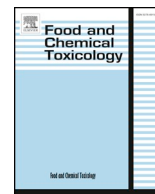




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Short Review

RIFM fragrance ingredient safety assessment, 3,7-dimethyl-6-octenoic acid, CAS Registry Number 502-47-6



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Version: 080318. This version replaces any previous versions.

Name: 3,7-Dimethyl-6-octenoic acid
CAS Registry Number: 502-47-6

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

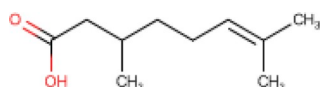
DST - Dermal Sensitization Threshold

ECHA - European Chemicals Agency

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

QRA - Quantitative Risk Assessment

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

RfD - Reference Dose

RIFM - Research Institute for Fragrance Materials

RQ - Risk Quotient

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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 safe under the limits 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 (i.e., 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).

*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 use of this material under current conditions is supported by existing information.

3,7-Dimethyl-6-octenoic acid was evaluated for genotoxicity, repeated dose toxicity, reproductive toxicity, local respiratory toxicity, phototoxicity/photoallergenicity, skin sensitization, and environmental safety. Data on 3,7-dimethyl-6-octenoic acid and read-across analog 2-methyl-trans-2-butenoic acid (CAS # 80-59-1) show that 3,7-dimethyl-6-octenoic acid is not expected to be genotoxic. The skin sensitization endpoint was completed using DST for non-reactive materials (90-0 $\mu\text{g}/\text{cm}^2$); exposure is below the DST. The repeated dose, reproductive, and local respiratory toxicity endpoints were evaluated using the TTC for a Cramer Class I material and the exposure to 3,7-dimethyl-6-octenoic acid is below the TTC (0-.03 mg/kg/day, 0.03 mg/kg/day, and 1.4 mg/day, respectively). The phototoxicity/photoallergenicity endpoints were evaluated based on UV spectra; 3,7-dimethyl-6-octenoic acid is not expected to be phototoxic/photoallergenic. The environmental endpoints were evaluated; 3,7-dimethyl-6-octenoic acid was found not to be PBT as per the IFRA Environmental Standards, and its risk quotients, based on its current volume of use in Europe and North America (i.e., PEC/PNEC), are < 1 .

Human Health Safety Assessment

Genotoxicity: Not expected to be genotoxic. (RIFM, 2017a; RIFM, 2016)

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

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

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

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

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

Environmental Safety Assessment

Hazard Assessment:

Persistence: Screening-level: 3.1 (BIOWIN 3) US EPA (2012a)

Bioaccumulation: Screening-level: 3.16 L/kg US EPA (2012a)

Ecotoxicity: Screening-level: Fish LC50: 7.62 mg/L (RIFM Framework; Salvito et al., 2002)

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: Fish LC50: 7.62 mg/L (RIFM Framework; Salvito et al., 2002)

RIFM PNEC is: 0.00762 $\mu\text{g}/\text{L}$

● **Revised PEC/PNECs (2015 IFRA VoU):** North America and Europe: Not applicable; cleared at the screening-level

1. Identification

- Chemical Name:** 3,7-Dimethyl-6-octenoic acid
- CAS Registry Number:** 502-47-6
- Synonyms:** Citronellic acid; 6-Octenoic acid, 3,7-dimethyl-; Rhodinolic acid; アルシロル酸 (C = 5 ~ 23); 3,7-Dimethyloct-6-enoic acid; 3,7-Dimethyl-6-octenoic acid
- Molecular Formula:** $\text{C}_{10}\text{H}_{18}\text{O}_2$
- Molecular Weight:** 170.25
- RIFM Number:** 3
- Stereochemistry:** Isomer not specified. One stereocenter and 2 stereoisomers possible.

2. Physical data

- Boiling Point:** 269.55 °C (US EPA, 2012a)
- Flash Point:** > 93 °C (GHS), > 200 °F; CC (FMA Database)
- Log K_{ow} :** 3.78 (US EPA, 2012a)
- Melting Point:** 49.8 °C (US EPA, 2012a)
- Water Solubility:** 89.48 mg/L (US EPA, 2012a)
- Specific Gravity:** Not Available
- Vapor Pressure:** 0.0237 mm Hg @ 20 °C (US EPA, 2012a), 0.041 mm Hg @ 25 °C (US EPA, 2012a)
- UV Spectra:** No significant absorbance between 290 and 700 nm; molar absorption coefficient is below the benchmark ($1000 \text{ L mol}^{-1} \cdot \text{cm}^{-1}$)
- Appearance/Organoleptic:** Colorless liquid with faint, fresh-green, somewhat grassy odor

3. Exposure to fragrance ingredient

- Volume of Use (Worldwide Band):** 0.1–1 metric ton/year (IFRA, 2015)
- 95th Percentile Concentration in Hydroalcohols:** 0.00018% (RIFM, 2017b)
- Inhalation Exposure*:** 0.0000005 mg/kg/day or 0.000037 mg/day (RIFM, 2017b)
- Total Systemic Exposure**:** 0.0000080 mg/kg/day (RIFM, 2017b)

*95th percentile calculated exposure derived from concentration survey data in the Creme RIFM aggregate exposure model (Comiskey et al., 2015; Safford et al., 2015a; Safford et al., 2017; and Comiskey et al., 2017).

**95th percentile calculated exposure; assumes 100% absorption unless modified by dermal absorption data as reported in Section IV. 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 et al., 2015; Safford et al., 2015a; Safford et al., 2017; and Comiskey et al., 2017).

4. Derivation of systemic absorption

- Dermal:** Assumed 100%
- Oral:** Assumed 100%
- Inhalation:** Assumed 100%

5. Computational toxicology evaluation

- Cramer Classification:** Class I, Low

Expert Judgment	Toxtree v 2.6	OECD QSAR Toolbox v 3.2
I	I	I

2. Analogs Selected:

- Genotoxicity:** 2-Methyl-trans-2-butenoic acid (CAS # 80-59-1)
- Repeated Dose Toxicity:** None
- Reproductive Toxicity:** None
- Skin Sensitization:** None
- Phototoxicity/Photoallergenicity:** None
- Local Respiratory Toxicity:** None
- Environmental Toxicity:** None

3. Read-across Justification:

 See Appendix below

6. Metabolism

No relevant data available for inclusion in this safety assessment.

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

3,7-Dimethyl-6-octenoic acid is reported to occur in the following foods by the VCF*:

- Black currants – buds.
- Black currants (*Ribes nigrum* L.)
- Black tea.
- Citrus fruits.
- Honey.
- Linden or Lime tree honey (*Tilia cordata*).
- Mandarin oil (*Citrus reticulata*).
- Mentha oils.
- Peppermint oil.
- Swangi (*Citrus hystrix* DC).
- Tea.

*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.

8. IFRA standard

None.

9. REACH dossier

Pre-registered for 11/30/2010; no dossier available as of 08/03/18.

10. Summary

10.1. Human health endpoint summaries

10.1.1. Genotoxicity

Based on the current existing data, 3,7-dimethyl-6-octenoic acid does not present a concern for genotoxicity.

10.1.1.1. Risk assessment. 3,7-Dimethyl-6-octenoic acid was assessed in the BlueScreen assay and found negative for genotoxicity, with and without metabolic activation (RIFM, 2014). The mutagenic activity of 3,7-dimethyl-6-octenoic acid 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, TA1537, and *Escherichia coli* strain WP2uvrA were treated with 3,7-dimethyl-6-octenoic acid 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, 2017a). Under the conditions of the study, 3,7-dimethyl-6-octenoic acid was not mutagenic in the Ames test.

There are no studies assessing the clastogenic activity of 3,7-dimethyl-6-octenoic acid; however, read-across can be made to 2-methyl-trans-2-butenoic acid (CAS # 80-59-1; see Section V). The clastogenic activity of 2-methyl-trans-2-butenoic acid 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 2-methyl-trans-2-butenoic acid in DMSO at concentrations up to 1000 µg/mL in the presence and absence of metabolic activation (S9) for 4 h and in the absence of metabolic activation for 24 h 2-Methyl-trans-2-butenoic acid did not induce binucleated cells with micronuclei when tested up to the maximum concentration in either non-activated or S9-activated test systems (RIFM, 2016). Under the conditions of the study, 2-methyl-trans-2-butenoic acid was considered to be non-clastogenic in the *in vitro* micronucleus test, and this can be extended to 3,7-dimethyl-6-octenoic acid.

Based on the data available, 3,7-dimethyl-6-octenoic acid does not present a concern for genotoxic potential.

Additional References: None.

Literature Search and Risk Assessment Completed On: 11/02/2017.

10.1.2. Repeated dose toxicity

There are insufficient repeated dose toxicity data on 3,7-dimethyl-6-octenoic acid nor any read-across materials. The total systemic exposure to 3,7-dimethyl-6-octenoic acid is below the TTC for the repeated dose toxicity endpoint of a Cramer Class I material at the current level of use.

10.1.2.1. Risk assessment. There are no repeated dose toxicity data on 3,7-dimethyl-6-octenoic acid nor any read-across materials that can be used to support the repeated dose toxicity endpoint. The total systemic exposure to 3,7-dimethyl-6-octenoic acid (0.008 µg/kg bw/day) is below the TTC (30 µg/kg bw/day; Kroes et al., 2007) for the repeated dose toxicity endpoint of a Cramer Class I material at the current level of use.

Additional References: None.

Literature Search and Risk Assessment Completed On: 11/08/17.

10.1.3. Reproductive toxicity

There are insufficient reproductive toxicity data on 3,7-dimethyl-6-octenoic acid nor any read-across materials. The total systemic exposure to 3,7-dimethyl-6-octenoic acid is below the TTC for the reproductive toxicity endpoint of a Cramer Class I material at the current level of use.

10.1.3.1. Risk assessment. There are no reproductive toxicity data on 3,7-dimethyl-6-octenoic acid nor any read-across materials that can be used to support the reproductive toxicity endpoint. The total systemic exposure to 3,7-dimethyl-6-octenoic acid (0.008 µg/kg bw/day) is below the TTC (30 µg/kg bw/day; Kroes et al., 2007; Laferriere et al., 2012) for the reproductive toxicity endpoint of a Cramer Class I material at the current level of use.

Additional References: None.

Literature Search and Risk Assessment Completed On: 11/10/17.

10.1.4. Skin sensitization

Based on the application of DST, 3,7-dimethyl-6-octenoic acid does not present a safety concern for skin sensitization under the current, declared levels of use.

10.1.4.1. Risk assessment. The chemical structure of this material indicates that it would not be expected to react with skin proteins (Toxtree 2.6.13; OECD toolbox v3.4). No predictive skin sensitization studies are available for 3,7-dimethyl-6-octenoic acid or read-across

materials. However, in a human maximization test, no skin sensitization reactions were observed (RIFM, 1978).

Acting conservatively, due to the limited data, the reported exposure was benchmarked utilizing the non-reactive Dermal Sensitization Threshold (DST) of 900 $\mu\text{g}/\text{cm}^2$ (Safford, 2008; Safford et al., 2011; Safford et al., 2015b; Roberts et al., 2015b). The current exposure from the 95th percentile concentration is below the DST for non-reactive materials when evaluated in all QRA categories. Table 1 provides the acceptable concentrations for 3,7-dimethyl-6-octenoic acid that present no appreciable risk for skin sensitization based on the non-reactive DST. These concentrations are not limits; they represent acceptable concentrations based on the DST approach.

Additional References: None.

Literature Search and Risk Assessment Completed On: 10/12/17.

10.1.5. Phototoxicity/photoallergenicity

Based on the available UV/Vis spectra, 3,7-dimethyl-6-octenoic acid would not be expected to present a concern for phototoxicity or photoallergenicity.

10.1.5.1. Risk assessment. There are no phototoxicity studies available for 3,7-dimethyl-6-octenoic acid 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 et al., 2009). Based on lack of absorbance, 3,7-dimethyl-6-octenoic acid does not present a concern for phototoxicity or photoallergenicity.

10.1.6. 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 et al., 2009).

Additional References: None.

Literature Search and Risk Assessment Completed On: 10/11/17.

10.1.7. Local Respiratory Toxicity

The margin of exposure could not be calculated due to lack of appropriate data. The exposure level for 3,7-dimethyl-6-octenoic acid is below the Cramer Class I TTC value for inhalation exposure local

effects.

10.1.7.1. Risk assessment. There are no inhalation data available on 3,7-dimethyl-6-octenoic acid. Based on the Creme RIFM Model, the inhalation exposure is 0.000037 mg/day. This exposure is 37838 times lower than the Cramer Class I TTC value of 1.4 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: 11/30/2017.

10.2. Environmental endpoint summary

10.2.1. Screening-level assessment

A screening-level risk assessment of 3,7-dimethyl-6-octenoic acid was performed following the RIFM Environmental Framework (Salvito 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 Salvito 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, 3,7-dimethyl-6-octenoic acid was identified as a fragrance material with no 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) did not identify 3,7-dimethyl-6-octenoic acid as possibly being either persistent or 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 et al., 2015). As noted in the Criteria Document,

Table 1

Acceptable concentrations for 3,7-dimethyl-6-octenoic acid that presents no appreciable risk for skin sensitization based on non-reactive DST.

IFRA Category ^a	Description of Product Type	Acceptable Concentrations in Finished Products Based on Non-reactive DST	Reported 95th Percentile Concentration in Finished Products
1	Products applied to the lips	0.07%	0.00% ^b
2	Products applied to the axillae	0.02%	0.00% ^b
3	Products applied to the face using fingertips	0.41%	0.00% ^b
4	Fine fragrance products	0.39%	0.00% ^b
5	Products applied to the face and body using the hands (palms), primarily leave-on	0.10%	0.00% ^b
6	Products with oral and lip exposure	0.23%	0.00%
7	Products applied to the hair with some hand contact	0.79%	0.00% ^b
8	Products with significant ano-genital exposure	0.04%	No Data ^c
9	Products with body and hand exposure, primarily rinse-off	0.75%	0.00% ^b
10	Household care products with mostly hand contact	2.70%	0.00% ^b
11	Products with intended skin contact but minimal transfer of fragrance to skin from inert substrate	1.50%	No Data ^c
12	Products not intended for direct skin contact, minimal or insignificant transfer to skin	Not Restricted	0.00% ^b

Note.

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

^b Negligible exposure (< 0.01%).

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

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 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). Data on persistence and bioaccumulation are reported below and summarized in the Environmental Safety Assessment section prior to Section 1.

10.2.1.1. Risk assessment. Based on the current Volume of Use (2015), 3,7-dimethyl-6-octenoic acid does not present a risk to the aquatic compartment in the screening-level assessment.

Biodegradation: No data available.

Ecotoxicity: No data available.

Other available data: No additional data is available.

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

Endpoints used to calculate PNEC are underlined.

	LC50 (Fish) (mg/L)	EC50 (Daphnia) (mg/L)	EC50 (Algae) (mg/L)	AF	PNEC ($\mu\text{g/L}$)	Chemical Class
RIFM Framework Screening-level (Tier 1)	<u>7.62</u>			1,000,000	0.00762	

Exposure information and PEC calculation (following RIFM Framework: Salvito et al., 2002).

Exposure	Europe (EU)	North America (NA)
Log K_{ow} Used	3.78	3.78
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 the available data, the RQ for this material is < 1. No further assessment is necessary.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.fct.2018.11.064>.

The RIFM PNEC is 0.00762 $\mu\text{g/L}$. The revised PEC/PNECs for EU and NA are: not applicable. The material was cleared at the screening-level and therefore does not present a risk to the aquatic environment at the current reported volumes of use.

Literature Search and Risk Assessment Completed On: 11/21/17.

11. Literature Search*

- **RIFM Database:** Target, Fragrance Structure Activity Group materials, other references, JECFA, CIR, SIDS
- **ECHA:** <http://echa.europa.eu/>
- **NTP:** <https://ntp.niehs.nih.gov/>
- **OECD Toolbox**
- **SciFinder:** <https://scifinder.cas.org/scifinder/view/scifinder/scifinderExplore.jsf>
- **PubMed:** <http://www.ncbi.nlm.nih.gov/pubmed>
- **TOXNET:** <http://toxnet.nlm.nih.gov/>
- **IARC:** <http://monographs.iarc.fr>
- **OECD SIDS:** <http://webnet.oecd.org/hpv/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:** <http://www.safe.nite.go.jp/english/db.html>

- **Japan Existing Chemical Data Base (JECDB):** http://dra4.nihs.go.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 06/12/2018.

Conflicts of interest

The authors declare that they have no conflicts of interest.

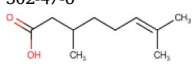
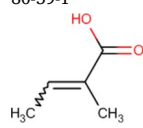
Appendix

Read-across justification

Methods:

The read-across analogs were identified following the strategy for structuring and reporting a read-across prediction of toxicity described in Schultz et al. (2015). The strategy is also consistent with the guidance provided by OECD within Integrated Approaches for Testing and Assessment (OECD, 2015) and the European Chemical Agency read-across assessment framework (ECHA, 2016).

- First, materials were clustered based on their structural similarity. Second, data availability and data quality on the selected cluster were examined. Third, appropriate read-across analogs from the cluster were confirmed by expert judgment.
- Tanimoto structure similarity scores were calculated using FCFC4 fingerprints (Rogers and Hahn, 2010).
- The physical–chemical properties of the target substance and the read-across analogs were calculated using EPI Suite v4.11 (US EPA, 2012a).
- J_{\max} values were calculated using RIFM's skin absorption model (SAM). The parameters were calculated using the consensus model (Shen et al., 2014).
- DNA binding, mutagenicity, genotoxicity alerts, and oncologic classification predictions were generated using OECD QSAR Toolbox v3.4 (OECD, 2012).
- ER binding and repeat dose categorization were generated using OECD QSAR Toolbox v3.4 (OECD, 2012).
- Developmental toxicity was predicted using CAESAR v2.1.7 (Cassano et al., 2010), and skin sensitization was predicted using Toxtree 2.6.13.
- Protein binding was predicted using OECD QSAR Toolbox v3.4 (OECD, 2012).
- The major metabolites for the target and read-across analogs were determined and evaluated using OECD QSAR Toolbox v3.4 (OECD, 2012).

	Target Material	Read-across Material
Principal Name	3,7-Dimethyl-6-octenoic acid	2-Methyl-trans-2-butenic acid
CAS No.	502-47-6	80-59-1
Structure		
Similarity (Tanimoto Score)		0.34
Read-across Endpoint		• Genotoxicity
Molecular Formula	$C_{10}H_{18}O_2$	$C_5H_8O_2$
Molecular Weight	170.25	100.12
Melting Point (°C, EPI Suite)	49.80	5.45
Boiling Point (°C, EPI Suite)	269.55	188.47
Vapor Pressure (Pa @ 25 °C, EPI Suite)	5.46	59.7
Log K_{ow} (KOWWIN v1.68 in EPI Suite)	3.78	1.4
Water Solubility (mg/L, @ 25 °C, WSKOW v1.42 in EPI Suite)	89.48	18450
J_{\max} ($\mu\text{g}/\text{cm}^2/\text{h}$, SAM)	79.955	1762.54
Henry's Law ($\text{Pa}\cdot\text{m}^3/\text{mol}$, Bond Method, EPI Suite)	5.49E-006	7.09E-007
Genotoxicity		
DNA Binding (OASIS v1.4, QSAR Toolbox v3.4)	• No alert found	• No alert found
DNA Binding (OECD QSAR Toolbox v3.4)	• No alert found	• No alert found
Carcinogenicity (ISS)	• Non-carcinogen (low reliability)	• Non-carcinogen (good reliability)
DNA Binding (Ames, MN, CA, OASIS v1.1)	• No alert found	• No alert found
<i>In Vitro</i> Mutagenicity (Ames, ISS)	• No alert found	• No alert found
<i>In Vivo</i> Mutagenicity (Micronucleus, ISS)	• No alert found	• No alert found
Oncologic Classification	• Not classified	• Not classified
Metabolism		
Rat Liver S9 Metabolism Simulator and Structural Alerts for Metabolites (OECD QSAR Toolbox v3.4)	See supplemental Data 1	No metabolites

Summary

There are insufficient toxicity data on 3,7-dimethyl-6-octenoic acid (CAS # 502-47-6). Hence, *in silico* evaluation was conducted to determine read-across analogs for this material. Based on structural similarity, reactivity, metabolism, physical–chemical properties, and expert judgment, 2-methyl-trans-2-butenic acid (CAS # 80-59-1) was identified as a read-across material with sufficient data for toxicological evaluation.

Conclusions

- 2-Methyl-trans-2-butenic acid (CAS # 80-59-1) was used as a read-across analog for the target material 3,7-dimethyl-6-octenoic acid (CAS # 502-47-6) for the genotoxicity endpoint.
 - o The target substance and the read-across analog are structurally similar and belong to the class of carboxylic acids.
 - o The target substance and the read-across analog both have an unsaturated aliphatic branched chain.
 - o The target substance is larger molecule while the read-across analog is a smaller molecule. But the key structural difference between the target substance and the read-across analog is that the target substance has unsaturation insulated from a carbonyl group while the read-across has alpha,beta-unsaturation to a carbonyl group with the alpha carbon substituted. This structural difference is expected to make the read-across analog more reactive compared to the target substance. This structural difference is toxicologically insignificant.
 - o Structural similarity between the target substance and the read-across analog is indicated by the Tanimoto score. The Tanimoto score is mainly driven by the unsaturated aliphatic branched chain. Differences between the structures that affect the Tanimoto score are toxicologically

insignificant.

- o The physical–chemical properties of the target substance and the read-across analog are sufficiently similar to enable comparison of their toxicological properties.
- o According to the OECD QSAR Toolbox v3.4, structural alerts for the toxicological endpoints are consistent between the target substance and the read-across analog.
- o The target substance is expected to be metabolized as shown by the metabolism simulator, while the read-across analog could form GSH adducts.

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