Or 3,4,4a,7,8,8a)-Hexahydro-3,3,6,7-tetramethyl-1H-2-benzopyran

CAS Registry Number: 72429-08-4



Abbreviation/Definition List:

2-Box Model - A RIFM, Inc. proprietary *in silico* tool used to calculate fragrance air exposure concentration

AF - Assessment Factor

BCF - Bioconcentration Factor

Crema RIFM Model - The Crema RIFM Model uses probabilistic (Monte Carlo) simulations to allow full distributions of data sets, providing a more realistic estimate of aggregate exposure to individuals across a population (Comiskey et al., 2015, 2017; Safford et al., 2015a, 2017) compared to a deterministic aggregate approach

DEREK - Derek Nexus is an *in silico* tool used to identify structural alerts

DRF - Dose Range Finding

DST - Dermal Sensitization Threshold

ECHA - European Chemicals Agency

ECOSAR - Ecological Structure-Activity Relationships Predictive Model

EU - Europe/European Union

GLP - Good Laboratory Practice

IFRA - The International Fragrance Association

LOEL - Lowest Observable Effect Level

MOE - Margin of Exposure

MPPD - Multiple-Path Particle Dosimetry. An *in silico* model for inhaled vapors used to simulate fragrance lung deposition

NA - North America

NESIL - No Expected Sensitization Induction Level

NOAEC - No Observed Adverse Effect Concentration

NOAEL - No Observed Adverse Effect Level

NOEC - No Observed Effect Concentration

NOEL - No Observed Effect Level

OECD - Organisation for Economic Co-operation and Development

OECD TG - Organisation for Economic Co-operation and Development Testing Guidelines

PBT - Persistent, Bioaccumulative, and Toxic

PEC/PNEC - Predicted Environmental Concentration/Predicted No Effect Concentration

Perfumery - In this safety assessment, perfumery refers to fragrances made by a perfumer used in consumer products only. The exposures reported in the safety assessment include consumer product use but do not include occupational exposures.

QRA - Quantitative Risk Assessment

QSAR - Quantitative Structure-Activity Relationship

REACH - Registration, Evaluation, Authorisation, and Restriction of Chemicals

RfD - Reference Dose

RIFM - Research Institute for Fragrance Materials

RQ - Risk Quotient

Statistically Significant - Statistically significant difference in reported results as compared to controls with a $p < 0.05$ using appropriate statistical test

TTC - Threshold of Toxicological Concern

UV/Vis spectra - Ultraviolet/Visible spectra

VCF - Volatile Compounds in Food

VoU - Volume of Use

vPvB - (very) Persistent, (very) Bioaccumulative

WoE - Weight of Evidence

The Expert Panel for Fragrance Safety × concludes that this material is as safe as described in this safety assessment.

This safety assessment is based on the RIFM Criteria Document (Api et al., 2015), which should be referred to for clarifications.

Each endpoint discussed in this safety assessment includes the relevant data that were available at the time of writing (version number in the top box is indicative of the date of approval based on a 2-digit month/day/year), both in the RIFM Database (consisting of publicly available and proprietary data) and through publicly available information sources (e.g., SciFinder and PubMed). Studies selected for this safety assessment were based on appropriate test criteria, such as acceptable guidelines, sample size, study duration, route of exposure, relevant animal species, most relevant testing endpoints, etc. A key study for each endpoint was selected based on the most conservative endpoint value (e.g., PNEC, NOAEL, LOEL, and NESIL).

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*The Expert Panel for Fragrance Safety is an independent body that selects its own members and establishes its own operating procedures. The Expert Panel is comprised of internationally known scientists that provide RIFM with guidance relevant to human health and environmental protection.

Summary: The existing information supports the use of this material as described in this safety assessment.

3,4,4a,5,8,8a (Or 3,4,4a,7,8,8a)-Hexahydro-3,3,6,7-tetramethyl-1H-2-benzopyran was evaluated for genotoxicity, repeated dose toxicity, reproductive toxicity, local respiratory toxicity, phototoxicity/photoallergenicity, skin sensitization, and environmental safety. Data show that 3,4,4a,5,8,8a (Or 3,4,4a,7,8,8a)-hexahydro-3,3,6,7-tetramethyl-1H-2-benzopyran is not genotoxic. The repeated dose, reproductive, and local respiratory toxicity endpoints were evaluated using the threshold of toxicological concern (TTC) for a Cramer Class III material, and the exposure to 3,4,4a,5,8,8a (Or 3,4,4a,7,8,8a)-hexahydro-3,3,6,7-tetramethyl-1H-2-benzopyran is below the TTC (0.0015 mg/kg/day, 0.0015 mg/kg/day, and 0.47 mg/day, respectively). The skin sensitization endpoint was completed using the dermal sensitization threshold (DST) for non-reactive materials (900 $\mu\text{g}/\text{cm}^2$); exposure is below the DST. The phototoxicity/photoallergenicity endpoints were evaluated based on ultraviolet (UV) spectra; 3,4,4a,5,8,8a (Or 3,4,4a,7,8,8a)-hexahydro-3,3,6,7-tetramethyl-1H-2-benzopyran is not expected to be phototoxic/photoallergenic. The environmental endpoints were evaluated; 3,4,4a,5,8,8a (Or 3,4,4a,7,8,8a)-hexahydro-3,3,6,7-tetramethyl-1H-2-benzopyran was found not to be persistent, bioaccumulative, and toxic (PBT) as per the International Fragrance Association (IFRA) Environmental Standards, and its risk quotients, based on its current volume of use in Europe and North America (i.e., Predicted Environmental Concentration/Predicted No Effect Concentration [PEC/PNEC]), are <1.

Human Health Safety Assessment

Genotoxicity: Not genotoxic. (RIFM, 2017b; RIFM, 2017c)

Repeated Dose Toxicity: No NOAEL available. Exposure is below TTC.

Reproductive Toxicity: No NOAEL available. Exposure is below TTC.

Skin Sensitization: No safety concerns at current, declared use levels; the exposure is below the DST.

Phototoxicity/Photoallergenicity: Not expected to be phototoxic/photoallergenic. (UV Spectra; RIFM Database)

Local Respiratory Toxicity: No NOAEC available. Exposure is below the TTC.

Environmental Safety Assessment

Hazard Assessment:

Persistence: Screening-level: 2.55 (BIO-WIN 3) (EPI Suite v4.11; US EPA, 2012a)

Bioaccumulation: Screening-level: 378.4 L/kg (EPI Suite v4.11; US EPA, 2012a)

Ecotoxicity: Screening-level: 48-h (ECOSAR; US EPA, 2012b)

Daphnia magna LC50: 0.359 mg/L

Conclusion: Not PBT or vPvB as per IFRA Environmental Standards

Risk Assessment:

Screening-level: PEC/PNEC (North America and Europe) > 1 (RIFM Framework; Salvito et al., 2002)

Critical Ecotoxicity Endpoint: 48-h (ECOSAR; US EPA, 2012b)

Daphnia magna LC50: 0.359 mg/L

RIFM PNEC is: 0.0359 $\mu\text{g}/\text{L}$

• Revised PEC/PNECs (2015 IFRA VoU): North America and Europe <1

I. Identification

1. Chemical Name: 3,4,4a,5,8,8a (Or 3,4,4a, 7,8,8a)-Hexahydro-3,3,6,7-tetramethyl-1H-2-benzopyran
2. CAS Registry Number: 72429-08-4
3. Synonyms: 1H-2-Benzopyran, 3,4,4a,5,8,8a (or 3,4,4a,7,8,8a)-hexahydro-3,3,6,7-tetramethyl-; 3,3,6,7-Tetramethylhexahydro-1H-2-benzopyran; 3,4,4a, 5,8,8a (Or 3,4,4a, 7,8,8a)-Hexahydro-3,3,6,7-tetramethyl-1H-2-benzopyran
4. Molecular Formula: $\text{C}_{13}\text{H}_{22}\text{O}$
5. Molecular Weight: 194.31
6. RIFM Number: 5971
7. Stereochemistry: Three stereocenters and 8 possible stereoisomers

II. Physical data

1. Boiling Point: 241.68 °C (EPI Suite)
2. Flash Point: Not Available
3. Log K_{OW} : 4.41 (EPI Suite)
4. Melting Point: 33.82 °C (EPI Suite)
5. Water Solubility: 7.983 mg/L (EPI Suite)
6. Specific Gravity: Not Available
7. Vapor Pressure: 0.054 mm Hg at 25 °C (EPI Suite), 0.032 mm Hg at 20 °C (EPI Suite v4.0)
8. UV Spectra: No significant absorbance between 290 and 700 nm; molar absorption coefficient is below the benchmark ($1000 \text{ L mol}^{-1} \cdot \text{cm}^{-1}$)
9. Appearance/Organoleptic: Not Available

III. Volume of use (worldwide band)

1.0.1–1 metric ton per year (IFRA, 2015).

IV. Exposure to fragrance ingredient (Creme RIFM Aggregate Exposure Model v3.0.3)

1. 95th Percentile Concentration in Fine Fragrance: 0.04% (RIFM, 2017a)
2. Inhalation Exposure*: 0.000036 mg/kg/day or 0.0024 mg/day (RIFM, 2017a)
3. Total Systemic Exposure**: 0.00096 mg/kg/day (RIFM, 2017a)

*95th percentile calculated exposure derived from concentration survey data in the Creme RIFM Aggregate Exposure Model (Comiskey, 2015, 2017; Safford, 2015a, 2017).

**95th percentile calculated exposure; assumes 100% absorption unless modified by dermal absorption data as reported in Section V. It is derived from concentration survey data in the Creme RIFM Aggregate Exposure Model and includes exposure via dermal, oral, and inhalation routes whenever the fragrance ingredient is used in products that include these routes of exposure (Comiskey, 2015, 2017; Safford, 2015a, 2017).

V. Derivation of systemic absorption

1. Dermal: 40%

Name	3,4,4a,5,8,8a (Or 3,4,4a,7,8,8a)-Hexahydro-3,3,6,7-tetramethyl-1H-2-benzopyran
J_{max} (mg/cm ² /h)	0.563 ¹
Skin Absorption Class	40%

¹ J_{max} was calculated based on estimated log K_{OW} = 4.41 (consensus model) and Solubility = 7.98 mg/L (consensus model).

- 2 Oral: Assumed 100%
- 3 Inhalation: Assumed 100%

VI. Computational toxicology evaluation

1. Cramer Classification: Class III, High

Expert Judgment	Toxtree v 3.1	OECD QSAR Toolbox v 3.2
III	III	III

2. Analogs Selected:
 - a. Genotoxicity: None
 - b. Repeated Dose Toxicity: None
 - c. Reproductive Toxicity: None

- d. Skin Sensitization: None
 - e. Phototoxicity/Photoallergenicity: None
 - f. Local Respiratory Toxicity: None
 - g. Environmental Toxicity: None
3. Read-across Justification: None

VII. Metabolism

No relevant data available for inclusion in this safety assessment.

Additional References: None.

VIII. Natural occurrence (discrete chemical) or composition (NCS)

3,4,4a,5,8,8a (Or 3,4,4a, 7,8,8a)-Hexahydro-3,3,6,7-tetramethyl-1H-2-benzopyran is not reported to occur in foods by the VCF*.

*VCF (Volatile Compounds in Food): Database/Nijssen, L.M.; Ingen-Visscher, C.A. van; Donders, J.J.H. (eds). – Version 15.1 – Zeist (The Netherlands): TNO Triskelion, 1963–2014. A continually updated database containing information on published volatile compounds that have been found in natural (processed) food products. Includes FEMA GRAS and EU-Flavis data.

IX. REACH dossier

3,4,4a,5,8,8a (Or 3,4,4a, 7,8,8a)-Hexahydro-3,3,6,7-tetramethyl-1H-2-benzopyran has been pre-registered for 2010; no dossier available as of 10/12/20.

X. Conclusion

The existing information supports the use of this material as described in this safety assessment.

XI. Summary

1. Human health endpoint summaries

Genotoxicity

Based on the current existing data, 3,4,4a,5,8,8a (or 3,4,4a, 7,8,8a)-hexahydro-3,3,6,7-tetramethyl-1H-2-benzopyran does not present a concern for genotoxicity.

Risk assessment. 3,4,4a,5,8,8a (or 3,4,4a, 7,8,8a)-hexahydro-3,3,6,7-tetramethyl-1H-2-benzopyran was assessed in the BlueScreen assay and found positive for cytotoxicity (positive: <80% relative cell density) and negative for genotoxicity without metabolic activation, and negative for both cytotoxicity (positive: <80% relative cell density) and genotoxicity with metabolic activation (RIFM, 2013). BlueScreen is a human cell-based assay for measuring the genotoxicity and cytotoxicity of chemical compounds and mixtures. Additional assays were considered to fully assess the potential mutagenic or clastogenic effects of the target material.

The mutagenic activity of 3,4,4a,5,8,8a (or 3,4,4a,7,8,8a)-hexahydro-3,3,6,7-tetramethyl-1H-2-benzopyran has been evaluated in a bacterial reverse mutation assay conducted in compliance with GLP regulations and in accordance with OECD TG 471 using the standard plate incorporation method. *Salmonella typhimurium* strains TA98, TA100, TA1535, and TA1537, and *Escherichia coli* strain WP2uvrA were treated with 3,4,4a,5,8,8a (or 3,4,4a, 7,8,8a)-hexahydro-3,3,6,7-tetramethyl-1H-2-benzopyran in dimethyl sulfoxide (DMSO) at concentrations up to 5000 µg/plate. No increases in the mean number of revertant colonies were observed at any tested concentration in the presence or absence of S9 (RIFM, 2017b). Under the conditions of the study, 3,4,4a, 5,8,8a (or 3,4,4a, 7,8,8a)-hexahydro-3,3,6,

7-tetramethyl-1H-2-benzopyran was not mutagenic in the Ames test.

The clastogenic activity of 3,4,4a,5,8,8a (or 3,4,4a,7,8,8a)-hexahydro-3,3,6,7-tetramethyl-1H-2-benzopyran was evaluated in an *in vitro* micronucleus test conducted in compliance with GLP regulations and in accordance with OECD TG 487. Human peripheral blood lymphocytes were treated with 3,4,4a,5,8,8a (or 3,4,4a, 7,8,8a)-hexahydro-3,3,6,7-tetramethyl-1H-2-benzopyran in DMSO at concentrations up to 1960 µg/mL in the dose range finding (DRF) study; micronuclei analysis was conducted at concentrations up to 200 µg/mL in the presence and absence of metabolic activation. 3,4,4a, 5,8,8a (or 3,4,4a, 7,8,8a)-Hexahydro-3,3,6,7-tetramethyl-1H-2-benzopyran did not induce binucleated cells with micronuclei when tested up to the cytotoxic level concentration in either the presence or absence of an S9 activation system (RIFM, 2017c). Under the conditions of the study, 3,4,4a, 5,8,8a (or 3,4,4a, 7,8,8a)-hexahydro-3,3,6,7-tetramethyl-1H-2-benzopyran was considered to be non-clastogenic in the *in vitro* micronucleus test.

Based on the data available, 3,4,4a,5,8,8a (or 3,4,4a, 7,8,8a)-hexahydro-3,3,6,7-tetramethyl-1H-2-benzopyran does not present a concern for genotoxic.

Additional References: None.

Literature Search and Risk Assessment Completed On: 04/15/20.

Repeated dose toxicity

There are insufficient repeated dose toxicity data on 3,4,4a,5,8,8a (Or 3,4,4a,7,8,8a)-hexahydro-3,3,6,7-tetramethyl-1H-2-benzopyran or any read-across materials. The total systemic exposure to 3,4,4a, 5,8,8a (Or 3,4,4a, 7,8,8a)-Hexahydro-3,3,6,7-tetramethyl-1H-2-benzopyran is below the TTC for the repeated dose toxicity endpoint of a Cramer Class III material at the current level of use.

Risk assessment. There are no repeated dose toxicity data on 3,4,4a,5,8,8a (Or 3,4,4a, 7,8,8a)-hexahydro-3,3,6,7-tetramethyl-1H-2-benzopyran or any read-across materials that can be used to support the repeated dose toxicity endpoint. The total systemic exposure (0.96 µg/kg/day) is below the TTC for 3,4,4a, 5,8,8a (Or 3,4,4a, 7,8,8a)-hexahydro-3,3,6,7-tetramethyl-1H-2-benzopyran (1.5 µg/kg/day; Kroes et al., 2007).

Additional References: None.

Literature Search and Risk Assessment Completed On: 03/18/20.

Reproductive toxicity

There are insufficient reproductive toxicity data on 3,4,4a,5,8,8a (Or 3,4,4a,7,8,8a)-hexahydro-3,3,6,7-tetramethyl-1H-2-benzopyran or any read-across materials. The total systemic exposure to 3,4,4a, 5,8,8a (Or 3,4,4a, 7,8,8a)-hexahydro-3,3,6,7-tetramethyl-1H-2-benzopyran is below the TTC for the reproductive toxicity endpoint of a Cramer Class III material at the current level of use.

Risk assessment. There are no reproductive toxicity data on 3,4,4a,5,8,8a (Or 3,4,4a, 7,8,8a)-hexahydro-3,3,6,7-tetramethyl-1H-2-benzopyran or any read-across materials that can be used to support the repeated dose toxicity endpoint. The total systemic exposure (0.96 µg/kg/day) is below the TTC for 3,4,4a, 5,8,8a (Or 3,4,4a, 7,8,8a)-hexahydro-3,3,6,7-tetramethyl-1H-2-benzopyran (1.5 µg/kg/day; Kroes et al., 2007; Laufersweiler et al., 2012).

Additional References: None.

Literature Search and Risk Assessment Completed On: 03/22/20.

Skin sensitization

Based on the application of DST, 3,4,4a,5,8,8a (Or 3,4,4a, 7,8,8a)-hexahydro-3,3,6,7-tetramethyl-1H-2-benzopyran does not present a safety concern for skin sensitization under the current, declared levels of use.

Risk assessment. No skin sensitization studies are available for

3,4,4a,5,8,8a (Or 3,4,4a, 7,8,8a)-hexahydro-3,3,6,7-tetramethyl-1H-2-benzopyran. The chemical structure of this material indicates that it would not be expected to react with skin proteins directly (Roberts et al., 2007; Toxtree v3.1.0; OECD Toolbox v4.2). Due to the lack of data, the reported exposure was benchmarked utilizing the non-reactive DST of 900 µg/cm² (Safford, 2008, 2011, 2015b; Roberts, 2015). The current exposure from the 95th percentile concentration is below the DST for non-reactive/reactive materials when evaluated in all QRA categories. Table 1 provides the maximum acceptable concentrations for 3,4,4a,5,8,8a (Or 3,4,4a, 7,8,8a)-hexahydro-3,3,6,7-tetramethyl-1H-2-benzopyran that present no appreciable risk for skin sensitization based on the non-reactive DST. These levels represent maximum acceptable concentrations based on the DST approach. However, additional studies may show it could be used at higher levels.

Table 1

Maximum acceptable concentrations for 3,4,4a,5,8,8a (Or 3,4,4a,7,8,8a)-hexahydro-3,3,6,7-tetramethyl-1H-2-benzopyran that present no appreciable risk for skin sensitization based on non-reactive DST.

IFRA Category ^a	Description of Product Type	Maximum Acceptable Concentrations in Finished Products Based on Non-Reactive DST	Reported 95th Percentile Use Concentrations in Finished Products
1	Products applied to the lips	0.069%	NRU ^b
2	Products applied to the axillae	0.021%	0.003%
3	Products applied to the face using fingertips	0.41%	NRU ^b
4	Fine fragrance products	0.39%	0.075%
5	Products applied to the face and body using the hands (palms), primarily leave-on	0.10%	0.03%
6	Products with oral and lip exposure	0.23%	NRU ^b
7	Products applied to the hair with some hand contact	0.79%	0.029%
8	Products with significant anogenital exposure	0.041%	No Data ^c
9	Products with body and hand exposure, primarily rinse-off	0.75%	0.0221%
10	Household care products with mostly hand contact	2.7%	0.015%
11	Products with intended skin contact but minimal transfer of fragrance to skin from inert substrate	1.5%	No Data ^c
12	Products not intended for direct skin contact, minimal or insignificant transfer to skin	No Restriction	0.0477%

Note.

^a For a description of the categories, refer to the IFRA/RIFM Information Booklet.

^b No reported use.

^c Fragrance exposure from these products is very low. These products are not currently in the Creme RIFM Aggregate Exposure Model.

Additional References: None.

Literature Search and Risk Assessment Completed On: 04/10/20.

Phototoxicity/photoallergenicity

Based on the available UV/Vis spectra, 3,4,4a,5,8,8a (Or 3,4,4a, 7,8,8a)-hexahydro-3,3,6,7-tetramethyl-1H-2-benzopyran would not be expected to present a concern for phototoxicity or photoallergenicity.

Risk assessment. There are no phototoxicity studies available for 3,4,4a,5,8,8a (Or 3,4,4a, 7,8,8a)-hexahydro-3,3,6,7-tetramethyl-1H-2-benzopyran in experimental models. UV/Vis absorption spectra indicate no significant absorption between 290 and 700 nm. The corresponding molar absorption coefficient is well below the benchmark of concern for phototoxicity and photoallergenicity (Henry, 2009). Based on the lack of absorbance, 3,4,4a, 5,8,8a (Or 3,4,4a, 7,8,8a)-hexahydro-3,3,6,7-tetramethyl-1H-2-benzopyran does not present a concern for phototoxicity or photoallergenicity.

UV spectra analysis. UV/Vis absorption spectra (OECD TG 101) were obtained. The spectra indicate no significant absorbance in the range of 290–700 nm. The molar absorption coefficient is below the benchmark of concern for phototoxic effects, $1000 \text{ L mol}^{-1} \cdot \text{cm}^{-1}$ (Henry, 2009).

Additional References: None.

Literature Search and Risk Assessment Completed On: 03/20/20.

Local respiratory toxicity

The margin of exposure could not be calculated due to a lack of appropriate data. The exposure level for 3,4,4a,5,8,8a (Or 3,4,4a, 7,8,8a)-hexahydro-3,3,6,7-tetramethyl-1H-2-benzopyran is below the Cramer Class III TTC value for inhalation exposure local effects.

Risk assessment. There are no inhalation data available on 3,4,4a,5,8,8a (Or 3,4,4a, 7,8,8a)-hexahydro-3,3,6,7-tetramethyl-1H-2-benzopyran. Based on the Creme RIFM Model, the inhalation exposure is 0.0024 mg/day. This exposure is 195.8 times lower than the Cramer Class III TTC value of 0.47 mg/day (based on human lung weight of 650 g; Carthew et al., 2009); therefore, the exposure at the current level of use is deemed safe.

Additional References: None.

Literature Search and Risk Assessment Completed On: 04/02/20.

2. Environmental endpoint summary

Screening-level assessment

A screening-level risk assessment of 3,4,4a,5,8,8a (Or 3,4,4a, 7,8,8a)-hexahydro-3,3,6,7-tetramethyl-1H-2-benzopyran was performed following the RIFM Environmental Framework Salvido et al. (2002), which provides 3 tiered levels of screening for aquatic risk. In Tier 1, only the material's regional VoU, its log K_{OW} , and its molecular weight are needed to estimate a conservative risk quotient (RQ), expressed as the ratio Predicted Environmental Concentration/Predicted No Effect Concentration (PEC/PNEC). A general QSAR with a high uncertainty factor applied is used to predict fish toxicity, as discussed in Salvido et al. (2002). In Tier 2, the RQ is refined by applying a lower uncertainty factor to the PNEC using the ECOSAR model (US EPA, 2012b), which provides chemical class-specific ecotoxicity estimates. Finally, if necessary, Tier 3 is conducted using measured biodegradation and ecotoxicity data to refine the RQ, thus allowing for lower PNEC uncertainty factors. The data for calculating the PEC and PNEC for this safety assessment are provided in the table below. For the PEC, the range from the most recent IFRA Volume of Use Survey is reviewed. The PEC is then calculated using the actual regional tonnage, not the extremes of the range. Following the RIFM Environmental Framework, 3,4,4a, 5,8,8a (Or 3,4,4a, 7,8,8a)-hexahydro-3,3,6,7-tetramethyl-1H-2-benzopyran was identified as a fragrance material with the potential to present a possible risk to the aquatic environment (i.e., its screening-level PEC/PNEC >1).

A screening-level hazard assessment using EPI Suite v4.11 (US EPA, 2012a) identified 3,4,4a, 5,8,8a (Or 3,4,4a, 7,8,8a)-hexahydro-3,3,6,7-tetramethyl-1H-2-benzopyran as possibly persistent but not bioaccumulative based on its structure and physical-chemical properties. This screening-level hazard assessment considers the potential for a material to be persistent *and* bioaccumulative *and* toxic, or very persistent *and* very bioaccumulative as defined in the Criteria Document (Api, 2015). As noted in the Criteria Document, the screening criteria applied are the same as those used in the EU for REACH (ECHA, 2012). For persistence, if the EPI Suite model BIOWIN 3 predicts a value < 2.2 and either BIOWIN 2 or BIOWIN 6 predicts a value < 0.5, then the

	LC50 (Fish) (mg/L)	EC50 (<i>Daphnia</i>) (mg/L)	EC50 (Algae) (mg/L)	AF	PNEC (µg/L)	Chemical Class
RIFM Framework Screening-level (Tier 1)	2.1			1000000	0.0021	
ECOSAR Acute Endpoints (Tier 2) Ver 1.11	0.439	0.359	0.497	10000	0.0359	Vinyl/Allyl Ethers
ECOSAR Acute Endpoints (Tier 2) Ver 1.11	1.089	0.773	1.445			Neutral Organics SAR (Baseline toxicity)

material is considered potentially persistent. A material would be considered potentially bioaccumulative if the EPI Suite model BCFBAF predicts a fish BCF ≥ 2000 L/kg. Ecotoxicity is determined in the above screening-level risk assessment. If, based on these model outputs (Step 1), additional assessment is required, a WoE-based review is then performed (Step 2). This review considers available data on the material's physical-chemical properties, environmental fate (e.g., OECD Guideline biodegradation studies or die-away studies), fish bioaccumulation, and higher-tier model outputs (e.g., US EPA's BIOWIN and BCFBAF found in EPI Suite v4.11).

Risk assessment

Based on the current Volume of Use (2015), 3,4,4a, 5,8,8a (Or 3,4,4a, 7,8,8a)-hexahydro-3,3,6,7-tetramethyl-1H-2-benzopyran presents a risk to the aquatic compartment in the screening-level assessment.

Key studies

Biodegradation. No data available.

Ecotoxicity. No data available.

Other available data. 3,4,4a,5,8,8a (Or 3,4,4a, 7,8,8a)-Hexahydro-3,3,6,7-tetramethyl-1H-2-benzopyran has been pre-registered for REACH with no additional information available at this time.

Risk assessment refinement. Risk Ecotoxicological data and PNEC derivation (all endpoints reported in mg/L; PNECs in $\mu\text{g/L}$).

Endpoints used to calculate PNEC are underlined.

Exposure information and PEC calculation (following RIFM Framework: [Salvito et al. \(2002\)](#)).

Exposure	Europe (EU)	North America (NA)
Log K_{ow} Used	4.41	4.41
Biodegradation Factor Used	0	0
Dilution Factor	3	3
Regional Volume of Use Tonnage Band	<1	<1
Risk Characterization: PEC/PNEC	< 1	< 1

Based on available data, the RQ for this material is < 1 . No additional assessment is necessary.

The RIFM PNEC is 0.0359 $\mu\text{g/L}$. The revised PEC/PNECs for EU and NA are < 1 ; therefore, the material does not present a risk to the aquatic environment at the current reported VoU.

Literature Search and Risk Assessment Completed On: 04/01/20.

XII. Literature Search*

- RIFM Database: Target, Fragrance Structure-Activity Group materials, other references, JECFA, CIR, SIDS
- ECHA: <https://echa.europa.eu/>
- NTP: <https://ntp.niehs.nih.gov/>
- OECD Toolbox: <https://www.oecd.org/chemicalsafety/risk-assessment/oecd-qsar-toolbox.htm>
- SciFinder: <https://scifinder.cas.org/scifinder/view/scifinder/scifinderExplore.jsf>
- PubMed: <https://www.ncbi.nlm.nih.gov/pubmed>
- National Library of Medicine's Toxicology Information Services: <https://toxnet.nlm.nih.gov/>
- IARC: <https://monographs.iarc.fr>
- OECD SIDS: <https://hpvchemicals.oecd.org/ui/Default.aspx>
- EPA ACToR: <https://actor.epa.gov/actor/home.xhtml>
- US EPA HPVIS: https://ofmpub.epa.gov/opthpv/public_search_publicdetails?submission_id=24959241&ShowComments=Yes&sqlstr=null&recordcount=0&User_title=DetailQuery%20Results&EndPointRpt=Y#submission

- Japanese NITE: https://www.nite.go.jp/en/chem/chrip/chrip_search/systemTop
- Japan Existing Chemical Data Base (JECDB): http://dra4.nihs.gov.jp/mhlw_data/jsp/SearchPageENG.jsp
- Google: <https://www.google.com>
- ChemIDplus: <https://chem.nlm.nih.gov/chemidplus/>

Search keywords: CAS number and/or material names.

*Information sources outside of RIFM's database are noted as appropriate in the safety assessment. This is not an exhaustive list. The links listed above were active as of 09/30/20.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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