Safety Assessment of Alkyl Taurate Amides and Taurate Salts as Used in Cosmetics

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ABSTRACT

This is a review of the safety of 20 alkyl taurate amides and taurate salts as used in cosmetics. The alkyl taurate amides and taurate salts in this report are all structurally related by having the same taurate (2-aminoethane-1-sulfonate) core. These ingredients mostly function in cosmetics as surfactants-cleansing agent. The Cosmetic Ingredient Review (CIR) Expert Panel (Panel) reviewed relevant data related to these ingredients. The Panel concluded that the alkyl taurate amides and taurate salts in this safety assessment are safe in cosmetics in the present practices of use and concentration described in this safety assessment when formulated to be non-irritating.

INTRODUCTION

This is a review of the scientific literature and unpublished data relevant to assessing the safety of alkyl taurate amides and taurate salts as used in cosmetics. The alkyl taurate amides and taurate salts in this report are all structurally related by having the same taurate (2-aminoethane-1-sulfonate) core. While the free acid, taurine, is a cosmetic ingredient, it is not included because it functions exclusively as a fragrance, which is within the purview of the Research Institute for Fragrance Materials (RIFM). According to the *International Cosmetic Ingredient Dictionary and Handbook*, these 20 ingredients mostly function in cosmetics as surfactants-cleansing agent (Table 1).[1] The ingredients in this report are:

- Potassium Taurate
- Sodium Methyltaurate
- Sodium Taurate
- Calcium Lauroyl Taurate
- Magnesium Methyl Cocoyl Taurate
- Potassium Cocoyl Taurate
- Potassium Methyl Cocoyl Taurate
- Sodium Caproyl Methyltaurate
- Sodium Cocoyl Taurate
- Sodium Methyl Cocoyl Taurate
- Sodium *n*-Isostearoyl Methyltaurate
- Sodium Lauroyl Taurate
- Sodium Methyl Lauroyl Taurate
- Sodium Methyl Myristoyl Taurate
- Sodium Methyl Oleoyl Taurate
- Sodium Methyl Palmitoyl Taurate
- Sodium Methyl Stearoyl Taurate
- Sodium Methyltaurate Isopalmitamide
- Sodium Methyltaurine Cocoyl Methyltaurate
- Sodium Taurine Cocoyl Methyltaurate

The Panel has previously concluded that many of the individual fatty acids that are residue components of the alkyl taurate amides are safe as used in cosmetics.[2-10] The safety of these fatty acids may be relevant to the safety of the alkyl taurate amides (e.g., as residual manufacturing impurities, metabolic products of dermal amidases); the available data are well-documented in the existing CIR reports that can be found on the CIR website (http://www.cir-safety.org/ingredients) and will not be summarized here. The cocoyl moieties are derived from the constituent fatty acids of coconut acid, which is composed largely of various amounts of caproic acid, caprylic acid, capric acid, lauric acid, linoleic acid, myristic acid, oleic acid, palmitoleic acid, and stearic acid. The Panel has reviewed coconut acid, lauric acid, myristic acid, and oleic acid and concluded that these ingredients are safe as used. [2-10] Linoleic acid has not been reviewed by the Panel.

Background information is provided on taurine, which is the starting material and a potential impurity in the manufacture of these ingredients. However, extensive toxicity information for taurine is not included because taurine is physiologically ubiquitous and present in relatively high concentrations throughout members of the animal kingdom, including humans.[11]

Pertinent data were discovered in the European Chemicals Agency (ECHA) database.[12-17] This database provides summaries of information generated by industry, and it is those summary data that are presented in this safety assessment when referenced.

CHEMISTRY

Definition and Structure

The alkyl taurate amides and taurate salts are structurally related because these ingredients have the same taurate core (Figure 1). These ingredients vary by *N*-substitution and by the counter-ion of the sulfonate functional group. The simple taurate salts, potassium taurate, sodium methyltaurate, and sodium taurate, also vary by *N*-substitution (hydrogen or methyl) and counter-ion (sodium or potassium).

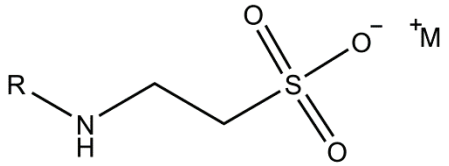


Figure 1. The simple taurate salts (wherein R is hydrogen or methyl).

The remaining ingredients in this report bear a fatty acyl *N*-substitution that forms, together with taurate, an amide (i.e., alkyl taurate amide; Figure 2). The alkyl taurate amides share a taurate core, and vary by fatty chain length and counter-ion. Some of the ingredients in this report have names that suggest discrete fatty chain-lengths; however, all of these ingredients, regardless of the nomenclature, are likely to be mixtures of substances with different chain lengths. The length specified in the names of each of these ingredients indicates the primary, or average, chain length of the substances in the mixture obtained through the batch separation and purification procedure employed. For example, those ingredients with a "cocoyl" name are the result of reaction with coconut acid, which has a known composition of approximately: 0-1% caproic, 5%-9% caprylic, 6%-10% capric, 44%-52% lauric, 13%-19% myristic, 0-1% palmitoleic, 1%-3% stearic, 5%-8% oleic, and trace-2.5% linoleic acid.[7] Accordingly, not only do these alkyl taurate amides share the same taurate core and similar fatty chain lengths, but many of these ingredients have identical component overlap (e.g., there is likely some sodium methyl lauroyl taurate in sodium methyl cocoyl taurate and in sodium methyl myristoyl taurate ("myristoyl" likely has some smaller [lauroyl] and longer [palmitoyl] chain lengths therein).

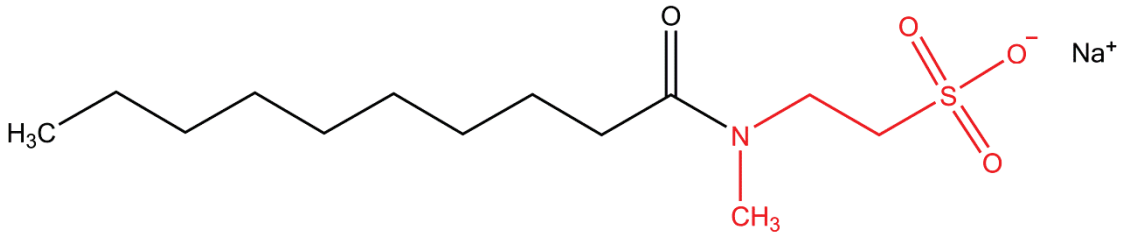


Figure 2. Sodium Caproyl Methyltaurate – an alkyl taurate amide.

Furthermore, the composition of ingredients with plant source-derived acyl compounds such as sodium methyl cocoyl taurate, can be expected to vary from batch to batch and alternative vendors, because the acid starting material, coconut fatty acid, has a high carbon chain-length variability, dependent on factors such as growth conditions.[18-24] As an illustrative example, the reported ranges of the components of sodium methyl cocoyl taurate are presented in Table 2.

Physical and Chemical Properties

Most of the alkyl taurate amides are solids (Table 3). For example, calcium lauroyl taurate is a white powder with a high fluidity.[25]

One commercial supplier reports that the particle size of their calcium lauroyl taurate is 8 µm and that the particles have a plate-like shape.[25] The particle size distribution reported by a supplier of sodium methyl cocoyl taurate was: D_{10} (the diameter at which 10% of a sample's mass is comprised of smaller particles) = 3.87±0.16 µm; D_{50} (the diameter at which 50% of a sample's mass is comprised of smaller particles) =16.58±0.67 µm; and D_{90} (the diameter at which 90% of a sample's mass is comprised of smaller particles) = 59.97±4.58 µm.[17]

TAURINE

Taurine is a white or colorless crystal powder.[26] It has high water solubility and is very hydrophilic because of its zwitterionic form, both in solids and in solution.

Method of Manufacture

ALKYL TAURATE AMIDES

In general, alkyl taurate amides may be manufactured by reaction of taurine, N-methyltaurine, or a taurate salt, with the appropriate fatty acid. For example, manufacture of sodium methyl stearoyl taurate may be accomplished by heating triple-pressed stearic acid, sodium methyltaurate solution, and boric acid to 200˚C while stirring with a subsurface nitrogen purge, distilling off any water.[27] The stirring continues at 195-200˚C for 6 h at atmospheric pressure and then for 3 h at 100 mm Hg vacuum. The mass is cooled and the resulting product, an off-white waxy solid, is ground to a powder. The product is reported to be 64.0% sodium methyl stearoyl taurate as active ingredient, 29.5% free fatty acid, 2.5% sodium *N*-methyltaurate, and 4.0% other unspecified chemicals. The conversion of sodium methyltaurate using this method was reported to be greater than 91%. Using coconut fatty acid in place of the triple-pressed stearic acid resulted in a conversion of 97%.

In another process, calcium lauroyl taurate was reported to be synthesized by dissolving taurine in a mixture of deionized water and isopropyl alcohol (86:14, wt/wt) followed by the addition of sodium hydrate. Lauric acid chloride and 48% aqueous sodium hydrate solution is dropped into the taurine solution for 1 h at 40˚C followed by stirring for 1 h at the same temperature to produce sodium lauroyl taurate. Hydrochloric acid (35%) and an aqueous calcium chloride solution (20%) are added, and the reaction mixture stirred for 1h at 40˚C. The white precipitate is filtered and the cake washed with deionized water and isopropyl alcohol, then dried.[27]

Sodium methyl cocoyl taurate is reported to be manufactured and sold as a mixture with sodium chloride and water, with active ingredient ranging from 24.0%-33%.[19-24]

TAURATE SALTS

Taurine may be produced by a cyclic process of reacting ethylene oxide with sodium bisulfite and ammonium to obtain sodium taurate.[28] Excess ammonia is removed from the reaction mixture, and the sodium taurate is neutralized with sulfur dioxide or sulfurous acid to recover taurine. Sodium bisulfate is regenerated and is then reacted with ethylene oxide. The salt forms can then by synthesized by simply reacting with the appropriate base, such as sodium hydroxide.

Impurities

Sodium methyltaurate is reported to be 87.0% - 96.0% (w/w) pure.[15] Impurities are sodium hydroxide and sodium 2-hydroxyethanesulfonate.

USE

Cosmetic

The safety of the cosmetic ingredients included in this safety assessment is evaluated based on the data the Panel receives from the U.S. Food and Drug Administration (FDA) and the cosmetics industry on the expected cosmetic use of ingredients. The data from the FDA are those it collects from manufacturers on the use of individual ingredients in cosmetics by cosmetic product category in its Voluntary Cosmetic Registration Program (VCRP). Those received from the cosmetic industry are submitted in response to a survey conducted by the Personal Care Products Council (Council) of the maximum reported use concentrations by category.

According to 2015 VCRP data, sodium methyl cocoyl taurate is reported to be used in 339 formulations; the majority of the uses (322) are in rinse-off formulations (Table 4).[29] Sodium methyltaurate, sodium methyl oleoyl taurate, and sodium methyl stearoyl taurate also have reported uses in the VCRP.

According to the survey conducted by the Council, sodium methyl oleoyl taurate had the highest reported maximum concentration of use, 28% in bath products.[30] This is followed by sodium cocoyl taurate in rinse-off products at up to 21.5%. Calcium lauroyl taurate and sodium methyl cocoyl taurate are used at up to 11% (highest concentration in a leave-on product) in foundations and 13% in rinse-off foot products, respectively. All the other ingredients with reported concentration of use are used at up to 6% or less.

In some cases, no reported uses were received in the VCRP, but a use concentration was provided in the industry survey. For example, magnesium methyl cocoyl taurate was not reported in the VCRP to be in use, but the industry survey indicated that it is used in non-coloring shampoo formulations at up to 0.26%. It should be presumed that magnesium methyl cocoyl taurate is used in at least 1 cosmetic formulation. The alkyl taurate amides and taurate salts that have no reported uses, according to the VCRP and Council survey, are listed in Table 5.

Sodium methyl cocoyl taurate is reported to be used in 1 baby product (a concentration of use was not reported). Several of these ingredients are reported to be used in products that result in exposure to mucous membranes (highest reported concentration of use at up to 28% in a bath product) and in products that may be ingested (highest reported concentration of use at up to 1.2% in dentifrices).

Additionally, sodium methyl cocoyl taurate, sodium methyl lauroyl taurate, and sodium methyl stearoyl taurate were reported to be used in tonics, dressings and other hair grooming aids and mouthwashes and breath fresheners that may be sprays and could possibly be inhaled. These ingredients are reportedly used at concentrations up to 1% in products that may be sprays. In practice, 95% to 99% of the droplets/particles released from cosmetic sprays have aerodynamic equivalent diameters >10 μm.[31-34] Therefore, most droplets/particles incidentally inhaled from cosmetic sprays would be deposited in the nasopharyngeal and bronchial regions and would not be respirable (i.e., they would not enter the lungs) to any appreciable amount.[32,35] Sodium methyl cocoyl taurate was reportedly used in face powder at concentrations up to 6%. Conservative estimates of inhalation exposures to respirable particles during the use of loose-powder cosmetic products are 400-fold to 1000-fold less than protective regulatory and guidance limits established for inert respirable particles in the workplace.[36-38]

None of the ingredients in this report are restricted from use in any way under the rules governing cosmetic products in the European Union.[39]

Non-Cosmetic

SODIUM METHYL OLEOYL TAURATE

Sodium methyl oleoyl taurate may be used as a component of paper and paperboard that comes into contact with dry food without restriction. It may come into contact with aqueous and fatty foods only as an adjuvant to control pulp absorbency and pitch content in the manufacturing process.[21CFR176.170; 21CFR176.180] When sodium methyl oleoyl taurate is used in pesticides for food crops, the residues are exempted from the requirement of a tolerance when used in accordance with good agricultural practice as inert (or occasionally active) ingredients in pesticide formulations applied to growing crops or to raw agricultural commodities after harvest.[40CFR180.910] Sodium methyl oleoyl taurate is also exempt from the requirement of a tolerance when used in accordance with good agricultural practice as inert (or occasionally active) ingredients in pesticide formulations applied to animals.[40CFR180.930]

TAURINE AND TAURATE SALTS

The European Food Safety Authority (EFSA) Panel on Additives and Products or Substances used in Animal Feed (FEEDAP) estimates the observed safe level of taurine in humans to be 6 g/person per day (corresponding to 100 mg/kg body weight per day).[40] Taurine is used in energy drinks up to 4000 mg/L.[41]

Dietary taurine is a requirement for domestic cats at levels of 0.05%–0.25 % in complete feed.[40]

Taurine may be safely used as an additive in the feed of growing chickens when the total taurine content does not exceed 0.054%.[21CFR573.980]

In Europe, magnesium taurate, magnesium acetyl taurate, and iron (II) taurate may be used in the manufacture of food supplements.[42]

TOXICOKINETICS

Absorption, Distribution, Metabolism, and Excretion

OVERVIEW OF TAURINE

Taurine is ubiquitous in high concentrations throughout the animal kingdom (except for protozoans).[11] A human body weighing 70 kg contains up to 70 g of taurine. Taurine plays a part in the regulation of the cardiovascular system, functions of the brain, retina, liver, sperm (motility/osmoprotection), muscle, and of other general biological activities (for example, osmoregulation and calcium modulation). Taurine levels are particularly high in electrically excitable tissues of mammals, especially in secretory structures.

After ingestion in mammals, taurine is mostly excreted unchanged or in the form of bile salts, such as taurocholate.[11] Most mammals acquire taurine as an end product of sulfur metabolism (cysteine to cysteine sulfonate to taurine). Mammals are unable to oxidize the sulfur in taurine, cleave the C-S bond, or recycle the carbon of taurine into the general metabolic pool.

ALKYL TAURATE AMIDES AND TAURATE SALTS

Data on toxicokinetics of the alkyl taurate amides and taurate salts in this safety assessment were not found in the published literature, nor were unpublished data submitted.

Penetration Enhancement

SODIUM METHYL COCOYL TAURATE

N-Ammonium thioglycolate (0.606 mg/kg/d; pH 9.32) was administered to the clipped skin of rabbits (n=11,12; strain not specified), covering >15% of the body surface, daily for 20 days with and without sodium methyl cocoyl taurate (3.0-4.0 mg/mL; volume not specified) under a rubber sleeve.[43] The rabbits were observed for 3 weeks after the last administration. The LD_{50} was >6.5 mg/kg/d for *N*-ammonium thioglycolate alone; 1 rabbit died after 12 doses. The LD_{50} was reduced to 3.44±0.14 mg/kg/d when sodium methyl cocoyl taurate was included in the mixture; the mean number of doses before death was 11.

The entire experiment was repeated an additional 2 times with *N*-ammonium thioglycolate (0.600 mg/kg/d; pH 9.35) and sodium methyl cocoyl taurate (3.0 mg/mL only). In the first of the additional studies (n=11), 4 rabbits died with the mean number of doses before death at 13. In the second (n=12), 1 rabbit died with the mean number of doses before death at 20. The authors concluded that sodium methyl cocoyl taurate, because of its surfactant properties, increased the toxicity of *N*-ammonium thioglycolate when both were administered to the skin of rabbits compared to *N*-ammonium thioglycolate alone.[43]

TOXICOLOGICAL STUDIES

Single Dose (Acute) Toxicity

The reported dermal LD_{50} values for sodium methyl cocoyl taurate were >20 and >2000 mg/kg and values were ≥2000 mg/kg for sodium methyl oleoyl taurate in rats (Table 6).[12,13,17,18,44] The reported oral LD_{50} for sodium methyltaurate was ≥4670 mg/kg in rats and values for sodium methyl cocoyl taurate were >2000 mg/kg in rats.[15,17,18] Clinical signs included hypoactivity, squatting posture, and coat bristling. An oral LD_{50} of 6.63 g/kg was reported for sodium methyl cocoyl taurate in mice.[45]

Inhalation

No acute inhalation toxicity studies were found in the published literature and no unpublished data were provided.

Repeated Dose Toxicity

Dermal

No dermal repeated dose toxicity studies were found in the published literature and no unpublished data were provided.

Oral – Non-Human

The no-observed-adverse-effects-level (NOAEL) was reported to be ≥1000 mg/kg/d for both sodium methyl cocoyl taurate and sodium methyl oleoyl taurate in 14-day oral toxicity studies in rats; there were no clinical signs in a 28-day oral toxicity study of sodium methyl cocoyl taurate in rats at up to 1000 mg/kg/d (Table 7).[12,13,18] When 0.662 g/kg sodium methyl oleoyl taurate was administered by gavage 6 days/week for 25 doses to 10 mice, 1 mouse was dead on day 5 and 5 were dead on day 10 due to the test substance. No additional mice died through day 25.[45]

Inhalation

No published repeated dose inhalation toxicity studies were found in the published literature and no unpublished data were provided.

REPRODUCTIVE AND DEVELOPMENTAL TOXICITY

SODIUM METHYL OLEYL TAURATE

A reproduction/developmental toxicity assay was performed on Sprague Dawley rats (n=10/sex) for sodium methyl oleoyl taurate (100, 300 and 1000 mg/kg/d) in accordance with Organization for Economic Cooperation and Development Test Guideline (OECD TG) 421.[12,14,18] The test substance was administered by gavage starting 2 weeks before pairing, during pairing, during gestation, and through post-partum day 3. The parental rats were monitored for clinical signs, body weight, feed consumption, estrous cycle and mating performance. Macroscopic observations and histopathological examinations were performed on the dams on day 4 post-partum. No adverse findings were observed in life phase or at post mortem evaluation in the parental rats; however, 1 male and 1 female rat died due to possible miss-dosing, but not due to the prescribed test conditions. The rats of the high-dose group showed salivation early after dosing. Body weight, body weight gain, and feed consumption were unaffected by treatment. No treatment-related findings were observed during macroscopic and microscopic examinations. No abnormalities were observed at the evaluation of the spermatogenic cycle. No differences were observed in the reproductive performance including gonadal function, mating behavior, conception, development of conceptus, and parturition. The dams had comparable length of gestation and live births. Litter and mean pup weights were also comparable between groups and no relevant findings were observed in the examination of the pups during the lactation period or at necropsy. The authors determined that the oral NOAEL for reproduction/developmental toxicity was >1000 mg/kg/d for both males and females.

GENOTOXICITY

In Vitro

Sodium methyltaurate, sodium cocoyl taurate, sodium methyl cocoyl taurate, and sodium methyl oleoyl taurate were not genotoxic in Ames tests up to 5000 µg/plate, with and without metabolic activation (Table 8).[12,13,15,17,18] Sodium methyl cocoyl taurate was not genotoxic in mammalian cell micronucleus tests up to 320 µg/mL without metabolic activation and up to 240 µg/mL with metabolic activation.[12,17,18] Sodium methyl cocoyl taurate, up to 100 µg/mL without metabolic activation and up to 120 µg/mL with metabolic activation, and sodium methyl oleoyl taurate, up to 32.3 µg/mL without metabolic activation and up to 600 µg/mL with metabolic activation, were not genotoxic in mammalian cell gene mutation tests.[12,13,17,18] Sodium methyl oleoyl taurate was not genotoxic in mammalian chromosome aberration test up to 5000 µg/mL with and without metabolic activation but was moderately cytotoxic at 156 µg/mL.[12,13]

CARCINOGENICITY

No published carcinogenicity studies were found in the published literature and no unpublished data were provided.

IRRITATION AND SENSITIZATION

Irritation

Dermal – Non-Human

SODIUM METHYLTAURATE

A dermal irritation assay of sodium methyltaurate (76%- 84%; 500 mg in saline) was conducted in accordance with OECD TG 404 (Acute Dermal Irritation/Corrosion).[15] The test substance was dermally administered to shaved New Zealand White rabbits (n=3) under semi-occlusion for 4 h. The test sites were observed at 0.5-1, 24, 48, 72 h and 7 and 14 d after patch removal. At observation times up to 24 h, the edema scores were between 1 and 3 of 4; edema was resolved at 48 h. The erythema score was between 1 and 3 of 6 starting at 0.5 h; erythema was fully resolved at 7 d. The test substance was a dermal irritant.

A dermal irritation assay of sodium methyltaurate (35%-37% mg in saline; 0.5 mL) was conducted in accordance with OECD TG 404.[15] The test substance was dermally administered to shaved New Zealand White rabbits (n=3) under semi-occlusion for 4 h. The test sites were observed at 0.5-1, 24, 48, and 72 h. The edema score was 0 of 4 at all observation times. Sodium methyltaurate was not an irritant or corrosive to rabbit skin.

Dermal-Human

SODIUM METHYL COCOYL TAURATE

An occlusive patch test of sodium methyl cocoyl taurate (40% in distilled water; pH 7) was performed on subjects (n=8 females, 3 males).[46] The 50 mm^2 patch was administered to the upper back for 24 h. The test site was observed at 30 min and 24 and 48 h after removal. There was slight to definite erythema at 24 h in 2 subjects and 1 subject at 48 h. There were no reactions observed in 9 of the subjects.

Dermal-In Vitro

SODIUM METHYL COCOYL TAURATE

An in vitro skin corrosion assay conducted in accordance with OECD TG 431 (EPISKIN™ In Vitro Skin Corrosion: Human Skin Model Test; EU Method B.40) did not predict that sodium methyl cocoyl taurate (100%; 20 mg in 100 µL sterile water to wet the test substance; >90% pure) would cause dermal irritation.[12,17,18] The test was conducted on intact reconstructed human epidermis. In this assay, a positive result would have indicated that the test substance is irritating or corrosive. However, a negative result is not definitive.

An in vitro skin corrosion assay conducted in accordance with OECD TG 439 (EPISKIN™ In Vitro Skin Irritation; EU method B.46) did not predict that sodium methyl cocoyl taurate (100%; 10 mg in 5 µL sterile water to wet the test substance; >90% pure) would cause dermal irritation.[12,17,18] However, as stated above, a negative result from this test is not definitive.

Ocular – In Vivo

SODIUM METHYLTAURATE

Sodium methyltaurate caused persistent corneal opacity, as well as inflammation of the iris and conjunctiva, resulting in irreversible eye damage in rabbits at concentrations as low as 35%-37% (Table 9).[15] Sodium methyl cocoyl taurate was an ocular irritant in rabbits at 100% and a mild irritant at 10%.[17,18,46] Sodium methyl myristoyl taurate at 10% had a Draize score of approximately 2.2 out of 5 in rabbits.[47] Sodium methyl oleoyl taurate had an irritation score of 2 out of 4 at 1% and was considered to not be an ocular irritant but was a mild ocular irritant at 100% in rabbits.[12-14,45]

Ocular – In Vitro

SODIUM METHYL COCOYL TAURATE

In a Bovine Corneal Opacity and Permeability (BCOP) test, administered in accordance with OECD TG 437, sodium methyl cocoyl taurate (20% in sodium chloride solution) was predicted to be a severe eye irritant.[12,18] The calculated in vitro irritancy score (IVIS) was 53.7 (a IVIS score of ≥55.1 is predictive of a corrosive or severe eye irritant). The positive control (imidazole, 20% in 0.9% sodium chloride solution) induced severe irritation of the cornea (IVIS score: 90.3). The negative control (solvent) showed no irritating effect on the cornea. On the basis of the test findings it was concluded that the test substance was corrosive and had severe irritation potential under the experimental conditions.

Sensitization

Dermal – Non-Human

SODIUM METHYL COCOYL TAURATE

In a Buehler sensitization assay conducted in accordance with OECD TG 406 (Skin Sensitization) in female Pirbright-White guinea pigs (n=20; control=10), the epicutaneous induction was conducted with sodium methyl cocoyl taurate at 100% under occlusion and the challenge was conducted at 20% (in water), also under occlusion.[17] The challenge sites were observed 24 and 48 h after administration. There were no reactions observed during induction or after the challenge. It was concluded that sodium methyl cocoyl taurate was not sensitizing.

SODIUM METHYL OLEOYL TAURATE

In a Buehler sensitization assay conducted in accordance with OECD TG 406 in female Himalayan spotted guinea pigs (n=20; control=10), the epicutaneous induction and challenge was conducted with sodium methyl oleoyl taurate (50% in PEG 300).[13] During the induction phase, the test material was administered to the left shoulder for 6 h, once per week for 3 weeks. The challenge involved administering the test material to the left posterior and back on day 29 for 6 h. The test site was examined 24 and 48 h after the challenge. Sodium methyl oleoyl taurate was not a sensitizer under these test conditions.

Case Reports

A 53-year-old woman, with a history of itching when having her hair colored, developed pruritus of the scalp followed by flushing of her entire body, dyspnea, vomiting, and hypotension while having her hair colored.[48] She was treated with intravenous steroids and hydration in the hospital. A skin prick test of the ingredients of the hair dye (1% of the concentration applied to the hair) showed positive responses to *p*-aminophenol and sodium methyl oleoyl taurate.

SUMMARY

This is a safety assessment of the scientific literature and unpublished data relevant for assessing the safety of 20 alkyl taurate amides and taurate salts used as ingredients in cosmetics. The alkyl taurate amides and taurate salts in this report are all structurally related by having the same taurate core. While the free acid, taurine, is a cosmetic ingredient, it is not included in this safety assessment because it functions exclusively as a fragrance and is under the purview of RIFM; relevant data on taurine that are informative on these ingredients are included. These ingredients are mostly reported to function as surfactants – cleansing agent.

Sodium methyl cocoyl taurate is reported to be used in 339 formulations; most of these uses are in rinse-off formulations.

Sodium methyl oleoyl taurate had the highest reported concentration of use of 28% in bath products. This is followed by sodium cocoyl taurate with a maximum concentration of use of 21.5% in rinse-off personal cleanliness products and up to 2% in leave-on skin care products. Calcium lauroyl taurate and sodium methyl cocoyl taurate are used up to 11% (highest concentration in a leave-on product) and 13%, respectively. All the other ingredients with reported concentrations of use are used at up to 6% or less.

Taurine is ubiquitous in high concentrations throughout the animal kingdom; a human body weighing 70 kg contains of up to 70 g of taurine.

Sodium methyl cocoyl taurate increased the toxicity of *N*-ammonium thioglycolate when both were administered to the skin of rabbits for 20 days compared to *N*-ammonium thioglycolate alone. The LD_{50} of *N*-ammonium thioglycolate decreased from >6.5 mg/kg/d to 3.44 mg/kg/d when combined with 3.0-4.0 mg/mL sodium methyl cocoyl taurate.

The reported acute dermal LD_{50} for sodium methyl cocoyl taurate was >2000 mg/kg and values were >2000 mg/kg for sodium methyl oleoyl taurate in rats. The reported oral LD_{50} for sodium methyltaurate was ≥4670 mg/kg in rats and values for sodium methyl cocoyl taurate were >2000 mg/kg in rats. Clinical signs included hypoactivity, squatting posture, and coat bristling. An oral LD_{50} of 6.63 g/kg was reported for sodium methyl cocoyl taurate in mice.

The NOAEL was ≥1000 mg/kg/d for both sodium methyl cocoyl taurate and sodium methyl oleoyl taurate in 14-day oral toxicity studies in rats; there were no clinical signs in a 28-day oral toxicity study of sodium methyl cocoyl taurate in rats at up to 1000 mg/kg/d. There were 2 mortalities when mice were orally administered 0.662 g/kg/d sodium methyl oleoyl taurate for 25 daily doses.

In a reproduction/developmental assay, the NOAEL for reproduction/developmental toxicity was ≥1000 mg/kg/d for both male and female rats when sodium methyl oleoyl taurate was orally administered from 2 weeks before pairing through postpartum day 3.

Sodium methyltaurate, sodium cocoyl taurate, sodium methyl cocoyl taurate, and sodium methyl oleoyl taurate were not genotoxic in an Ames test up to 5000 µg/plate. Sodium methyl cocoyl taurate was not genotoxic in mammalian cell micronucleus tests up to 320 µg/mL without metabolic activation and up to 240 µg/mL with metabolic activation. Sodium methyl cocoyl taurate, up to 100 µg/mL without metabolic activation and up to 120 µg/mL with metabolic activation, and sodium methyl oleoyl taurate, up to 32.3 µg/mL without metabolic activation and up to 600 µg/mL with metabolic activation, were not genotoxic in mammalian cell gene mutation tests. Sodium methyl oleoyl taurate was not genotoxic in mammalian chromosome aberration test up to 5000 µg/mL with and without metabolic activation but was moderately cytotoxic at156 µg/mL.

Sodium methyltaurate at 76%-84% was dermally irritating to rabbits but was not irritating at 35%-37%.

In a patch test, there was slight to definite erythema at 24 h in 2 of 11 subjects and 1 subject at 48 h when sodium methyl cocoyl taurate was administered at 40%. There were no reactions observed in 9 of the subjects.

In 2 in vitro assays, sodium methyl cocoyl taurate was not predicted to be irritating.

Sodium methyltaurate at 80%-84% and 35%-37% caused persistent corneal opacity as well as inflammation of the iris and conjunctiva resulting in irreversible eye damage. Sodium methyl cocoyl taurate at 100% was an ocular irritant to rabbits and was less irritating at 10%. In a Draize test of sodium methyl myristoyl taurate at 10% aqueous, the score was approximately 2.2 out of 5 in rabbits. The ocular irritation score was 2 (out of a possible 4) for sodium methyl oleoyl taurate at 1% administered to the eyes of rabbits. At 1% and 100%, sodium methyl oleoyl taurate was rated not irritating and mildly irritating in rabbits.

In a BCOP test, sodium methyl cocoyl taurate at 20% was predicted to be corrosive to the eyes.

Sodium methyl cocoyl taurate was not sensitizing to guinea pigs at 100% when challenged at 20%. Sodium methyl oleoyl taurate was not sensitizing when induced and challenged at 50%.

A woman developed sensitization to sodium methyl oleoyl taurate after repeatedly dying her hair.

DISCUSSION

The Panel considered the data on method of manufacture, impurities, genotoxicity, irritation, and sensitization. Dermal absorption may occur, but there were no adverse effects observed in studies at concentrations greater than the reported concentrations of use; however, there were no chronic studies. Taurine is ubiquitous in humans and other mammals. In addition, data reviewed showed no signs of toxicity, and the results of a reproduction study raised no concerns. The results of genotoxicity tests were negative, and the Panel determined that these ingredients are not likely carcinogens.

Because dermal and ocular irritation was observed at concentrations above the reported concentrations of use, and there were few tests conducted at the maximum concentrations of use, the Panel cautioned that cosmetic products should be formulated to be non-irritating.

The Expert Panel recognized that these ingredients, particularly sodium methyl cocoyl taurate, may enhance the penetration of other ingredients through the skin. The Panel cautioned that care should be taken when formulating cosmetic products that contain these ingredients in combination with ingredients whose safety was based on their lack of dermal absorption, or when dermal absorption is a concern.

The Panel noted gaps in the available safety data for some of the alkyl taurate amides and taurate salts. The available data on many of the ingredients are insufficient, however, similarities among structures and functions in cosmetic concentrations of use can be extrapolated to support the safety of the entire group. For example, the data available for sodium methyl taurate can be used for read-across to the other simple taurate salts and the data for sodium methyl cocoyl taurate can be used for read across to the fatty acid amides.

The Panel expressed concern regarding pesticide residues and heavy metals that may be present in botanical-derived ingredients. They stressed that the cosmetics industry should continue to use the necessary procedures to limit these impurities in the ingredient before blending into cosmetic formulation.

The Panel discussed the issue of incidental inhalation exposure from tonics, dressings and other hair grooming aids and mouthwashes, breath fresheners, and face powders. There were no inhalation toxicity data available. These ingredients are reportedly used at concentrations up to 1% in cosmetic products that may be sprayed and up to 6% in loose-powder products that may become airborne. The Panel noted that 95%-99% of droplets/particles from sprays would not be respirable to any appreciable amount. Furthermore, these ingredients are not likely to cause any direct toxic effects in the upper respiratory tract, based on the low toxicity by dermal and oral routes. Coupled with the small actual exposure in the breathing zone and the concentrations at which the ingredients are used, the available information indicates that incidental inhalation would not be a significant route of exposure that might lead to local respiratory or systemic effects. A detailed discussion and summary of the Panel's approach to evaluating incidental inhalation exposures to ingredients in cosmetic products is available at http://www.cir-safety.org/cir-findings.

CONCLUSION

The CIR Expert Panel concluded that the following ingredients are safe in cosmetics in the present practices of use and concentration described in this safety assessment when formulated to be non-irritating:

- Potassium Taurate*
- Sodium Methyltaurate
- Sodium Taurate*
- Calcium Lauroyl Taurate
- Magnesium Methyl Cocoyl Taurate
- Potassium Cocoyl Taurate*
- Potassium Methyl Cocoyl Taurate*
- Sodium Caproyl Methyltaurate*
- Sodium Cocoyl Taurate
- Sodium Methyl Cocoyl Taurate
- Sodium *n*-Isostearoyl Methyltaurate*
- Sodium Lauroyl Taurate
- Sodium Methyl Lauroyl Taurate
- Sodium Methyl Myristoyl Taurate
- Sodium Methyl Oleoyl Taurate
- Sodium Methyl Palmitoyl Taurate*
- Sodium Methyl Stearoyl Taurate
- Sodium Methyltaurate Isopalmitamide*
- Sodium Methyltaurine Cocoyl Methyltaurate*
- Sodium Taurine Cocoyl Methyltaurate

* Were ingredients in this group not in current use to be used in the future, the expectation is that they would be used in product categories and at concentrations comparable to others in this group

TABLES

Table 1. Definitions, structures, and functions of the ingredients in this safety assessment.[1, CIR Staff]

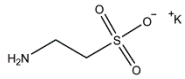
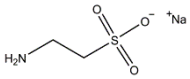
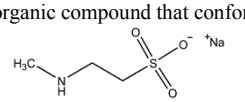
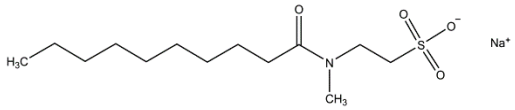
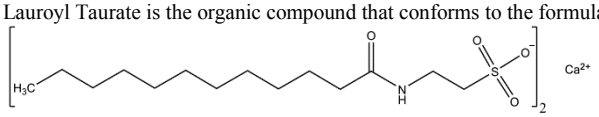
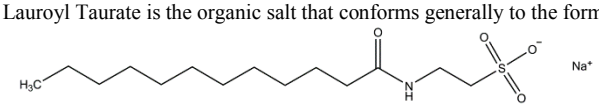
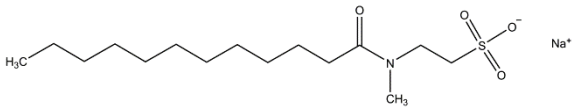
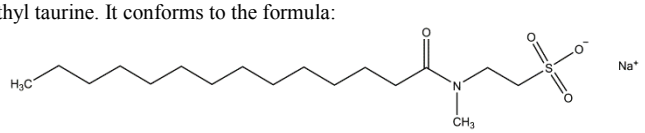
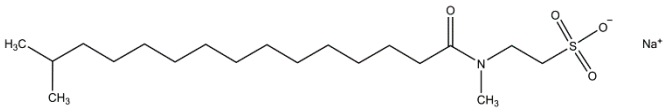
Ingredient/CAS No.	Definition & Structure	Function
	Simple Taurate Salts	
Potassium Taurate [22890-34-2]	Potassium Taurate is the organic salt that conforms to the formula:  [Potassium Taurate is the potassium salt of 2-aminoethane-1-sulfonate.]	Surfactant - cleansing agent; surfactant - foam booster
Sodium Taurate [7347-25-3]	Sodium Taurate is the organic salt that conforms to the formula:  [Sodium Taurate is the sodium salt of 2-aminoethane-1-sulfonate.]	Surfactant – cleansing agent; surfactant – foam booster
Sodium Methyltaurate 4316-74-9	Sodium Methyltaurate is the organic compound that conforms to the formula:  [Sodium Methyltaurate is the sodium salt of 2-(methylamino)ethane-1-sulfonate.]	Skin-conditioning agent - miscellaneous
	Alkyl Taurate Amides	
Sodium Caproyl Methyltaurate [20461-70-5]	Sodium Caproyl Methyltaurate is the sodium salt of the caproic acid amide of *N*-methyl taurine. It conforms to the formula:  [Sodium Caproyl Methyltaurate is the sodium salt of 2-(*N*-methyldecanamido)ethane-1-sulfonate.]	Surfactant – cleansing agent
Calcium Lauroyl Taurate 138705-25-6	Calcium Lauroyl Taurate is the organic compound that conforms to the formula:  [Calcium Lauroyl Taurate is the calcium salt of 2-dodecanamidoethane-1-sulfonate.]	Surfactant – cleansing agent
Sodium Lauroyl Taurate 70609-66-4	Sodium Lauroyl Taurate is the organic salt that conforms generally to the formula:  [Sodium Lauroyl Taurate is the sodium salt of 2-dodecanamidoethane-1-sulfonate.]	Surfactant – cleansing agent
Sodium Methyl Lauroyl Taurate 4337-75-1 [115049-64-4 for C13]	Sodium Methyl Lauroyl Taurate is the sodium salt of the lauric acid amide of *N*-methyl taurine. It conforms to the formula:  [Sodium Methyl Lauroyl Taurate is the sodium salt of 2-(*N*-methyldodecanamido)ethane-1-sulfonate.]	Surfactant – cleansing agent
Sodium Methyl Myristoyl Taurate 18469-44-8	Sodium Methyl Myristoyl Taurate is the sodium salt of the myristic acid amide of *N*-methyl taurine. It conforms to the formula:  [Sodium Methyl Myristoyl Taurate is the sodium salt of 2-(*N*-methyltetradecanamido)ethane-1-sulfonate.]	Surfactant – cleansing agent
Sodium Methyltaurate Isopalmitamide	Sodium Methyltaurate Isopalmitamide is the organic compound that conforms to the formula:  [This is just one example of an "iso" compound, according to the INCI definition. Sodium Methyltaurate Isopalmitamide is the sodium salt of 2-(*N*-isooctadecanamido)ethane-1-sulfonate.]	Surfactant – cleansing agent

Table 1. Definitions, structures, and functions of the ingredients in this safety assessment.[1, CIR Staff]

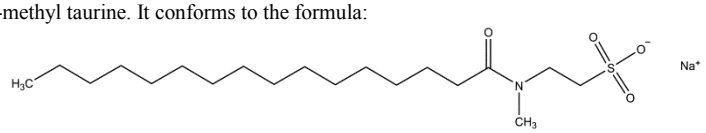
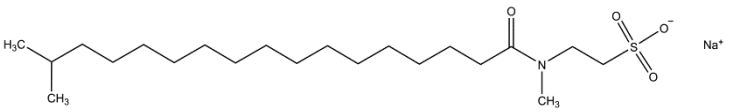
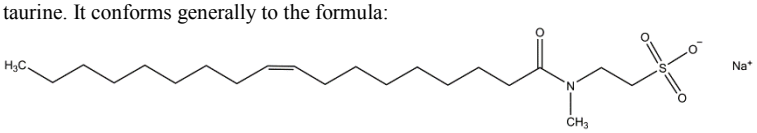
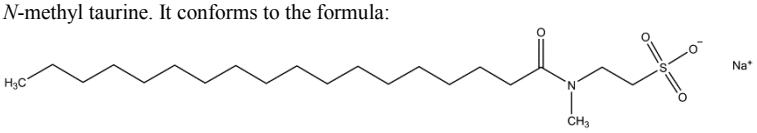
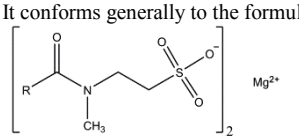
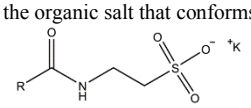
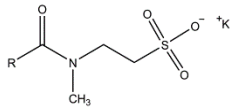
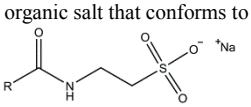
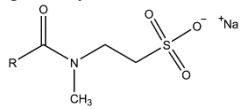
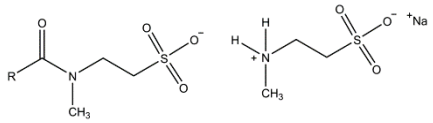
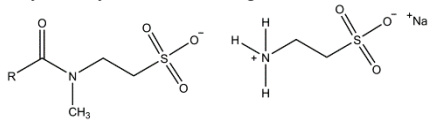
Ingredient/CAS No.	Definition & Structure	Function
Sodium Methyl Palmitoyl Taurate 3737-55-1	Sodium Methyl Palmitoyl Taurate is the sodium salt of the palmitic acid amide of *N*-methyl taurine. It conforms to the formula:  [Sodium Methyl Palmitoyl Taurate is the sodium salt of 2-(*N*-methylpalmitamido)ethane-1-sulfonate.]	Surfactant – cleansing agent
Sodium *N*-Isostearoyl Methyltaurate [170150-64-8]	Sodium *N*-Isostearoyl Methyltaurate is the organic compound that conforms to the formula:  [This is just one example of an "iso" compound, according to the INCI definition. Sodium *N*-Isostearoyl Methyltaurate is the sodium salt of 2-(*N*-isooctadecanamido)ethane-1-sulfonate.]	Surfactant – cleansing agent
Sodium Methyl Oleoyl Taurate 137-20-2 7308-16-9	Sodium Methyl Oleoyl Taurate is the sodium salt of the oleic acid amide of *N*-methyl taurine. It conforms generally to the formula:  [Sodium Methyl Oleoyl Taurate is the sodium salt of 2-(*N*-methyloleamido)ethane-1-sulfonate.]	Surfactant – cleansing agent
Sodium Methyl Stearoyl Taurate 149-39-3 [87111-75-9 for C19] [27236-38-0]	Sodium Methyl Stearoyl Taurate is the sodium salt of the stearic acid amide of *N*-methyl taurine. It conforms to the formula:  [Sodium Methyl Stearoyl Taurate is the sodium salt of 2-(*N*-methylstearamido)ethane-1-sulfonate.]	Surfactant – cleansing agent
Magnesium Methyl Cocoyl Taurate	Magnesium Methyl Cocoyl Taurate is the magnesium salt of the coconut fatty acid amide of *N*-methyltaurine. It conforms generally to the formula:  where RC(O)- represents the coconut acid radical. [Magnesium Methyl Cocoyl Taurate is the magnesium salt of 2-(*N*-methylcocamido)ethane-1-sulfonate.*]	Surfactant – cleansing agent
Potassium Cocoyl Taurate	Potassium Cocoyl Taurate is the organic salt that conforms to the formula:  where RC(O)- represents the coconut acid radical. [Potassium Cocoyl Taurate is the potassium salt of 2-cocamidoethane-1-sulfonate.*]	Surfactant – cleansing agent
Potassium Methyl Cocoyl Taurate	Potassium Methyl Cocoyl Taurate is the potassium salt of the coconut acid amide of *N*-methyl taurine. It conforms to the formula:  where RC(O)- represents the fatty acids derived from coconut oil. [Potassium Methyl Cocoyl Taurate is the potassium salt of 2-(*N*-methylcocamido)ethane-1-sulfonate.*]	Surfactant – cleansing agent
Sodium Cocoyl Taurate	Sodium Cocoyl Taurate is the organic salt that conforms to the formula:  where RC(O)- represents the coconut acid radical. [Sodium Cocoyl Taurate is the sodium salt of 2-cocamidoethane-1-sulfonate.*]	Surfactant – cleansing agent

Table 1. Definitions, structures, and functions of the ingredients in this safety assessment.[1, CIR Staff]

Ingredient/CAS No.	Definition & Structure	Function
Sodium Methyl Cocoyl Taurate 12765-39-8 61791-42-2	Sodium Methyl Cocoyl Taurate is the sodium salt of the coconut fatty acid amide of *N*-methyltaurine. It conforms generally to the formula:  where RC(O)- represents the coconut acid radical. [Sodium Methyl Cocoyl Taurate is the sodium salt of 2-(*N*-methylcocamido)ethane-1-sulfonate.*]	Surfactant – cleansing agent
Sodium Methyltaurine Cocoyl Methyltaurate	Sodium Methyltaurine Cocoyl Methyltaurate is the organic salt that conforms to the formula:  where RC(O)- represents the cocoyl group. [Sodium Methyltaurine Cocoyl Methyltaurate is the sodium methyltaurine salt of 2-(*N*-methylcocamido)ethane-1-sulfonate.*]	Surfactant – cleansing agent; surfactant – emulsifying agent
Sodium Taurine Cocoyl Methyltaurate	Sodium Taurine Cocoyl Methyltaurate is the organic salt that conforms to the formula:  where RC(O)- represents the cocoyl group. [Sodium Taurine Cocoyl Methyltaurate is the sodium taurine salt of 2-(*N*-methylcocamido)ethane-1-sulfonate.*]	Surfactant – cleansing agent; surfactant – emulsifying agent

* The fatty acid distribution of coconut acid is approximately 0-1% caproic, 5%-9% caprylic, 6%-10% capric, 44%-52% lauric, 13%-19% myristic, 0-1% palmitoleic, 1%-3% stearic, 5%-8% oleic, and trace-2.5% linoleic acid.[7]

Table 2. The reported concentration ranges, from one manufacturer, of the chain-length constituents of sodium methyl cocoyl taurate demonstrating how these ingredients are complex mixtures.[18]

Constituent	Typical concentration	Concentration ranges
Fatty acid, C8, sodium-N,N-methyl taurate	ca. 3.0 % (w/w)	> 0.0 — <= 8.0 % (w/w)
Fatty acid, C10, sodium-N,N-methyl taurate	ca. 8.0 % (w/w)	> 0.0 — < 10.0 % (w/w)
Sodium 2-[methyl(1-oxododecyl)amino]ethanesulphonate*	ca. 54.0 % (w/w)	>= 40.0 — <= 62.0 % (w/w)
Fatty acid, C14, sodium-N,N-methyl taurate	ca. 20.0 % (w/w)	>= 15.0 — <= 30.0 % (w/w)
Sodium 2-[methyl(1-oxohexadecyl) amino]ethanesulphonate	ca. 8.0 % (w/w)	>= 5.0 — <= 15.0 % (w/w)
Sodium 2-[methyloleoylamino]ethane-1-sulphonate	ca. 1.0 % (w/w)	> 0.0 — < 15.0 % (w/w)
Sodium 2-[methyl(1-oxooctadecyl)amino]ethanesulphonate	ca. 6.0 % (w/w)	> 0.0 — <= 10.0 % (w/w)
Sodium N-methyltaurinate	0.0 % (w/w)	>= 0.0 — < 3.0 % (w/w)
Sodium chloride	0.3 % (w/w)	>= 0.0 — <= 1.5 % (w/w)

* Sodium methyl lauroyl taurate

Table 3. Chemical and physical properties of alkyl taurate amides and taurate salts.

Property	Value	Reference
Sodium Methyl Cocoyl Taurate		
Physical Form	Solid/powder	[17]
Formula Weight g/mol	287.4-427.6	[18]
Density g/cm^3 @ 25ºC	0.185	[17]
Melting Point ºC	205.1	[17]
Boiling Point ºC	378.6-385.5	[17]
Water Solubility g/L @ 20ºC & pH 6.4	0.23	[17]
@ 20ºC & pH 8.03	>250	[17]
Other Solubility g/L		
n-octanol @ 20ºC	0.4	[17]
Partition Coefficient		
log Po/w	-0.44-0.54	[18]
Disassociation Constants		
pKa @ 25ºC	<1	[18]
Calcium Lauroyl Taurate		
Physical Form	Powder	[25]
Color	White	[25]
Formula Weight g/mol	803.30	[49]
Density/Specific Gravity		
Specific Gravity	1.25	[25]
Bulk Specific Gravity	0.37	[25]
Water Solubility	Insoluble	[25]
Potassium Taurate		
Formula Weight g/mol	163.2372	[50]
Sodium Lauroyl Taurate		
Formula Weight g/mol	329.43	[51]
Sodium Methyl Lauroyl Taurate		
Physical Form	Crystalline solid	[52]
Color	White to slight-yellow	[52]
Odor	Faint characteristic	[52]
Water Solubility	Soluble	[52]
Sodium Methyl Myristoyl Taurate		
Formula Weight g/mol	371.51	[53]
Sodium Methyl Oleoyl Taurate		
Physical Form	Powder	[44]
Color	Yellowish	[44]
Odor	Characteristic	[44]
Formula Weight g/mol	425.60	[54]
Bulk Density kg/m^3	600	[44]
Melting Point ºC	~170	[44]
Sodium Methyl Palmitoyl Taurate		
Physical Form	Crystalline solid	[55]
Color	White	[55]
Formula Weight g/mol	399.56	[55]
Sodium Methyl Stearoyl Taurate		
Molecular Weight g/mol	427.61	[55]
Sodium Methyltaurate		
Physical Form	Solid	[15]
Color	Yellow	[15]
Formula Weight g/mol	161.16	[56]
Density/Specific Gravity	1.21	[56]
Melting Point ºC	160	[15]
Water Solubility g/L @ 20 ºC	410	[15]
Sodium Taurate		
Physical Form	Solid	[16,57]
Formula Weight g/mol	147.128	[58]

Table 4. Frequency of use according to duration and exposure of alkyl taurate amides and taurate salts.[29,30]

Use type	Uses	Maximum Concentration (%)	Uses	Maximum Concentration (%)	Uses	Maximum Concentration (%)	Uses	Maximum Concentration (%)
	Sodium Methyltaurate		Calcium Lauroyl Taurate		Magnesium Methyl Cocoyl Taurate		Sodium Cocoyl Taurate	
Total/range	**2**	**0.11-3**	**NR**	**0.48-11**	**NR**	**0.26**	**NR**	**0.3-21.5**
Duration of use								
Leave-on	NR	NR	NR	0.48-11	NR	NR	NR	2
Rinse-off	2	0.11-3	NR	NR	NR	0.26	NR	0.3-21.5
Diluted for (bath) use	NR	NR	NR	NR	NR	NR	NR	7
Exposure type								
Eye area	NR	NR	NR	0.48	NR	NR	NR	0.3
Incidental ingestion	NR	NR	NR	NR	NR	NR	NR	NR
Incidental Inhalation-sprays	NR	NR	NR	NR	NR	NR	NR	NR
Incidental inhalation-powders	NR	NR	NR	NR	NR	NR	NR	2[c]
Dermal contact	2	2	NR	0.48-11	NR	NR	NR	0.3-21.5
Deodorant (underarm)	NR	NR	NR	NR	NR	NR	NR	NR
Hair-noncoloring	NR	0.11-3	NR	NR	NR	0.26	NR	0.75-9
Hair-coloring	NR	NR	NR	NR	NR	NR	NR	NR
Nail	NR	NR	NR	NR	NR	NR	NR	NR
Mucous Membrane	NR	NR	NR	NR	NR	NR	NR	7-21.5
Baby	NR	NR	NR	NR	NR	NR	NR	NR

	Sodium Methyl Cocoyl Taurate		Sodium Lauroyl Taurate		Sodium Methyl Lauroyl Taurate		Sodium Methyl Myristoyl Taurate	
Total/range	**339**	**0.000095-13**	**NR**	**0.09-1**	**NR**	**0.2-0.7**	**NR**	**1-6**
Duration of use								
Leave-on	10	0.21-6	NR	NR	NR	NR	NR	NR
Rinse-off	322	0.000095-13	NR	0.09-1	NR	0.2-0.7	NR	1-6
Diluted for (bath) use	7	0.38-1.2	NR	NR	NR	NR	NR	NR
Exposure type								
Eye area	NR	2.4	NR	NR	NR	NR	NR	NR
Incidental ingestion	NR	0.24-1.2	NR	NR	NR	0.3-0.7	NR	NR
Incidental Inhalation-sprays	2[a]; 6[b]	0.21-0.24[a]	NR	NR	NR	0.3[a]	NR	NR
Incidental inhalation-powders	6[b]	6; 0.9-1.5[c]	NR	NR	NR	NR	NR	NR
Dermal contact	269	0.38-13	NR	1	NR	0.2	NR	6
Deodorant (underarm)	NR	NR	NR	NR	NR	NR	NR	NR
Hair-noncoloring	70	0.000095-9.7	NR	0.09	NR	NR	NR	1
Hair-coloring	NR	0.5	NR	NR	NR	NR	NR	NR
Nail	NR	3.2-3.9	NR	NR	NR	NR	NR	NR
Mucous Membrane	140	0.24-10.2	NR	NR	NR	0.3-0.7	NR	NR
Baby	1	NR	NR	NR	NR	NR	NR	NR

Table 4. Frequency of use according to duration and exposure of alkyl taurate amides and taurate salts.[29,30]

Use type	Uses	Maximum Concentration (%)	Uses	Maximum Concentration (%)	Uses	Maximum Concentration (%)	Uses	Maximum Concentration (%)
	Sodium Methyl Oleoyl Taurate		**Sodium Methyl Stearoyl Taurate**		**Sodium Taurine Cocoyl Methyltaurate**			
Total/range	**1**	**28**	**8**	**0.0076-4**	**NR**	**2-6**		
Duration of use								
Leave-on	NR	NR	8	0.024-1	NR	NR		
Rinse-off	1	NR	NR	0.0076-4	NR	2-6		
Diluted for (bath) use	NR	28	NR	NR	NR	NR		
Exposure type								
Eye area	NR	NR	NR	0.5-0.9	NR	NR		
Incidental ingestion	NR	NR	NR	0.0076	NR	NR		
Incidental Inhalation-sprays	NR	NR	4[a]; 4[b]	1[a]	NR	NR		
Incidental inhalation-powders	NR	NR	NR	0.7-1[c]	NR	NR		
Dermal contact	NR	28	8	0.024-1	NR	2		
Deodorant (underarm)	NR	NR	NR	0.028[d]	NR	NR		
Hair-noncoloring	1	NR	NR	0.8-2	NR	6		
Hair-coloring	NR	NR	NR	0.1-4	NR	NR		
Nail	NR	NR	NR	NR	NR	NR		
Mucous Membrane	NR	28	NR	0.0076	NR	NR		
Baby	NR	NR	NR	NR	NR	NR		

NR = Not Reported; NS = Not Surveyed; Totals = Rinse-off + Leave-on Product Uses.

Note: Because each ingredient may be used in cosmetics with multiple exposure types, the sum of all exposure type uses may not equal the sum total uses.

[a] It is possible these products may be sprays, but it is not specified whether the reported uses are sprays.

[b] Not specified whether a powder or a spray, so this information is captured for both categories of incidental inhalation.

[c] It is possible these products may be powders, but it is not specified whether the reported uses are powders.

[d] Not spray products.

Table 5. Alkyl taurate amides and taurate salts with no reported uses.[29,30]

Potassium Taurate	Potassium Cocoyl Taurate
Potassium Methyl Cocoyl Taurate	Sodium *n*-Isostearoyl Methyltaurate
Sodium Caproyl Methyltaurate	Sodium Methyltaurate Isopalmitamide
Sodium Methyl Palmitoyl Taurate	Sodium Methyltaurine Cocoyl Methyltaurate
Sodium Taurate	

Table 6. Acute non-human toxicity studies of alkyl taurate amides and taurate salts.

Ingredient	Animals	Concentrations/ Dosages	Methods	Results	Reference
			Dermal		
Sodium Methyl Cocoyl Taurate	Male and female Wistar rats (n=5/sex)	100%; 2000 mg/kg	OECD TG 402; 10% of body under semi-occlusion for 24 h followed by 14-day observation period.	Effects level > 2000 mg/kg. No mortalities, no signs of toxicity. Residual discoloration at test site.	[12,13]
Sodium Methyl Cocoyl Taurate	Male and female Wistar rats	Not specified	OECD TG 402; administered under semi-occlusion in a paste	LD_{50}>2000 mg/kg	[18]
Sodium Methyl Cocoyl Taurate	Rats	Not specified	OECD TG 402	LD_{50} >20 mg/kg; No signs of toxicity observed in the 14-day observation period. No effects to body weights and there were no gross pathology findings.	[18]
Sodium Methyl Oleoyl Taurate	Wistar rats	100%; 2000 mg/kg	OECD TG 402; administered under semi-occlusion to 10% of the body surface	No mortalities or clinical signs. At necropsy, no specific pathology associated with test substance observed, except some residual discoloration of the skin at the test site.	[17]
Sodium Methyl Oleoyl Taurate	Rats	Not specified	Not specified	>2000 mg/kg	[44]
			Oral		
Sodium Methyltaurate (80%-84% pure)	Wistar rats	4000, 4500, 4750, 5000, 6300 mg/kg	OECD TG 401	LD_{50}≥4670 mg/kg in water (the highest dose tested). Necropsies showed unspecified changes to the intestines/ gastrointestinal tract, especially in the rats that died before the end of the experiment (number not specified).	[15]
Sodium Methyl Cocoyl Taurate	Sprague-Dawley rats (n=5/sex)	2000 mg/kg; 20% in water; 10 mL/kg	OECD TG 401	There were no deaths during 14-day observation period.- Hypoactivity, squatting posture, and coat bristling were observed in all rats from 10-30 min to 4-6 h post administration. No signs of toxicity observed during the observation period. There were no effects to body weights and there were no gross pathology findings.	[17,18]
Sodium Methyl Cocoyl Taurate	Male and female Sprague-Dawley rats	Not specified	OECD TG 401	LD_{50}>2000 mg/kg	[18]
Sodium Methyl Cocoyl Taurate	Wistar rats (n=5/sex)	Not specified	OECD TG 401	LD_{50}>2000 mg/kg. No mortalities or signs of toxicity were observed during the 14-day observation period. There were no macroscopic findings at necropsy.	[18]
Sodium Methyl Cocoyl Taurate	Albino Harlan mice (n=10)	Not specified	The mice were observed for 72 h after dosing.	LD_{50}=6.63 g/kg	[45]

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Table 7. Repeated dose non-human oral toxicity studies of alkyl taurate amides.

Ingredient	Animals	Concentrations/ Dosages	Methods	Results	Reference
Sodium Methyl Cocoyl Taurate	Sprague-Dawley rats (n=3/sex)	62.5, 250, 1000 mg/kg/d. Controls received purified water.	Gavage daily for 14 days; equivalent or similar to OECD TG 407 (Repeated Dose 28-Day Oral Toxicity in Rodents)	NOAEL≥1000 mg/kg/d (actual dose received). No clinical signs with regards to mortality; feed consumption; body weight; hematology; clinical chemistry; gross pathology; organ weights; histopathology; male reproductive organs including sperm staging	[13,18]
Sodium Methyl Cocoyl Taurate	Sprague-Dawley rats (n=10/sex; controls= 5/sex); 5 additional controls and high-dose rats were allowed 2 weeks of recovery before necropsy.	100, 300, 1000 mg/kg/d; 10 mL/kg	Gavage for 28 days; OECD TG 407 (Repeated Dose 28-Day Oral Toxicity in Rodents)	No clinical signs; normal weekly neurotoxicity assessment. No changes in body weights or feed consumption between groups. Increased white blood cell count was observed, especially in high-dose males; considered to be secondary to inflammatory changes due to forestomach findings in high dose animals. Increases in transaminases in high dose male animals were not considered to be indicative of liver injury but may represent adaptive changes. Macroscopic and histopathological examinations of the forestomach showed diffuse mucosal hyperplasia usually associated with hyperkeratosis and with focal to diffused inflammation located in the submucosa mainly in males at in the high-dose group. Focal ulcers with diffuse mucosal hyperplasia were still noted in the forestomach of the rats in the treatment/recovery subgroup. Comparable forestomach effects were not observed in the low- and mid-dose groups.	[18]
Sodium Methyl Oleoyl Taurate	Sprague-Dawley rats (n=3/sex)	62.5, 250, or 1000 mg/kg	Gavage for 14 days	NOAEL≥1000 mg/kg/d (actual dose received). No clinical signs with regards to mortality; feed consumption; body weight; hematology; clinical chemistry; gross pathology; organ weights; histopathology; male reproductive organs including sperm staging.	[12]
Sodium Methyl Oleoyl Taurate	Albino Harlan mice (n=10)	0.662 g/kg ; 10% LD_{50}	Administered by gavage for 6 days/week until 25 doses were administered	1 mouse was dead on day 5 and 5 were dead on day 10. No more mice died through the 25th dose.	[45]

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Table 8. Genotoxicity studies of alkyl taurate amides and taurate salts.

Concentration/dose	Method	Results	Reference
Sodium Methyltaurate			
4-5000 µg/plate	Ames test conducted similar to OECD TG 471 (bacterial reverse mutation assay) using *Salmonella typhimurium* (strains TA1535, TA1537, TA98 and TA100) with and without metabolic activation	Not genotoxic. The controls had the expected results.	[15]
Sodium Cocoyl Taurate			
4-5000 µg/ plate	Ames test conducted in accordance with OECD TG 471 using *S. typhimurium* (strains TA1535, TA1537, TA98, and TA100)	Not mutagenic with or without metabolic activation.	[12]
Sodium Methyl Cocoyl Taurate			
5-5000 µg/plate in distilled water; 97.7% pure	Ames test conducted in accordance with OECD TG 471 using *S. typhimurium* (strains TA1535, TA1537, TA98, and TA100) and *Escherichia coli* (strain WP2 uvr A) with and without metabolic activation	Not genotoxic. Visible reductions in the growth of the bacterial background lawns of *S. typhimurium* strains at 500 µg/plate and above. The results of the controls were as expected.	[17,18]
4-hour without S9: 200, 240, 320 µg/mL; 4-hour with S9: 160, 200, 240 µg/mL 20-hour without S9: 40, 80, 160 µg/mL; 97.7% pure	Genotoxicity assay conducted in accordance with OECD TG 487 (*in vitro* mammalian cell micronucleus test) using human lymphocytes.	Not genotoxic up to 320 µg/mL without metabolic activation and up to 240 µg/mL with metabolic activation when incubated for 4 h; test substance was cytotoxic at these concentrations and above. When incubated for 20 h without metabolic activation, there were still no genotoxic effects observed. The positive controls had the expected results; there were no negative controls.	[12,17,18]
Experiment 1: 4-h exposure, -S9: 10, 20, 40, 50, 60, 100 µg/mL 4-h exposure, +S9: 15, 30, 60, 70, 80, 90, 100, 120 µg/mL Experiment 2: 24-h exposure, -S9: 3.75, 7.5, 15, 30, 40, 50, 60, 80 µg/mL 4-h exposure, +S9: 3.75, 7.5, 15, 30, 60, 70, 80, 90 µg/mL (97.7% pure)	Mammalian cell gene mutation assay conducted in accordance with OECD TG 476 (*in vitro* mammalian cell gene mutation test) using mouse lymphoma L5178Y cells	Not genotoxic up to 100 µg/mL without metabolic activation and up to 120 µg/mL with metabolic activation when incubated for 4 h. When incubated for 24 h without metabolic activation, there were no genotoxic effects observed up to 80 µg/mL. Cytotoxicity was observed in the 4-h exposure at 60 µg/mL and above with metabolic activation and at 50 µg/mL and above without metabolic activation. In the 24-h exposure without metabolic activation, cytotoxicity was observed at 15 µg/mL and above. The positive controls had the expected results; there were no negative controls. The test material was cytotoxic - Experiment 1: 4-h exposure, +S9: at 60 µg/mL and above; 4-h exposure, -S9: at 50 µg/mL and above; Experiment 2: 4-h exposure, +S9: at 60 µg/mL: 24-h exposure, -S9: at 15 µg/mL and above.	[12,17,18]
Sodium Methyl Oleoyl Taurate			
TA97a: 1.6-160 µg/plate (-S9), 16-1600 µg/plate (+S9) TA98: 50-5000 µg/plate (+/-S9) TA100: 16-1600 µg/plate (+/-S9) TA102: 50-5000 µg/plate (+/-S9) TA1535: 16-1600 µg/plate (+/-S9) in bidistilled water	OECD TG 471 using *S. typhimurium* (strains TA97a, TA 100, TA102, TA1535) with and without metabolic activation	Not mutagenic	[13]
Experiment 1: 6.00, 8.40, 11.8, 16.5, 23.1, and 32.3 µg/mL without S9; 162, 210, 273, 355, 462, and 600 µg/mL with S9 Experiment 2: 9.87, 12.8, 16.7, 21.7, 28.2, µg/mL without S9; 265, 318, 382, 458, and 500 µg/mL with S9	Mammalian cell gene mutation assay conducted in accordance with OECD TG 476 (*in vitro* mammalian cell gene mutation test) and Guideline EU Method B.17 (mutagenicity - *in vitro* mammalian cell gene mutation test) Using Chinese hamster lung fibroblast (V79)	Not genotoxic	[12,13]

Table 8. Genotoxicity studies of alkyl taurate amides and taurate salts.

Concentration/dose	Method	Results	Reference
First experiment: 19.5, 39.1, 78.1, 156, 313, 625, 1250, 2500, and 5000 µg/mL with and without S9 metabolism. Second experiment: 7.02, 10.5, 15.8, 23.7, 35.6, 53.3, 80.0, 120, 180, and 270 µg/mL without S9	Mammalian chromosome aberration test OECD TG 473 (*in vitro* mammalian chromosome aberration test) and Guideline EU Method B.10 (mutagenicity - *in vitro* mammalian chromosome aberration test) using human lymphocytes	Not genotoxic. Marked toxicity was observed at 313 µg/mL, where the relative mitotic index was 18% and 22% of the control in the absence and presence of S9 metabolism respectively. Moderate toxicity was observed at 156 µg/mL, where the relative mitotic index was 48% and 52% of the concurrent negative control with and without metabolic activation, respectively. No remarkable toxicity was observed at 78.1, 39.1 and 19.5 µg/mL for both treatment series.	[12,13]

Table 9. In vivo ocular studies of alkyl taurate amides and taurate salts.

Dose/ concentration	Method	Results	Reference
Sodium Methyltaurate			
80%-84% in saline; 100 mg	OECD TG 405 (Acute Eye Irritation/ Corrosion) in New Zealand White rabbits (n=3)	There was persistent corneal opacity as well as inflammation of the iris and conjunctivae. The iris irritation scores was between 0 and 1 of 2 up to 72 h; then the irritation was resolved at the next observation. There was conjunctiva irritation at all observation times and was not fully reversed at 21 d. Conclusion: sodium methyltaurate caused persistent corneal opacity as well as inflammation of the iris and conjunctiva resulting in irreversible eye damage.	[15]
35%-37% aqueous; 0.1 mL	OECD TG 405 in New Zealand White rabbits (n=3)	There was persistent corneal opacity as well as inflammation of the iris and conjunctivae at all observation times, and was not fully reversed by 7 d. The iris irritation scores were between 0 and 1 of 2 up to 72 h; the irritation was resolved by 7 d. The conjunctiva irritation score was between 2 and 3 of 3 at all observation times and irritation was not fully reversed at 7 d. Conclusion: sodium methyltaurate caused persistent corneal opacity as well as inflammation of the iris and conjunctiva resulting in irreversible eye damage.	[15]
Sodium Methyl Cocoyl Taurate			
100% in a paste as provided; 100 mg	OECD TG 405 (Acute Eye Irritation/Corrosion) in New Zealand White rabbits (n=3)	The conjunctivae were swollen above normal, including swellings with lids about half closed and definitely injected blood vessels up to a diffuse red color from 1 h to 3 days after administration. The iris was reddened in 2 rabbits up to day 2 and in the remaining rabbit until day 3. The overall irritation score was 0.67 of 4. The iris irritation score was 0.78 of 2. The conjunctiva irritation score was 2.8 of 3. The chemosis score was 2.1 of 4. All signs of irritation were fully resolved by day 7. Conclusion: sodium methyl cocoyl taurate was an ocular irritant under these conditions.	[17,18]
10%; 0.1 mL in distilled water	Ocular irritation assay with and without rinsing. Rabbits (n=3). The eyes were observed at 1 h and 1, 2, 3, 4, and 7 days post administration	Unrinsed eyes-the maximum irritation index was 49.7 at 1 h, which was resolved at 4 days. Rinsed eyes-the maximum irritation index was 25.3 at 1 h, which was resolved at day 4. The test substance was a mild irritant.	[46]
Sodium Methyl Myristoyl Taurate			
10% aqueous; 0.1 mL	Draize test, Japanese albino rabbits (n not specified)	Draize score ~2.2 out of 5	[47]
Sodium Methyl Oleoyl Taurate			
1%	Rabbits (n and species not specified). The eyes were observed at 5 and 10 min, and 1 and 24 h.	The irritation score was 2 out of 4. Inflammation was observed, but not photophobia, discharge or clouded corneas.	[45]
100%; 0.1 g ; 0.1 mL	OECD TG 405 (Acute Eye Irritation/Corrosion)	Mild to moderate, early-onset and transient ocular changes, such as corneal opacity, reddening of the conjunctivae and sclerae, discharge and chemosis; resolved at 7 days after treatment. The individual mean scores for corneal opacity was 0.67 for all 3 rabbits. The individual mean scores for the conjunctivae were 2.00 for reddening and 0.67, 0.33 and 0.67 for chemosis for each rabbit. No abnormal findings were observed in the iris of any rabbit at any time. No corrosion was observed at any of the measuring intervals. White test item remnants were evident in the eye or conjunctival sac of 1 female 1 h after instillation. No staining of the treated eyes by the test item was observed and no clinical signs were observed. Based on the findings and in accordance with the classification criteria of Directive 67/548 EEC (DSD), the registration substance is considered to be "not irritating" to the rabbit eye. However, based on the criteria of Directive (EC) 1272/2008 (GHS-CLP) the registration substance should be considered to be "mildly irritating to eyes" (category 2B).	[12-14]

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