Supplementary Online Content

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This supplementary material has been provided by the authors to give readers additional information about their work.

eTable 1. Active and Inactive Ingredients

Product	Active Ingredients	Inactive Ingredients
Lotion	Avobenzone 3%, Octocrylene 6%, Oxybenzone 4%	Water, Ethylhexyl Benzoate, Butyloctyl Salicylate, Cetearyl Alcohol, Diisopropyl Adipate, Phenethyl Benzoate, Phenoxyethanol, Polymethylsilsesquioxyane, VP/eicosene copolymer, Caprylyl Glycol, Dimethicone, Glycerine, Fragrance, Triethanolamine, Coco-Glucoside, Acrylates/C10-30 Alkyl acrylate crosspolymer, Methylparaben, Ceteth-10 Phosphate, Dicityl Phosphate, Propylparaben, Disodium EDTA, Paraffin, Xanthan Gum, Butyrospermum Parkil (Shea) butter, Mangifera Indica (Mango) seed butter, Sodium Ascorbyl Phosphate, Tocopheryl Acetate, Panthenol, Alov Barbadensis Leaf Juice, Carica Papaya (Papaya) Fruit Extract, Colocasia Antiquorem Root Extract, Mangifera Indica (Mango) Fruit Extract, Passflora Incarnata Fruit Extract, Plumeria Acutifolia Flower Extract, Psidium Guajava Fruit Extract
Aerosol Spray	Avobenzone 3%, Homosalate 15%, Octisalate 5%, Octocrylene 10%, Oxybenzone 6%	Alcohol Denat., Isobutane, Butyloctyl Salicylate, Acrylates/ Octylacrylamide copolymer, Cyclopentasiloxane, Acrylates/Dimethicone Copolymer, Fragrance, Tocopheryl Acetate, Diethylhexyl 2,6-naphthalate, Ascorbyl Palmitate, Retinyl Palmitate, Tocopherol
Nonaerosol Spray	Avobenzone 3%, Homosalate 10%, Octinoxate 7.5% Octisalate 5%, Octocrylene 10%	Alcohol Denat, Camellia Sinensis Leaf Extract, Cananga Odorata Flower Oil, Caprylic/Capric Triglyceride, Citrus Aurantifolia (Lime) Oil, Citrus Grandis (Grapefruit) Peel Oil, Citrus Limon Fruit Oil, Citrus Nobilis (Mandarin Orange) Peel Oil, Citrus Reticulata (Tangerine) Peel Oil, Citrus Sinensis Peel Oil, Dicaprylyl Carbonate, Diisopropyl Adipate, Euterpe Oleracea Fruit Extract, Helianthus Annuus (Sunflower) Seed Oil, Isodecyl Neopentanoate, Lavandula Angustifolia (Lavender) Oil, Mentha Piperita (Peppermint) Oil, Mentha Viridis (Spearmint) Leaf Oil, Tetrahexyldecyl Ascorbate (Vitamin C), Tridecyl Neopentanoate, VA/Butyl Maleate/Isobornyl Acrylate Copolymer, Vitis Vinifera (Grape) Seed Oil
Pump Spray	Avobenzone 3%, Homosalate 10%, Octinoxate 7.5% Octisalate 5%	Caprylic/Capric Triglyceride, SD Alcohol 40-B., C12-15 Alkyl Benzoate, Octyldodecanol, Polyamide-3, Polyester-8, Diisopropyl Sebacate, Isodecyl Neopentanoate, Lauryl Lactate, Limonene, Diethylhexyl Syringylidenemalonate, Punica Granatum Fruit Extract, Citrus Aurantium Dulcis (Orange) Peel Extract, Citrus Grandis (Grapefruit) Peel Oil, Calendula Officinalis Flower Extract, Citrus Limon (Lemon) Peel Extract, Citrus Tangerina (Tangerine) Peel Extract, Elaeis Guineensis (Palm) Oil, Tocotrienols, Argania Spinosa Kernel Oil, Butyrospermum Parkii (Shea) Butter, Cocos Nucifera (Coconut) Oil, Helianthus Annuus (Sunflower) Seed Oil, Limnanthes Alba (Meadowfoam) Seed Oil, Raphanus Sativus (Radish) Seed Oil, Vitis Vinifera (Grape) Seed Oil, Tocopherol, Alaria Esculenta Extract, BHT, Citral, Citric Acid

eTable 2. Complete Pharmacokinetic Parameters of Sunscreen Active Ingredients

	Lotion Geometric Mean [CV%] (range)	Aerosol Spray Geometric Mean [CV%] (range)	Nonaerosol Spray Geometric Mean [CV%] (range)	Pump Spray Geometric Mean [CV%] (range)
Avobenzone				
AUC Day 1 (ng*h/mL)	23.1 (45.3%) (10.6-40.6)	16.5 (85.7%) (3.2-48.2)	11.6 (99.1%) (1.2-23.9)	10.3 (61.5%) (3.5-29.9)
AUC Day 4 (ng*h/mL)	93.4 (33.1%) (53.3-150)	55.1 (64.4%) (16.4-130.2)	51.6 (45.2%) (20.2-92.5)	42.7 [37.3%] (26.5-89.8)
AUC_{last} (ng*h/mL)	591.2 (30.7%) (303.2-890.1)	350.1 (69.3%) (101.2-910.5)	264.6 (107.3%) (31.6-606.5)	213.8 (71.9%) (43.4-545.1)
C_{max} (ng/mL) Overall	7.1 (73.9%) (2.9-28)	3.5 (70.9%) (1-9)	3.5 (73%) (1-10)	3.3 (47.8%) (1.2-6.2)
C_{max} (ng/mL) Day 1	1.6 (49%) (0.7-2.7)	1.2 (90.6%) (0.2-5.2)	1 (65.2%) (0.3-1.9)	0.7 (64.5%) (0.3-2)
C_{max} (ng/mL) Day 4	5.7 (58.7%) (2.9-20.5)	3.2 (65.5%) (1-7.8)	3.4 (73.1%) (1-10)	3.1 [40.3%] (2.0-6.2)
$C_{predose}$ Day 2 (ng/mL)	1.4 (57.3%) (0.5-2.7)	1 (93.6%) (0.2-5.2)	0.9 (65.9%) (0.3-1.9)	0.6 (63.3%) (0.3-1.6)
$C_{predose}$ Day 3 (ng/mL)	2.7 (43.2%) (1.3-4.6)	2.1 (79.9%) (0.4-7.7)	1.6 (63.4%) (0.6-4.3)	1.2 (56.9%) (0.7-3.9)
$C_{predose}$ Day 4 (ng/mL)	3.5 (43.4%) (1.5-6.6)	2.1 (63%) (0.7-4.9)	1.8 (55.1%) (0.6-3.8)	1.3 (51.1%) (0.8-3.6)
Conc. Day 5 (ng/mL)	3.9 (28.9%) (2.5-5.8)	2.1 (62.7%) (0.7-5.3)	2 (41.2%) (1-3.4)	1.4 (44.7%) (0.7-3.2)
Conc. Day 6 (ng/mL)	2.4 (37.2%) (1.4-4.2)	1.6 (68.7%) (0.4-4.1)	1.3 (54.7%) (0.6-2.8)	0.9 (29%) (0.6-1.6)
Conc. Day 7 (ng/mL)	1.6 (29.4%) (1.1-2.4)	1.1 (56.7%) (0.5-3.1)	1.1 (54%) (0.6-2.7)	0.8 (34.2%) (0.4-1.4)
Skin Day 7 (ng/cm2)	843.1 [96%] (396.2-6556.6)	939.3 [77.3%] (393.8-3840.6)	1157.3 [117.4%] (333.9-3784.3)	498.7 [200.3%] (52.9-1852.9)
Conc Day 10 (ng/mL)	0.5 (28.5%) (0.4-1)	0.3 (196.8%) (0-1.2)	0.5 (38.6%) (0.2-0.8)	0.1 (314.5%) (0-0.6)
Conc Day 14 (ng/mL)	0.4 (41.9%) (0.2-1)	0.1 (473.8%) (0-0.9)	0.2 (332.8%) (0-0.6)	0.1 (465.2%) (0-0.6)
Skin Day 14 (ng/cm2)	39.8 [99%] (12.7-133.1)	25.9 [209.1%] (6.2-733.5)	75.8 [378.1%] (5.3-854.9)	48.3 [295%] (8.9-650.4)
Conc Day 21 (ng/mL)	0.1 (393.6%) (0-1)	0.1 (461.5%) (0-0.4)	0.1 (475.8%) (0-0.6)	0 (472.4%) (0-0.7)
Terminal Half-Life (h)	112.3 (69.7%) (63.1-481.6)	94.2 (80.1%) (29-434.5)	101.1 (66.6%) (50.4-306)	73.7 (93.1%) (29.1-299.2)

	Lotion Geometric Mean [CV%] (range)	Aerosol Spray Geometric Mean [CV%] (range)	Nonaerosol Spray Geometric Mean [CV%] (range)	Pump Spray Geometric Mean [CV%] (range)
T_{max} (h) Overall	69.3 (20.5%) (52-95)	67.6 (30.9%) (33-95)	68.3 (21.4%) (47-95)	71.2 (21%) (47-86)
T_{max} (h) Day 1	13.7 (43%) (8-23)	14.1 (46.7%) (9-23)	11.4 (158%) (0.5-23)	14.8 (42.1%) (9-23)
T_{max} (h) Day 4	81.9 (8.1%) (73-95)	81.3 (8.6%) (74-95)	81.9 (6.5%) (74-95)	81.3 (4.4%) (73-86)
Oxybenzone				
AUC Day 1 (ng*h/mL)	1204 (33.4%) (683.2-1901.4)	1159.6 (51.3%) (524.4-3137.6)	NA	NA
AUC Day 4 (ng*h/mL)	3443.7 (34.8%) (2053.7-5579.6)	2757.3 (41.3%) (1390.7-5216)	NA	NA
AUC_{last} (ng*h/mL)	16297.2 (30.4%) (9746.8-27391.1)	14292.4 (41.2%) (8246.3-29719.2)	NA	NA
C_{max} (ng/mL) Overall	258.1 (53%) (131.3-498.1)	180.1 (57.3%) (70.1-476.9)	NA	NA
C_{max} (ng/mL) Day 1	94.2 (44.3%) (44.6-177.6)	85.4 (73.9%) (34.8-401.2)	NA	NA
C_{max} (ng/mL) Day 4	252.3 (54.8%) (131.3-498.1)	171.1 (52.1%) (66-426.8)	NA	NA
$C_{predose}$ Day 2 (ng/mL)	30.1 (40.9%) (16.6-58.9)	32.9 (63.3%) (17.6-140.2)	NA	NA
$C_{predose}$ Day 3 (ng/mL)	79 (53.8%) (42.5-188.4)	85.9 (76.1%) (34.1-377.9)	NA	NA
$C_{predose}$ Day 4 (ng/mL)	95.3 (62%) (36-278.8)	99 (42.1%) (63.7-188.9)	NA	NA
Conc. Day 5 (ng/mL)	114.8 (39.4%) (64.9-244.3)	91.2 (44.4%) (49.2-162.6)	NA	NA
Conc. Day 6 (ng/mL)	43.2 (30.6%) (28-64.7)	46.7 (53%) (25.6-112.9)	NA	NA
Conc. Day 7 (ng/mL)	30.6 (53.3%) (13.7-70)	28.3 (42.5%) (16.8-62.4)	NA	NA
Skin Day 7 (ng/cm2)	358.7 [195.1%] (40.7-5848.6)	698.5 [154.9%] (114.2-6729.9)	NA	NA
Conc Day 10 (ng/mL)	7.8 (62.6%) (3.3-24.6)	8.8 (51%) (4.8-27.5)	NA	NA
Conc Day 14 (ng/mL)	5.1 (92.3%) (1.6-32.5)	3.8 (68.2%) (1.3-9)	NA	NA
Skin Day 14 (ng/cm2)	18.2 [195%] (3.9-341.3)	29.1 [238.2%] (7-979.6)	NA	NA

	Lotion Geometric Mean [CV%] (range)	Aerosol Spray Geometric Mean [CV%] (range)	Nonaerosol Spray Geometric Mean [CV%] (range)	Pump Spray Geometric Mean [CV%] (range)
Conc Day 21 (ng/mL)	1.3 (517.6%) (0-14.4)	2 (73%) (0.6-8)	NA	NA
Terminal Half-Life (h)	78.5 (40.6%) (41.8-135.3)	79.2 (49.3%) (27.4-206.7)	NA	NA
T_{max} (h) Overall	78.2 (12.2%) (57-95)	72.6 (14.8%) (52-84)	NA	NA
T_{max} (h) Day 1	4.9 (64.8%) (1.5-12)	7.1 (55%) (3-14)	NA	NA
T_{max} (h) Day 4	80.7 (7.1%) (73-95)	78.3 (6.1%) (73-86)	NA	NA
Octocrylene				
AUC Day 1 (ng*h/mL)	20 (62.9%) (6.4-38.1)	14 (1772.3%) (0-94.2)	16.9 (66.8%) (6.5-40.4)	NA
AUC Day 4 (ng*h/mL)	94.7 (48.6%) (41.4-210)	89.4 (67.4%) (23.2-178.2)	89.5 (60%) (33.2-177)	NA
AUC_{last} (ng*h/mL)	526.8 (42.6%) (243.5-990.3)	514.6 (86.3%) (96-1095)	434.2 (131%) (38.2-1538.7)	NA
C_{max} (ng/mL) Overall	7.8 (87.1%) (2.6-38.7)	6.6 (78.1%) (1.4-16.2)	6.6 (103.9%) (1.7-34.4)	NA
C_{max} (ng/mL) Day 1	1.5 (67.8%) (0.5-3.6)	1.3 (438%) (0-12.3)	1.4 (73.9%) (0.4-3.1)	NA
C_{max} (ng/mL) Day 4	6.8 (83.4%) (2.5-38.7)	5.9 (66.5%) (1.4-12.9)	6.4 (111%) (1.7-34.4)	NA
$C_{predose}$ Day 2 (ng/mL)	1.4 (72.9%) (0.5-3.6)	1.2 (435.8%) (0-12.3)	1.2 (86.8%) (0.4-3.1)	NA
$C_{predose}$ Day 3 (ng/mL)	2.6 (47.7%) (1-4.9)	3.3 (105.3%) (0.4-16.2)	2.8 (75.4%) (1.2-10.6)	NA
$C_{predose}$ Day 4 (ng/mL)	3.6 (57.7%) (1.6-8.9)	3.6 (71.5%) (1-7.7)	3.2 (67.5%) (1.1-9.4)	NA
Conc. Day 5 (ng/mL)	3.8 (40.3%) (2.5-8.1)	3.5 (67.9%) (1.2-7.8)	3.5 (53.8%) (1.7-6.6)	NA
Conc. Day 6 (ng/mL)	2.7 (51.1%) (1.3-5.5)	2.8 (87.5%) (0.5-5.8)	2.6 (75.4%) (1.1-8.2)	NA
Conc. Day 7 (ng/mL)	1.9 (44.2%) (1-2.9)	2.1 (63.8%) (0.6-4.9)	2.3 (92.9%) (0.6-8.6)	NA
Skin Day 7 (ng/cm2)	2090.7 [99.6%] (730.6-16676.6)	3141.9 [97.8%] (570.1-19841.8)	4488.8 [120.4%] (1072.3-20606.2)	NA
Conc Day 10 (ng/mL)	0.1 (826.8%) (0-1.5)	0.2 (903.9%) (0-2.7)	0.8 (54%) (0.4-2.1)	NA

	Lotion Geometric Mean [CV%] (range)	Aerosol Spray Geometric Mean [CV%] (range)	Nonaerosol Spray Geometric Mean [CV%] (range)	Pump Spray Geometric Mean [CV%] (range)
Conc Day 14 (ng/mL)	0 (669.5%) (0-1.2)	0 (1645.7%) (0-2)	0.1 (1254%) (0-1.1)	NA
Skin Day 14 (ng/cm2)	123.3 [74.6%] (50-327)	111.1 [187.1%] (35.1-3239.2)	354.9 [335.7%] (39.2-3144.1)	NA
Conc Day 21 (ng/mL)	0 (262.2%) (0-1.4)	0 (0%) (0-0)	0 (1253.9%) (0-1.2)	NA
Terminal Half-Life (h)	49.5 (59.1%) (23.7-121.8)	48.4 (36.7%) (28.9-70.9)	79.1 (40.1%) (41.2-118.8)	NA
T_{max} (h) Overall	72 (15%) (57-82)	65.3 (38.4%) (33-95)	69 (21.6%) (47-95)	NA
T_{max} (h) Day 1	18.7 (32.4%) (10-23)	8.7 (1067.2%) (0-23)	12.5 (147.5%) (0.5-23)	NA
T_{max} (h) Day 4	80.9 (7.1%) (73-95)	80.5 (7.2%) (74-95)	81 (7.4%) (73-95)	NA
Homosalate				
AUC Day 1 (ng*h/mL)	NA	104 (87.1%) (24-424.9)	62.3 (42.4%) (32.5-111.6)	47.6 (79.5%) (14.6-130.7)
AUC Day 4 (ng*h/mL)	NA	350.8 (52.1%) (140.6-726.7)	267.4 (46.8%) (142.3-457.3)	199.0 [52.9%] (101.9-452.9)
AUC_{last} (ng*h/mL)	NA	1943.8 (49.3%) (903-4219.7)	1212 (107.7%) (170.9-3463.6)	843.6 (95%) (148.4-2444.2)
C_{max} (ng/mL) Overall	NA	23.1 (68%) (8.7-67.7)	17.9 (61.7%) (7.4-39)	13.9 (70.2%) (3.7-35.8)
C_{max} (ng/mL) Day 1	NA	7.6 (108.7%) (1.5-44.9)	4.6 (48.7%) 2-8.8)	3.8 (110%) (0.9-23.1)
C_{max} (ng/mL) Day 4	NA	21.9 (60.5%) (8.7-58.1)	18.1 (70%) (7.6-39)	14.3 [60.7%] (6.7-35.8)
$C_{predose}$ Day 2 (ng/mL)	NA	5.1 (87.4%) (1.5-31.7)	3.4 (47.2%) (1.6-7.1)	2.7 (112.2%) (0.7-23.1)
$C_{predose}$ Day 3 (ng/mL)	NA	12.7 (90.8%) (2.9-67.7)	8.8 (65.2%) (2.8-19.6)	5 (54%) (1.7-10.1)
$C_{predose}$ Day 4 (ng/mL)	NA	14.2 (54.2%) (5.5-28.1)	10.1 (47.3%) (5.6-23.9)	5.9 (60.6%) (2.9-18.6)
Conc. Day 5 (ng/mL)	NA	12.8 (46.4%) (6.7-22.8)	10.1 (63.7%) (4.3-26.1)	5.9 (61%) (2.5-12.9)
Conc. Day 6 (ng/mL)	NA	7.6 (58.1%) (2.7-16.9)	5.5 (83.6%) (2.3-18.5)	3.8 (60%) (1.5-9.6)
Conc. Day 7 (ng/mL)	NA	5.2 (41.4%) (2.7-10.3)	4.7 (103.8%) (1.4-21.7)	3.5 (114.1%) (0.5-11.5)

	Lotion Geometric Mean [CV%] (range)	Aerosol Spray Geometric Mean [CV%] (range)	Nonaerosol Spray Geometric Mean [CV%] (range)	Pump Spray Geometric Mean [CV%] (range)
Skin Day 7 (ng/cm2)	NA	4517 [102.2%] (1180.3-32776.8)	2814.9 [178.7%] (361.9-15029.4)	2165.7 [164.1%] (401.9-7248)
Conc Day 10 (ng/mL)	NA	1.2 (65.2%) (0.5-5.2)	1.3 (68.7%) (0.7-4)	0.2 (1405.7%) (0-2.4)
Conc Day 14 (ng/mL)	NA	0.4 (637.8%) (0-3.8)	0.7 (410.2%) (0-5.8)	0.2 (2388.7%) (0-2.3)
Skin Day 14 (ng/cm2)	NA	190.2 [202.9%] (72.8-5218.6)	436.9 [253.6%] (56.5-5988.6)	181.8 [157.1%] (31.3-839.6)
Conc Day 21 (ng/mL)	NA	0.2 (723%) (0-1)	0.3 (1654.1%) (0-2.9)	0 (1552.1%) (0-3.9)
Terminal Half-Life (h)	NA	67.9 (62.2%) (24.4-155.6)	78.4 (61.6%) (49-162.4)	46.9 (67.5%) (18-82.4)
T_{max} (h) Overall	NA	68.5 (29.6%) (33-86)	57 (51.5%) (14-81)	67.8 (38%) (23-86)
T_{max} (h) Day 1	NA	12.1 (46.3%) (6-23)	9.1 (143.7%) (0.5-23)	12.2 (42.5%) (8-23)
T_{max} (h) Day 4	NA	78.5 (5.8%) (73-86)	80.6 (7.5%) (74-95)	80.1 (6.2%) (73-86)
Octisalate				
AUC Day 1 (ng*h/mL)	NA	12 (1529.4%) (0-94.6)	14.7 (89.6%) (2.7-28)	4.5 (9367.4%) (0-75.7)
AUC Day 4 (ng*h/mL)	NA	67.9 (55.5%) (30.1-172.6)	76.9 (62.8%) (32.5-137.5)	54.0 [83.3%] (13.8-134.3)
AUC_{last} (ng*h/mL)	NA	281.3 (75.8%) (72.2-814.7)	277.3 (116.2%) (53-809.7)	208.1 (115.4%) (33.8-860.1)
C_{max} (ng/mL) Overall	NA	5.1 (81.6%) (2-17.3)	5.8 (77.4%) (2.3-16.7)	4.6 (97.6%) (0.9-12.2)
C_{max} (ng/mL) Day 1	NA	1.3 (441.4%) (0-12.9)	1.4 (51.6%) (0.5-2.3)	0.7 (974.7%) (0-10.6)
C_{max} (ng/mL) Day 4	NA	4.6 (63.8%) (2-13.6)	6.1 (88.7%) (1.9-16.7)	4.6 [85.1%] (1.5-12.2)
$C_{predose}$ Day 2 (ng/mL)	NA	0.4 (564.2%) (0-5.2)	0.4 (478.9%) (0-2.1)	0.2 (1837.2%) (0-10.6)
$C_{predose}$ Day 3 (ng/mL)	NA	2.4 (104.9%) (0.5-14.8)	2.3 (94.3%) (0.5-7.7)	0.9 (303.8%) (0-3.1)
$C_{predose}$ Day 4 (ng/mL)	NA	2.7 (56.5%) (1.2-6.2)	2.6 (64.2%) (1.1-6.5)	1.4 (75%) (0.5-5.6)
Conc. Day 5 (ng/mL)	NA	2.1 (54.8%) (0.9-3.8)	2.3 (100.9%) (0.8-8.9)	0.9 (441%) (0-3.5)

	Lotion Geometric Mean [CV%] (range)	Aerosol Spray Geometric Mean [CV%] (range)	Nonaerosol Spray Geometric Mean [CV%] (range)	Pump Spray Geometric Mean [CV%] (range)
Conc. Day 6 (ng/mL)	NA	0.8 (278.6%) (0-3)	1.3 (111.8%) (0.4-5.3)	0.7 (343.8%) (0-4.4)
Conc. Day 7 (ng/mL)	NA	0.4 (444.3%) (0-1.4)	0.6 (1247.5%) (0-5.9)	0.5 (1011.8%) (0-4.5)
Skin Day 7 (ng/cm2)	NA	1265.4 [107.3%] (277.4-9311.2)	1128.3 [204.5%] (125.4-6746.4)	907.8 [168.7%] (193.6-2767.7)
Conc Day 10 (ng/mL)	NA	0 (229%) (0-0.9)	0 (718.4%) (0-0.8)	0 (209.3%) (0-0.5)
Conc Day 14 (ng/mL)	NA	0 (163.6%) (0-0.4)	0 (630.3%) (0-1.4)	0 (557.2%) (0-0.5)
Skin Day 14 (ng/cm2)	NA	63.9 [174.6%] (17.9-1194.1)	195.7 [250.4%] (28.9-2591.1)	82.3 [85.6%] (32.3-263.4)
Conc Day 21 (ng/mL)	NA	0 (0%) (0-0)	0 (260.8%) (0-0.9)	0 (286.2%) (0-1.1)
Terminal Half-Life (h)	NA	37.4 (61.2%) (19.3-122.5)	27.3 (37.2%) (16.9-41)	77.1 (213.8%) (22.9-323.6)
T_{max} (h) Overall	NA	68.2 (29.2%) (33-84)	65.2 (29.6%) (33-86)	68.6 (39.2%) (23-84)
T_{max} (h) Day 1	NA	5.9 (820.8%) (0-23)	7.8 (126.9%) (0.5-23)	3.3 (4279.5%) (0-23)
T_{max} (h) Day 4	NA	78.2 (5.2%) (73-84)	80.6 (4.5%) (74-86)	82.0 (2%) (81-86)
Octinoxate				
AUC Day 1 (ng*h/mL)	NA	NA	21.6 (116.4%) (2.7-57.7)	9.9 (1435.1%) (0-53.3)
AUC Day 4 (ng*h/mL)	NA	NA	103.4 (56.2%) (45.1-213.5)	79.5 [50.1%] (40.4-144.7)
AUC_{last} (ng*h/mL)	NA	NA	449.2 (134.1%) (74.2-1843.2)	295.8 (92.8%) (50.9-775.4)
C_{max} (ng/mL) Overall	NA	NA	7.9 (86.5%) (2.6-30.6)	5.2 (68.2%) (1.5-11.8)
C_{max} (ng/mL) Day 1	NA	NA	2 (96%) (0.6-5)	1.1 (326.2%) (0-4.1)
C_{max} (ng/mL) Day 4	NA	NA	7.6 (108.3%) (2.4-30.6)	6.1 [53.8%] (3.2-11.8)
$C_{predose}$ Day 2 (ng/mL)	NA	NA	1.4 (423.8%) (0-4.5)	0.8 (280.6%) (0-2.6)
$C_{predose}$ Day 3 (ng/mL)	NA	NA	3.6 (91.4%) (0.8-12.6)	1.9 (46.9%) (0.7-3.3)

	Lotion Geometric Mean [CV%] (range)	Aerosol Spray Geometric Mean [CV%] (range)	Nonaerosol Spray Geometric Mean [CV%] (range)	Pump Spray Geometric Mean [CV%] (range)
$C_{predose}$ Day 4 (ng/mL)	NA	NA	4.1 (56%) (2-10.8)	2.5 (57.2%) (1.1-6.3)
Conc. Day 5 (ng/mL)	NA	NA	3.7 (70.8%) (1.3-9.9)	2.3 (58.2%) (1.2-6.7)
Conc. Day 6 (ng/mL)	NA	NA	2.3 (87.8%) (0.8-10.1)	1.7 (58.2%) (0.9-5)
Conc. Day 7 (ng/mL)	NA	NA	1.3 (571.9%) (0-12.5)	1 (453.9%) (0-5.8)
Skin Day 7 (ng/cm2)	NA	NA	2373.6 [149.7%] (493.2-12200.5)	1675.2 [132.7%] (470-5856.9)
Conc Day 10 (ng/mL)	NA	NA	0 (1662.9%) (0-2.3)	0.1 (1238.3%) (0-1.2)
Conc Day 14 (ng/mL)	NA	NA	0 (1653.6%) (0-2.3)	0 (961.9%) (0-0.8)
Skin Day 14 (ng/cm2)	NA	NA	284 [353.3%] (22.2-2977.6)	151.3 [410.9%] (24-1809.8)
Conc Day 21 (ng/mL)	NA	NA	0 (1399.2%) (0-1)	0 (332.7%) (0-1.5)
Terminal Half-Life (h)	NA	NA	50.6 (74.4%) (25.8-109.5)	157.4 (229.8%) (31.7-671)
T_{max} (h) Overall	NA	NA	68.1 (22.6%) (47-95)	80.4 (16.9%) (57-120)
T_{max} (h) Day 1	NA	NA	12.2 (163.9%) (0.5-23)	6.1 (1308.5%) (0-23)
T_{max} (h) Day 4	NA	NA	80 (7.9%) (73-95)	80.7 (4.4%) (73-86)

Abbreviations: CV, coefficient of variation.
C_{max} Overall is the maximum active ingredient concentration observed over the study duration. C_{max} Day 1 is the maximum concentration over the interval of 0 to 23 h. C_{max} Day 4 is the maximum active ingredient concentration over the interval of 71 to 95 h.
T_{max} Overall is reported as median (range) and is the time of maximum active ingredient concentration observed over the study duration. T_{max} Day 1 is the time of maximum active ingredient concentration over the interval of 0 to 23 h. T_{max} Day 4 is the time of maximum active ingredient concentration over the interval of 71 to 95 h.
AUClast is the area under the curve for the active ingredient from time 0 to last detectable observation. AUC Day 1 is the area under the curve for the active ingredient over the interval of 0 to 23 h. AUC Day 4 is the area under the curve for the active ingredient over the interval of 71 to 95 h.
Nonaerosol spray had n=10 participants with evaluable C_{max} and AUC on Day 4 due to treatment interruptions
Pump spray had n=10 participants with evaluable C_{max} and AUC on Day 4 due to treatment interruptions
Amount of active ingredient in the skin at day 7 and day 14 is reported for a subset of participants : avobenzone - lotion (n=10), aerosol spray (n=11), nonaerosol spray (n=9), and pump spray (n=8); oxybenzone - lotion (n=10) and aerosol spray (n=11); octocrylene - lotion (n=10), aerosol spray (n=11), and nonaerosol spray (n=9); homosalate - aerosol spray (n=10), nonaerosol spray (n=9), and pump spray (n=6); octisalate - aerosol spray (n=10), nonaerosol spray (n=9), and pump spray (n=6); and octinoxate - nonaerosol spray (n=9), and pump spray (n=7)

Terminal half-life is only reported for a subset of participants: avobenzone - lotion (n=11), aerosol spray (n=12), nonaerosol spray (n=7), and pump spray (n=6); oxybenzone - lotion (n=11) and aerosol spray (n=12); octocrylene - lotion (n=10), aerosol spray (n=8), and nonaerosol spray (n=8); homosalate - aerosol spray (n=11), nonaerosol spray (n=4), and pump spray (n=6); octisalate - aerosol spray (n=11), nonaerosol spray (n=5), and pump spray (n=5); and octinoxate - nonaerosol spray (n=5), and pump spray (n=5)

eTable 3. Percentage of Study Participants With Samples Exceeding 0.5 ng/mL at Select Time Points on Day 1 by Product and Ingredient

Active Ingredient	Product	Timepoint on Day 1 (h)				
		2	4	6	8	>0.5 ng/mL any time on Day 1
Avobenzone % patients >0.5 ng/mL [n/N]	Lotion	0% [0/12]	41.7% [5/12]	83.3% [10/12]	100% [12/12]	100% [12/12]
	Aerosol spray	8.3% [1/12]	33.3% [4/12]	58.3% [7/12]	66.7% [8/12]	83.3% [10/12]
	Non-aerosol spray	0% [0/12]	8.3% [1/12]	50% [6/12]	58.3% [7/12]	83.3% [10/12]
	Pump spray	0% [0/12]	16.7% [2/12]	33.3% [4/12]	41.7% [5/12]	75% [9/12]
Oxybenzone % patients >0.5 ng/mL [n/N]	Lotion	100% [12/12]	100% [12/12]	100% [12/12]	100% [12/12]	100% [12/12]
	Aerosol spray	100% [12/12]	100% [12/12]	100% [12/12]	100% [12/12]	100% [12/12]
Octocrylene % patients >0.5 ng/mL [n/N]	Lotion	0% [0/12]	25% [3/12]	58.3% [7/12]	83.3% [10/12]	91.7% [11/12]
	Aerosol spray	0% [0/12]	25% [3/12]	75% [9/12]	75% [9/12]	91.7% [11/12]
	Non-aerosol spray	8.3% [1/12]	16.7% [2/12]	58.3% [7/12]	66.7% [8/12]	91.7% [11/12]
Homosalate % patients >0.5 ng/mL [n/N]	Aerosol spray	83.3% [10/12]	100% [12/12]	100% [12/12]	100% [12/12]	100% [12/12]
	Non-aerosol spray	50% [6/12]	100% [12/12]	100% [12/12]	100% [12/12]	100% [12/12]
	Pump spray	50% [6/12]	83.3% [10/12]	100% [12/12]	100% [12/12]	100% [12/12]
Octisalate % patients >0.5 ng/mL [n/N]	Aerosol spray	25% [3/12]	75% [9/12]	83.3% [10/12]	83.3% [10/12]	83.3% [10/12]
	Non-aerosol spray	16.7% [2/12]	58.3% [7/12]	75% [9/12]	91.7% [11/12]	100% [12/12]
	Pump spray	16.7% [2/12]	33.3% [4/12]	66.7% [8/12]	66.7% [8/12]	75% [9/12]
Octinoxate % patients >0.5 ng/mL [n/N]	Non-aerosol spray	25% [3/12]	58.3% [7/12]	58.3% [7/12]	83.3% [10/12]	100% [12/12]
	Pump spray	8.3% [1/12]	25% [3/12]	58.3% [7/12]	66.7% [8/12]	83.3% [10/12]

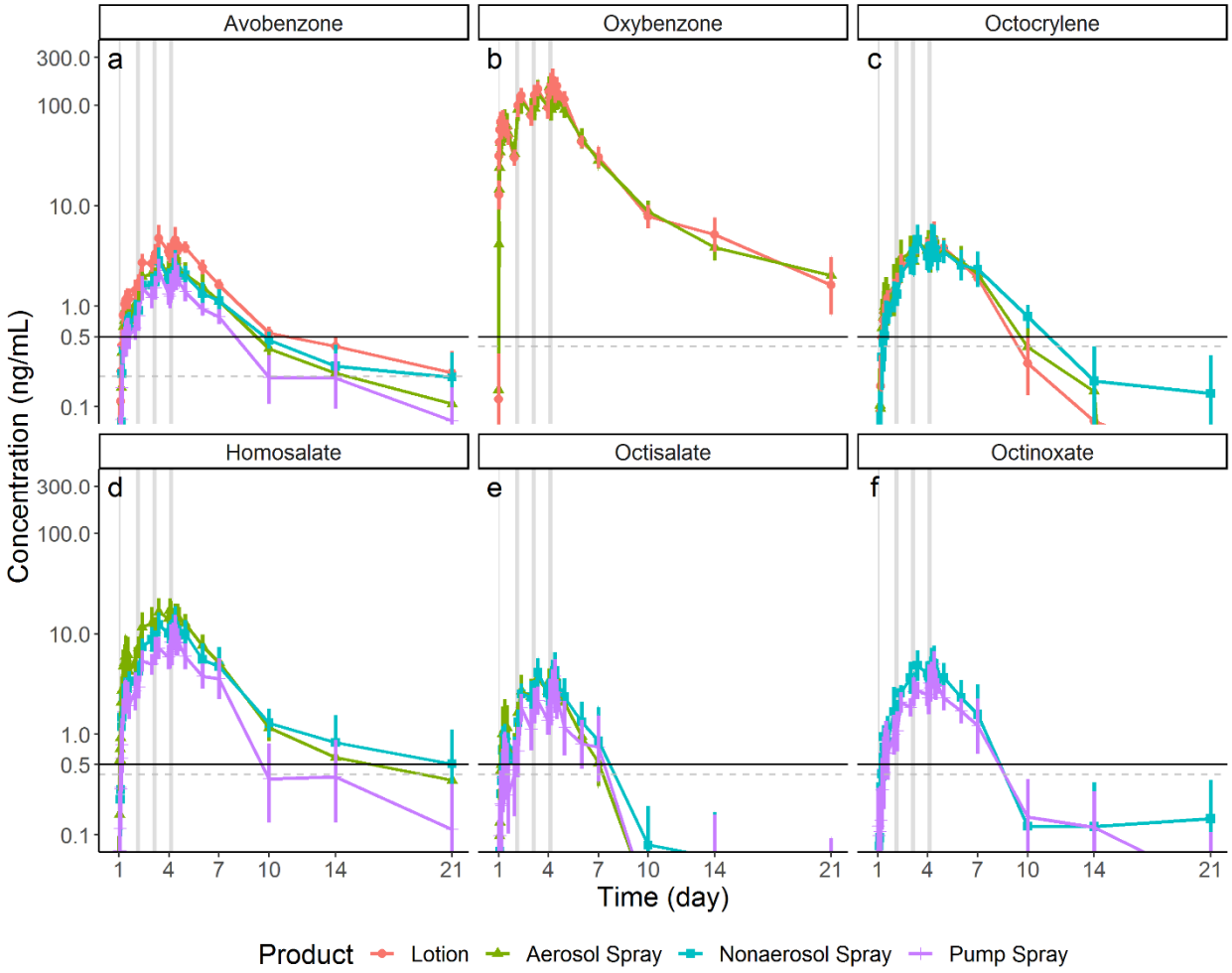
eTable 4. Number and Percentage of Adverse Events by Treatment Group

Adverse Event	Lotion (N=12) Incidence (number of events)	Aerosol Spray (N=12) Incidence (number of events)	Nonaerosol Spray (N=12) Incidence (number of events)	Pump Spray (N=12) Incidence (number of events)
Application Site Erythema	2 (2)	0 (0)	3 (5)	0 (0)
Burning sensation	1 (1)	0 (0)	0 (0)	0 (0)
Cough	1 (1)	0 (0)	1 (1)	0 (0)
Dizziness	0 (0)	0 (0)	0 (0)	1 (1)
Ear pain	0 (0)	1 (1)	0 (0)	0 (0)
Erythema	2 (4)	0 (0)	1 (2)	0 (0)
Eye irritation	0 (0)	2 (4)	1 (1)	1 (1)
Eye pain	0 (0)	0 (0)	1 (1)	0 (0)
Headache	2 (2)	0 (0)	1 (1)	0 (0)
Haematoma	0 (0)	0 (0)	1 (1)	0 (0)
Hyperesthesia	1 (1)	0 (0)	0 (0)	0 (0)
Nasal congestion	0 (0)	1 (1)	0 (0)	0 (0)
Ocular hyperemia	0 (0)	1 (1)	1 (1)	0 (0)
Oropharyngeal pain	1 (1)	0 (0)	1 (1)	0 (0)
Pain of skin	0 (0)	0 (0)	0 (0)	1 (2)
Pruritus	0 (0)	0 (0)	0 (0)	2 (2)
Rash	1 (1)	6 (7)	5 (11)	2 (7)
Rhinorrhea	0 (0)	1 (1)	1 (1)	0 (0)
Skin abrasion	0 (0)	0 (0)	1 (1)	1 (1)
Skin disorder	0 (0)	0 (0)	0 (0)	1 (1)
Skin irritation	1 (2)	0 (0)	0 (0)	0 (0)
Sneezing	1 (1)	0 (0)	0 (0)	0 (0)
Tenderness	0 (0)	0 (0)	0 (0)	1 (1)
Vessel puncture site bruise	1 (1)	1 (1)	1 (1)	0 (0)
Vessel puncture site hematoma	0 (0)	0 (0)	1 (1)	0 (0)
Vessel puncture site pain	0 (0)	1 (1)	1 (1)	0 (0)
Vessel puncture site reaction	0 (0)	0 (0)	1 (1)	0 (0)
Vessel puncture site swelling	1 (1)	1 (1)	0 (0)	0 (0)

First number stands for incidence and second number in parenthesis stands for number of events.
There were 12 subjects per treatment group.
This table reports all Medical Dictionary for Regulatory Activities (MedDRA v.21.1)-defined adverse events during the study

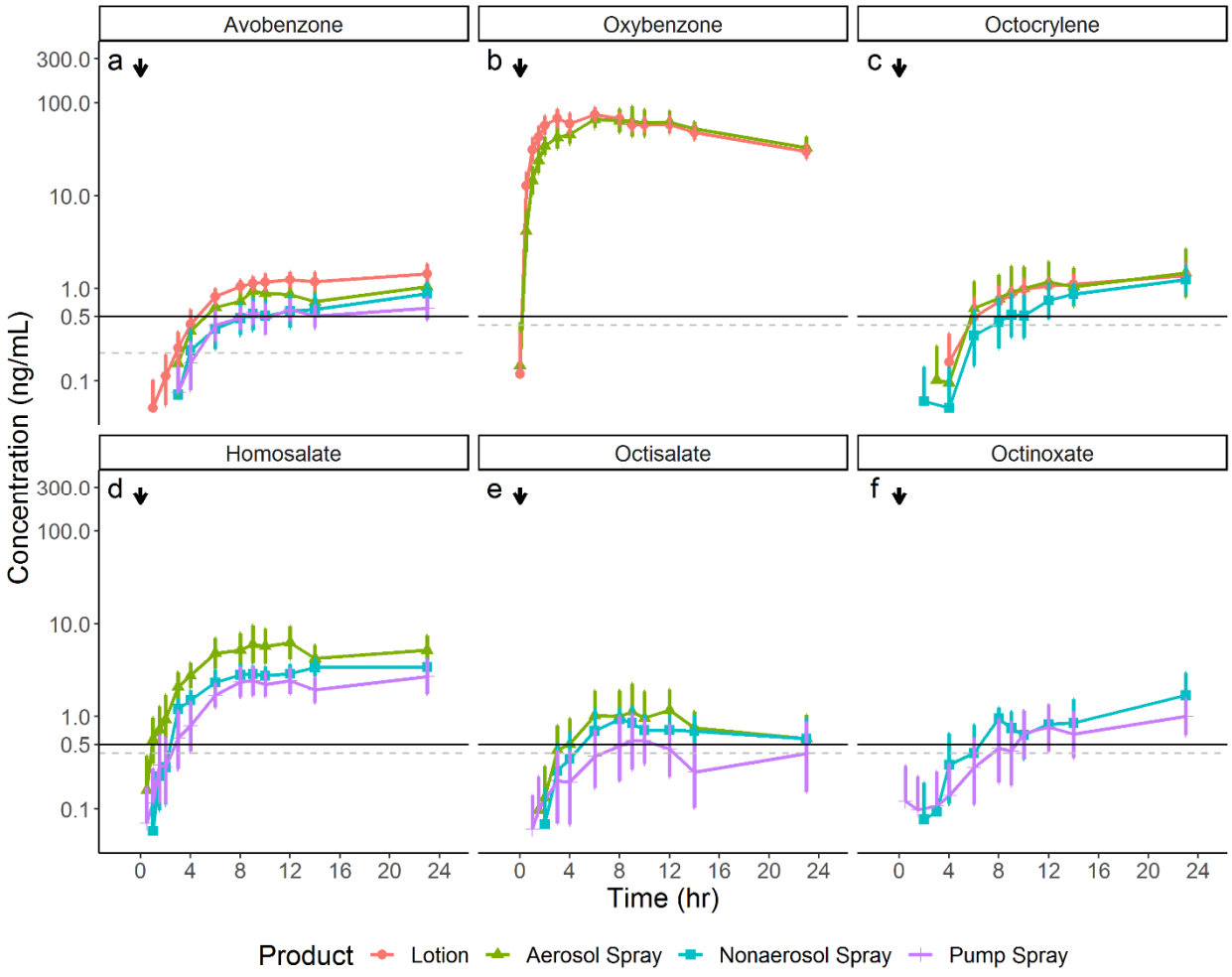
eFigure 1. Pharmacokinetic Profiles of Sunscreen Active Ingredients Upon Multiple Applications

Pharmacokinetic profiles of each ingredient by product from top to bottom: (A) lotion, (B) aerosol spray, (C) nonaerosol spray and (D) pump spray. Concentration profiles for each participant are shown for the study duration. The gray vertical shaded regions indicate the single application at 0 hours on day 1 and the 6-hour window (e.g., at 0, 2, 4 and 6 hours) of sunscreen application on day 2, 3, and 4. The black horizontal line denotes 0.5 ng/mL. Lower limit of quantitation (LLOQ) was 0.2 ng/mL for avobenzone and 0.4 ng/mL for oxybenzone, octocrylene, homosalate, octisalate, and octinoxate (horizontal gray line). All samples below the LLOQ were set to 0.1 ng/mL for plotting individual profiles in this figure. Lotion did not contain homosalate, octisalate, or octinoxate. Aerosol spray did not contain octinoxate. Nonaerosol spray did not contain oxybenzone. Pump spray did not contain oxybenzone or octocrylene.



eFigure 2. Pharmacokinetic Profiles of Sunscreen Active Ingredients Upon Single Application

Pharmacokinetic profile of each ingredient by product from top to bottom: (A) lotion, (B) aerosol spray, (C) nonaerosol spray and (D) pump spray. Concentration profile for each participant are shown for day 1. The arrows indicate sunscreen application at 0 hours. The black horizontal line denotes 0.5 ng/mL. Lower limit of quantitation (LLOQ) was 0.2 ng/mL for avobenzone and 0.4 ng/mL for oxybenzone, octocrylene, homosalate, octisalate, and octinoxate (horizontal gray line). All samples below the LLOQ were set to 0.1 ng/mL for plotting individual profiles in this figure. Lotion did not contain homosalate, octisalate, or octinoxate. Aerosol spray did not contain octinoxate. Nonaerosol spray did not contain oxybenzone. Pump spray did not contain oxybenzone or octocrylene.



eMethods.

Liquid chromatography tandem mass spectrometric assay methods were developed and validated to support the analysis of clinical study samples. All the assays were developed with the aim of high sensitivity with reliable quantitation. While optimizing the lower limit of quantitation (LLOQ) of each analyte, various parameters like signal to noise, accuracy, and precision were evaluated. The upper limit of quantitation (ULOQ) was selected based on the concentration at which acceptable linearity range was observed (i.e., concentration vs linear detector response). The details of individual methods and validation parameters are described below.

eMethods 1. Bioanalytical Method Conditions for Avobenzone and Oxybenzone in Plasma

Validation range:	0.2–12 ng/mL for Avobenzone and 0.4–300 ng/mL for Oxybenzone
High Performance Liquid Chromatography (HPLC) instrument:	Agilent 1290 Infinity
Mass Spectrometer:	AB SCIEX 6500^{+} Mass spectrometer

HPLC Conditions

Mobile Phase:	10 mM Ammonium formate with 0.1% Formic acid in water and methanol (24: 76, v/v)
Flow rate:	0.7 mL/min
Column:	Acquity UPLC® BEH Shield RP18 (2.1 x 50 mm) 1.7 µm
Injection Volume:	5 µL
Retention Time:	Avobenzone and Avobenzone-d_3: 2.00 minute Oxybenzone and Oxybenzone-d_3: 0.50 minute
Run Time:	3.0 minutes

Mass Spectrometer conditions

Ionization Source and scan type:	Atmospheric Pressure Chemical Ionization (APCI); Multiple Reaction Monitoring (MRM)
Data acquisition:	Analyst 1.6.3

AB SCIEX 6500^{+} Q-TRAP mass spectrometer state file parameters:

Parameter	**Avobenzone**	**Avobenzone–d_3 (IS1)**	**Oxybenzone**	**Oxybenzone–d_3 (IS2)**
Q1 mass/Q3 mass (amu)	311.2/161.2	314.2/161.2	229.2/151.2	232.2/154.1
Declustering potential, V	100	100	100	100
Collision Energy (V)	31	31	25	27
Collision Cell Exit Potential (V)	11	11	11	11
Source Temperature (^{0} C):	500	500	500	500
Collision Gas (CAD)	Medium	Medium	Medium	Medium
Curtain Gas (CUR)	40	40	40	40
Ion Source Gas 1 (GS1)	50	50	50	50
Nebulizer Current	3	3	3	3

Sample Preparation for Avobenzone and Oxybenzone: A 150 µL aliquot of the sample was added to Phree Phospholipid removal 96-well plates (Make: Phenomenex, Part no 8E-S133-TGB) and treated with 500 µL of acetonitrile containing 4.00 ng/mL of internal standard-1 (Avobenzone-d_3) and 10.00 ng/mL of internal standard-2 (Oxybenzone-d_3). The samples were vortexed for 4 min, followed by centrifugation at 5 *g* for 5 min. Then, 100µL of the filtrate was transferred to 96-well collection plates, 50µL of 10mM ammonium formate in 0.1% formic acid was added, and plates were shaken for 1 minute.

Validation Summary Table for Avobenzone and Oxybenzone

Description	**Avobenzone**	**Oxybenzone**
Short description of method	Protein precipitation with Phospholipid removal plates Reverse-phase HPLC with tandem mass spectrometric detection	Protein precipitation with Phospholipid removal plates Reverse-phase HPLC with tandem mass spectrometric detection
Biological matrix	Human plasma (dipotassium ethylenediaminetetraacetic acid)	Human plasma (dipotassium ethylenediaminetetraacetic acid)
Analyte	Avobenzone	Oxybenzone
Internal standard (IS)	Avobenzone –d_3	Oxybenzone–d_3
Calibration concentrations	0.20 ng/mL to 12.00 ng/mL	0.40 ng/mL to 300.00 ng/mL
QC concentrations	0.20 ng/mL, 0.60 ng/mL, 1.50 ng/mL, 6.00 ng/mL and 10.00 ng/mL	0.40 ng/mL, 1.20 ng/mL, 40.00 ng/mL, 150.00 ng/mL, and 260.00 ng/mL
Selectivity	No significant interference observed in the 16 blank matrix lots screened.	No significant interference observed in the 16 blank matrix lots screened.
Specificity	No significant interference observed.	No significant interference observed.
Lower limit of quantitation	0.20 ng/mL Between-run accuracy 108% Between-run precision 11% Within-run accuracy 108% Within-run precision 9%	0.40 ng/mL Between-run accuracy 101% Between-run precision 11% Within-run accuracy 111% Within-run precision 5%
Between-run accuracy	94% to 104%	96% to 101%
Between-run precision	4% to 9%	2% to 8%
Within-run accuracy	91% to 104%	95% to 105%
Within-run precision	3% to 8%	1% to 6%
IS normalized matrix factor	LQC: 1.13 (%CV: 3) HQC: 1.00 (%CV: 3)	LQC: 1.12 (%CV: 7) HQC: 1.02 (%CV: 1)
Dilution integrity	Concentration 36.00 ng/mL Diluted 5-fold: Accuracy 103%, Precision 4% Diluted 10-fold: Accuracy 104%, Precision 4%.	Concentration 900.00 ng/mL Diluted 5-fold: Accuracy 99%, Precision 2% Diluted 10-fold: Accuracy 100%, Precision 2%
Recovery of analyte	76% -85%	98% -105%
Recovery of IS	81%	90%
Auto-sampler storage stability	Confirmed up to 35 hours at 5°C nominal Accuracy 107% for LQC and 99% for HQC	Confirmed up to 35 hours at 5°C nominal Accuracy 97% for LQC and 100% for HQC
Freeze thaw stability	Confirmed up to five cycles Accuracy 103% for LQC and 106% for HQC	Confirmed up to five cycles Accuracy 112% for LQC and 104% for HQC

Description	Avobenzone	Oxybenzone
Bench top stability	Confirmed up to 15 hours at 24°C nominal Accuracy 104% for LQC and 111% for HQC	Confirmed up to 15 hours at 24°C nominal Accuracy 113% for LQC and 105% for HQC
Stock solution stability	Confirmed up to 90 days at -20°C nominal. %Stability 102%	Confirmed up to 90 days at -20°C nominal. %Stability 101%
Injector Carryover	Not significant (not detected)	Not significant (not detected)
Co-administration drug effect	Accuracy LQC: 113% Accuracy HQC: 107%	Accuracy LQC: 101% Accuracy HQC: 103%
Long term Stability in Plasma	Confirmed up to 187 days at -80°C nominal % Stability 104% for LQC and 99% for HQC	Confirmed up to 187 days at -80°C nominal % Stability 96% for LQC and 100% for HQC
QC: Quality control; LQC: Low quality control; HQC: High quality control; CV: Coefficient of variance		

eMethods 2. Bioanalytical Method Conditions for Octocrylene in Plasma

Validation range:	0.4–20 ng/mL
High Performance Liquid Chromatography (HPLC) instrument:	Agilent 1290 Infinity
Mass Spectrometer:	AB SCIEX 6500^{+} Mass spectrometer

HPLC Conditions

Mobile Phase:	10 mM Ammonium formate with 0.1% Formic acid in water and methanol (15: 85, v/v)
Flow rate:	0.4 mL/min
Column:	Acquity UPLC® BEH Shield RP18 (2.1 x 50 mm) 1.7 µm
Injection Volume:	5 µL
Retention Time:	Octocrylene and Octocrylene -d_{15}: 0.9 minute
Run Time:	2.0 minutes

Mass Spectrometer conditions

Ionization Source and scan type:	Atmospheric Pressure Chemical Ionization (APCI); Multiple Reaction Monitoring (MRM)
Data acquisition:	Analyst 1.6.3

AB SCIEX 6500^{+} Q-TRAP mass spectrometer state file parameters:

Parameter	**Octocrylene Ammonium adduct**	**Octocrylene –d_{15}**
Q1 mass/Q3 mass (amu)	379.0/250.0	377.1/251.1
Declustering potential, V	50	60
Collision Energy (V)	15	15
Collision Cell Exit Potential (V)	11	11
Source Temperature (^{0} C):	500	500
Collision Gas (CAD)	Medium	Medium
Curtain Gas (CUR)	40	40
Ion Source Gas 1 (GS1)	50	50
Nebulizer Current	3	3

Sample Preparation Octocrylene: 150 µL of acetonitrile containing 20 ng/mL of octocrylene-d_{15} was added to MultiScreen® solvinert protein precipitation 96-well plates (0.45µm, Low-Binding, Hydrophilic) (Make: Merck, Part no MSRLN0450) and a 50 µL aliquot of plasma sample was added to each well. The samples were vortexed for 5 min, followed by centrifugation at 4000 rpm for 5 min. Then, 50µL of 10mM ammonium formate in 0.1% formic acid was added and plates were shaken for 1 minute.

Validation Summary Table for Octocrylene

Description	**Octocrylene**
Short description of method	Protein precipitation with 96-well plates Reverse-phase HPLC with tandem mass spectrometric detection
Biological matrix	Human plasma (dipotassium ethylenediaminetetraacetic acid)
Analyte	Octocrylene
Internal standard (IS)	Octocrylene –d_{15}
Calibration concentrations	0.40 ng/mL to 20.00 ng/mL

Description	Octocrylene
QC concentrations	0.40 ng/mL, 1.20 ng/mL, 3.00 ng/mL, 10.00 ng/mL and 18.00 ng/mL
Selectivity	No significant interference observed in the 10 blank matrix lots screened.
Specificity	No significant interference observed.
Lower limit of quantitation	0.40 ng/mL Between-run accuracy 101% Between-run precision 14% Within-run accuracy 105% Within-run precision 9%
Between-run accuracy	98% to 104%
Between-run precision	6% to 9%
Within-run accuracy	101% to 104%
Within-run precision	3% to 7%
IS normalized matrix factor	LQC: 0.93 (%CV: 13) HQC: 1.04 (%CV: 5)
Dilution integrity	Concentration 60.00 ng/mL Diluted 5-fold: Accuracy 104%, Precision 5% Diluted 10-fold: Accuracy 111%, Precision 4%
Recovery of analyte	91% -102%
Recovery of IS	107%
Auto-sampler storage stability	Confirmed up to 36 hours at 5°C nominal. Accuracy 103% for LQC and 98% for HQC
Freeze thaw stability	Confirmed up to seven cycles, Accuracy 90% for LQC and 98% for HQC
Bench top stability	Confirmed up to 15 hours at 24°C nominal. Accuracy 88% for LQC and 88% for HQC
Stock solution stability	Confirmed up to 45 days at -20°C nominal. %Stability 97%
Injector Carryover	Not significant (not detected)
Co-administration drug effect	Accuracy LQC: 109% Accuracy HQC: 103%
Long term Stability in Plasma	Confirmed up to 168 days at -80°C nominal % Stability 103% for LQC and 87% for HQC
QC: Quality control; LQC: Low quality control; HQC: High quality control; CV: Coefficient of variance	

eMethods 3. Bioanalytical Method Conditions for Homosalate, Octisalate, and Octinoxate in Plasma

Validation range:	0.4–40 ng/mL for Homosalate, Octisalate and Octinoxate
High Performance Liquid Chromatography (HPLC) Instrument:	Agilent 1290 Infinity
Mass Spectrometer:	AB SCIEX 6500^{+} Mass spectrometer

HPLC Conditions

Mobile Phase A:	0.1% Ammonium hydroxide in water
Mobile Phase B:	Methanol

Gradient Table:

Time (min)	Flow (mL/min)	A (%)	B (%)
0.0	0.7	80	20
0.2	0.7	80	20
0.3	0.7	26	74
3.2	0.7	26	74
3.5	0.7	80	20
3.8	0.7	80	20

Column:	Acquity UPLC BEH C_{18} (2.1 x 50 mm) 1.8 µm
Injection Volume:	10 µL
Autosampler Temperature:	5°C
Colum Temperature:	40 °C
Retention Time:	Homosalate: 2.90 minute Homosalate-d_4: 2.90 minute Octisalate: 2.70 minute Octisalate-d_4: 2.70 minute Octinoxate: 2.60 minute Octinoxate-d_3: 2.60 minute
Run Time:	3.8 minutes

Mass Spectrometer Conditions

Ionization Source and Scan type:	Atmospheric Pressure Chemical Ionization (APCI) Multiple Reaction Monitoring (MRM)
Polarity	Positive and negative switch
Data acquisition	Analyst 1.6.3

AB SCIEX 6500+ Q-TRAP mass spectrometer state file parameters:

	Positive mode		Negative mode			
Parameter	**Octinoxate**	**Octinoxate –d_3**	**Homosalate**	**Homosalate–d_4**	**Octisalate**	**Octisalate–d_4**
Q1 mass/Q3 mass (amu)	291.0/179.2	294.2/182.3	261.2/137.0	265.2/141.1	249.2/136.9	253.2/141.0
Declustering potential, V	38	25	-65	-65	-75	-75
Collision Energy (V)	11	11	-25	-25	-24	-25
Collision Cell Exit Potential (V)	11	11	-14	-14	-15	-15
Entrance potential, V	10	10	-10	-10	-10	-10
Source Temperature (^{0} C):	550	550	550	550	550	550
Collision Gas (CAD)	Medium	Medium	Medium	Medium	Medium	Medium
Curtain Gas (CUR)	30	30	30	30	30	30
Ion Source Gas (GS1)	40	40	40	40	40	40
Ion Source Gas (GS2)	50	50	50	50	50	50
Nebulizer Current	3	3	-3	-3	-3	-3
Dwell time (ms)	100	50	100	50	100	50

Sample Preparation: A 150 µL of acetonitrile containing internal standards (20 ng/mL of Homosalate –d_4, 10 ng/mL of Octisalate –d_4, and 10 ng/mL of Octinoxate –d_3) was added to MultiScreen® solvinert protein precipitation plates (0.45µm, Low-Binding, Hydrophilic PTFE) 96 well plates (Make: Merck, Part no MSRLN0450) and an aliquot of 50 µL of plasma sample was added to each Well. The samples were vortexed for 5 min, followed by centrifugation at 4000 rpm for 5 min.

Validation Summary Table for Homosalate, Octisalate and Octinoxate in Plasma

Description	Homosalate	Octisalate	Octinoxate
Short description of method	Protein precipitation Reverse-phase HPLC with MS/MS detection	Protein precipitation Reverse-phase HPLC with MS/MS detection	Protein precipitation Reverse-phase HPLC with MS/MS detection
Biological matrix	Human plasma (K_2 EDTA)	Human plasma (K_2 EDTA)	Human plasma (K_2 EDTA)
Analyte	Homosalate	Octisalate	Octinoxate
Internal standard (IS)	Homosalate–d_4	Octisalate–d_4	Octinoxate–d_3
Calibration concentrations	0.40 ng/mL to 40.00 ng/mL	0.40 ng/mL to 40.00 ng/mL	0.40 ng/mL to 40.00 ng/mL
QC concentrations	0.40 ng/mL, 1.20 ng/mL, 2.00 ng/mL, 20.00 ng/mL and 34.00 ng/mL	0.40 ng/mL, 1.20 ng/mL, 2.00 ng/mL, 20.00 ng/mL and 34.00 ng/mL	0.40 ng/mL, 1.20 ng/mL, 2.00 ng/mL, 20.00 ng/mL and 34.00 ng/mL
Selectivity	No interference observed	No interference observed	No interference observed
Specificity	No interference observed	No interference observed	No interference observed
Lower limit of quantification	0.40 ng/mL Between-run accuracy 103% Between-run precision 15% Within-run accuracy 111% Within-run precision 14%	0.40 ng/mL Between-run accuracy 100% Between-run precision 15% Within-run accuracy 108% Within-run precision 12%	0.40 ng/mL Between-run accuracy 104% Between-run precision 14% Within-run accuracy 109% Within-run precision 16%
Between-run accuracy	95% to 103%	97% to 106%	95% to 105%
Between-run precision	5% to 12%	6% to 11%	6% to 13%
Within-run accuracy	90% to 111%	102% to 114%	98% to 114%
Within-run precision	5% to 10%	5% to 11%	2% to 13%
Matrix effect (IS normalized)	LQC: 1.00 (%CV: 4) HQC: 1.03 (%CV: 4)	LQC: 0.89 (%CV: 3) HQC: 1.03 (%CV: 4)	LQC: 1.07 (%CV: 7) HQC: 1.11 (%CV: 2)
Dilution integrity	Concentration 120.00 ng/mL Diluted 5-fold: Accuracy 91%, Precision 5% Diluted 10-fold: Accuracy 86%, Precision 11%	Concentration 120.00 ng/mL Diluted 5-fold: Accuracy 95%, Precision 7% Diluted 10-fold: Accuracy 90%, Precision 12%	Concentration 120.00 ng/mL Diluted 5-fold: Accuracy 90%, Precision 6% Diluted 10-fold: Accuracy 88%, Precision 10%
Recovery of analyte	111% -113%	96% -107%	106% -112%
Recovery of IS	109%	107%	108%
Auto-sampler storage stability	Confirmed up to 36 hours at 5°C nominal Accuracy 95% for LQC and 104% for HQC	Confirmed up to 36 hours at 5°C nominal Accuracy 105% for LQC and 104% for HQC	Confirmed up to 36 hours at 5°C nominal Accuracy 108% for LQC and 102% for HQC
Freeze thaw stability	Confirmed up to VII cycles Accuracy 103% for LQC and 103% for HQC	Confirmed up to VII cycles Accuracy 97% for LQC and 104% for HQC	Confirmed up to VII cycles Accuracy 106% for LQC and 102% for HQC

Description	Homosalate	Octisalate	Octinoxate
Bench top stability	Confirmed up to 5 hours on ice water bath Accuracy 99% for LQC and 96% for HQC	Confirmed up to 5 hours on ice water bath Accuracy 89% for LQC and 94% for HQC	Confirmed up to 5 hours on ice water bath Accuracy 101% for LQC and 93% for HQC
Stock solution stability	Confirmed up to 62 days at -20°C %Stability 98%	Confirmed up to 62 days at -20°C %Stability 96%	Confirmed up to 62 days at -20°C %Stability 93%
Injector Carryover	Not significant (0.00%)	Not significant (0.00%)	Not significant (0.00)
Co-administration drug effect	Accuracy 93% for LQC and 101% for HQC	Accuracy 96% for LQC and 99% for HQC	Accuracy 106% for LQC and 98% for HQC
Long term Stability in Plasma	Confirmed up to 173 days at -80°C % Stability 108% for LQC and 102% for HQC	Confirmed up to 173 days at -80°C % Stability 109% for LQC and 99% for HQC	Confirmed up to 173 days at -80°C % Stability 105% for LQC and 99% for HQC
QC: Quality Control; LQC: Low Quality Control; HQC: High Quality Control; CV: Coefficient of variance			

eMethods 4. Bioanalytical Method Conditions for Avobenzone, Oxybenzone, and Octocrylene in Skin Samples

Validation range:	0.2–100 ng/mL for Avobenzone, 0.4–400 ng/mL for Oxybenzone and 0.4–100 ng/mL for Octocrylene
High Performance Liquid Chromatography (HPLC) Instrument:	Agilent 1290 Infinity
Mass Spectrometer:	AB SCIEX 6500^+ Mass spectrometer

HPLC Conditions

Mobile Phase:	10 mM Ammonium formate with 0.1% Formic acid in water and Methanol (24:76, v/v)
Flow Rate	0.7mL/min
Column:	Acquity UPLC BEH C_{18} (2.1 x 50 mm) 1.8 µm
Injection Volume:	5 µL
Autosampler Temperature:	5°C
Colum Temperature:	40 °C
Retention Time:	Avobenzone: 1.90 minute Avobenzone-d_3: 1.90 minute Oxybenzone: 0.50 minute Oxybenzone-d_3: 0.50 minute Octocrylene: 1.1 minute Octocrylene -d_{15}: 1.1 minute
Run Time:	3 minutes

Mass Spectrometer Conditions

Ionization Source and Scan type:	Atmospheric Pressure Chemical Ionization (APCI) Multiple Reaction Monitoring (MRM)
Polarity	Positive and negative switch
Data acquisition	Analyst 1.6.3

AB SCIEX 6500+ Q-TRAP mass spectrometer state file parameters:

Parameter	Avobenzone	Avobenzone $-d_3$	Oxybenzone	Oxybenzone $-d_3$	Octocrylene	Octocrylene $-d_{15}$
Q1 mass/Q3 mass (amu)	311.2/161.2	314.2/161.2	229.2/151.2	232.2/154.1	379.0/250.0	377.1/251.1
Declustering Potential, V	100	58	100	100	50	60
Collision Energy (V)	29	35	27	27	15	15
Collision Cell Exit Potential (V)	17	18	13	13	11	11
Entrance Potential, V	10	10	10	10	10	10
Nebulizer Current (NC)	3	3	3	3	3	3
Source Temperature (^{0} C):	550	550	550	550	550	550
Collision Gas (CAD)	Medium	Medium	Medium	Medium	Medium	Medium
Curtain Gas (CUR)	30	30	30	30	30	30
Ion Source Gas (GS1)	40	40	40	40	40	40
Ion Source Gas (GS2)	50	50	50	50	50	50
Dwell Time (ms)	50	100	50	30	100	50

Sample Preparation: The analytes were extracted from the tapes using 80% acetonitrile in water. A 120 µL of acetonitrile containing internal standards (8 ng/mL of Avobenzone $-d_3$, 16 ng/mL of Oxybenzone $-d_3$, and 25 ng/mL of Octocrylene $-d_{15}$) was added to 96 well autosampler loading plates and an aliquot of 30 µL of sample was added to each Well followed by 30µL of mobile phase buffer (10mM ammonium formate with 0.1% formic acid). The samples were shaken for 1 min and placed in autosampler.

Validation Summary Table for Avobenzone, Oxybenzone and Octocrylene in Skin Samples

Description	Avobenzone	Oxybenzone	Octocrylene
Short description of method	Tape-Stripping Technique Reverse-phase HPLC with MS/MS detection	Tape-Stripping Technique Reverse-phase HPLC with MS/MS detection	Tape-Stripping Technique Reverse-phase HPLC with MS/MS detection
Biological matrix	Skin samples	Skin samples	Skin samples
Analyte	Avobenzone	Oxybenzone	Octocrylene
Internal standard (IS)	Avobenzone–d_3	Oxybenzone–d_3	Octocrylene–d_{15}
Calibration concentrations	0.20 ng/mL to 100.00 ng/mL	0.40 ng/mL to 300.00 ng/mL	0.40 ng/mL to 100.00 ng/mL
QC concentrations	0.20 ng/mL, 0.60 ng/mL, 12.00 ng/mL, 50.00 ng/mL and 85.00 ng/mL	0.40 ng/mL, 1.20 ng/mL, 40.00 ng/mL, 150.00 ng/mL and 260.00 ng/mL	0.40 ng/mL, 1.20 ng/mL, 12.00 ng/mL, 50.00 ng/mL and 85.00 ng/mL
Selectivity	No ant interference observed	No interference observed	No interference observed
Specificity	No interference observed	No interference observed	No interference observed
Lower limit of quantification	0.20 ng/mL Between-run accuracy 102% Between-run precision 17% Within-run accuracy 118% Within-run precision 11%	0.40 ng/mL Between-run accuracy 104% Between-run precision 14% Within-run accuracy 110% Within-run precision 9%	0.40 ng/mL Between-run accuracy 109% Between-run precision 18% Within-run accuracy 116% Within-run precision 18%
Between-run accuracy	97% to 106%	97% to 108%	100% to 109%
Between-run precision	1% to 6%	2% to 4%	3% to 9%
Within-run accuracy	98% to 111%	97% to 107%	103% to 112%
Within-run precision	1% to 4%	2% to 6%	2% to 6%
Matrix effect (IS normalized)	LQC: 1.00 (%CV: 4) HQC: 1.03 (%CV: 1)	LQC: 0.97 (%CV: 2) HQC: 0.99 (%CV: 1)	LQC: 1.03 (%CV: 7) HQC: 1.02 (%CV: 2)
Dilution integrity	Concentration 300.00 ng/mL for 5-fold and 10-fold and 2000.00 ng/mL for 50-fold and 300-fold Diluted 5-fold: Accuracy 105%, Precision 1% Diluted 10-fold: Accuracy 99%, Precision 0.4% Diluted 50-fold: Accuracy 104%, Precision 1% Diluted 300-fold: Accuracy 109%, Precision 2%	Concentration 900.00 ng/mL for 5-fold and 10-fold and 6000.00 ng/mL for 50-fold and 300-fold Diluted 5-fold: Accuracy 105%, Precision 1% Diluted 10-fold: Accuracy 99%, Precision 0.4% Diluted 50-fold: Accuracy 103%, Precision 1% Diluted 300-fold: Accuracy 111%, Precision 1%	Concentration 300.00 ng/mL for 5-fold and 10-fold and 2000.00 ng/mL for 50-fold and 300-fold Diluted 5-fold: Accuracy 105%, Precision 1% Diluted 10-fold: Accuracy 99%, Precision 0.4% Diluted 50-fold: Accuracy 97%, Precision 3% Diluted 300-fold: Accuracy 105%, Precision 6%
Recovery of analyte	96% -99%	95% -96%	94% -96%
Recovery of IS	91%	97%	96%

Description	Avobenzone	Oxybenzone	Octocrylene
Auto-sampler storage stability	Confirmed up to 34 hours at 5°C nominal Accuracy 111% for LQC and 103% for HQC	Confirmed up to 34 hours at 5°C nominal Accuracy 113% for LQC and 103% for HQC	Confirmed up to 34 hours at 5°C nominal Accuracy 106% for LQC and 107% for HQC
Freeze thaw stability	Confirmed up to IV cycles Accuracy 104% for LQC and 92% for HQC	Confirmed up to IV cycles Accuracy 102% for LQC and 92% for HQC	Confirmed up to IV cycles Accuracy 110% for LQC and 98% for HQC
Bench top stability	Confirmed up to 8 hours Accuracy 110% for LQC and 100% for HQC	Confirmed up to 8 hours Accuracy 112% for LQC and 98% for HQC	Confirmed up to 8 hours Accuracy 100% for LQC and 103% for HQC
Injector carryover	Not significant (0.00%)	Not significant (0.00%)	Not significant (0.00)
Co-administration drug effect	Accuracy 109% for LQC and 97% for HQC	Accuracy 108% for LQC and 98% for HQC	Accuracy 106% for LQC and 99% for HQC
Long term Stability in 80% Acetonitrile in Water (Extracted samples)	Confirmed up to 49 days at -80°C % Stability 98% for LQC and 103% for HQC	Confirmed up to 49 days at -80°C % Stability 105% for LQC and 104% for HQC	Confirmed up to 49 days at -80°C % Stability 95% for LQC and 105% for HQC
QC: Quality Control; LQC: Low Quality Control; HQC: High Quality Control; CV: Coefficient of variance			

eMethods 5. Bioanalytical Method Conditions for Homosalate, Octisalate, and Octinoxate in Skin Samples

Validation range:	5–500 ng/mL for Homosalate and Octisalate; 5–300 ng/mL for Octinoxate
High Performance Liquid Chromatography (HPLC) Instrument:	Agilent 1290 Infinity
Mass Spectrometer:	AB SCIEX 6500$^+$ Mass spectrometer

HPLC Conditions

Mobile Phase A:	0.1% Ammonium hydroxide in water
Mobile Phase B:	Methanol

Gradient Table:

Time (min)	Flow (mL/min)	A (%)	B (%)
0.0	0.7	80	20
0.2	0.7	80	20
0.3	0.7	26	74
3.2	0.7	26	74
3.5	0.7	80	20
3.8	0.7	80	20

Column:	Acquity UPLC BEH C_{18} (2.1 x 50 mm) 1.8 µm
Injection Volume:	10 µL
Autosampler Temperature:	5°C
Colum Temperature:	40 °C
Retention Time:	Homosalate: 2.90 minute Homosalate-d_4: 2.90 minute Octisalate: 2.70 minute Octisalate-d_4: 2.70 minute Octinoxate: 2.60 minute Octinoxate-d_3: 2.60 minute
Run Time:	3.8 minutes

Mass Spectrometer Conditions

Ionization Source and Scan type:	Electro Spray Ionization (ESI) Multiple Reaction Monitoring (MRM)
Polarity	Positive and negative switch
Data acquisition	Analyst 1.6.3

AB SCIEX 6500+ Q-TRAP mass spectrometer state file parameters:

Parameter	Positive mode		Negative mode			
	Octinoxate	**Octinoxate –d_3**	**Homosalate**	**Homosalate–d_4**	**Octisalate**	**Octisalate–d_4**
Q1 mass/Q3 mass (amu)	291.0/179.0	294.2/182.3	261.1/136.9	265.2/141.1	249.0/136.9	253.2/141.0
Declustering potential, V	50	25	-80	-65	-50	-75
Collision Energy (V)	12	11	-25	-25	-24	-25
Collision Cell Exit Potential (V)	11	11	-15	-14	-15	-15
Entrance potential, V	10	10	-10	-10	-10	-10
Source Temperature (^{0} C):	550	550	550	550	550	550
Ion Spray Voltage, V	5500	5500	-4500	-4500	-4500	-4500
Collision Gas (CAD)	Medium	Medium	Medium	Medium	Medium	Medium
Curtain Gas (CUR)	30	30	30	30	30	30
Ion Source Gas (GS1)	40	40	40	40	40	40
Ion Source Gas (GS2)	50	50	50	50	50	50
Dwell time (ms)	100	50	100	50	100	50

Sample Preparation: The analytes were extracted from the tapes using 80% acetonitrile in water. A 200 µL of acetonitrile containing internal standards (70 ng/mL of Homosalate –d_4, 50 ng/mL of Octisalate –d_4, and 15 ng/mL of Octinoxate –d_3) was added to 96 well autosampler loading plates and an aliquot of 30 µL of sample was added to each Well. The samples were shaken for 1 min and placed in autosampler.

Validation Summary Table for Homosalate, Octisalate and Octinoxate in Skin Samples

Description	Homosalate	Octisalate	Octinoxate
Short description of method	Tape-Stripping Technique Reverse-phase HPLC with MS/MS detection	Tape-Stripping Technique Reverse-phase HPLC with MS/MS detection	Tape-Stripping Technique Reverse-phase HPLC with MS/MS detection
Biological matrix	Skin samples	Skin samples	Skin samples
Analyte	Homosalate	Octisalate	Octinoxate
Internal standard (IS)	Homosalate–d_4	Octisalate–d_4	Octinoxate–d_3
Calibration concentrations	5.00 ng/mL to 500.00 ng/mL	5.00 ng/mL to 500.00 ng/mL	05.00 ng/mL to 300.00 ng/mL
QC concentrations	5.00 ng/mL, 15.00 ng/mL, 50.00 ng/mL, 250.00 ng/mL and 425.00 ng/mL	5.00 ng/mL, 15.00 ng/mL, 50.00 ng/mL, 250.00 ng/mL and 425.00 ng/mL	5.00 ng/mL, 15.00 ng/mL, 30.00 ng/mL, 150.00 ng/mL and 250.00 ng/mL
Selectivity	No interference observed	No interference observed	No interference observed
Specificity	No interference observed	No interference observed	No interference observed
Lower limit of quantification	5.00 ng/mL Between-run accuracy 96% Between-run precision 9% Within-run accuracy 101% Within-run precision 6%	5.00 ng/mL Between-run accuracy 99% Between-run precision 8% Within-run accuracy 103% Within-run precision 8%	5.00 ng/mL Between-run accuracy 102% Between-run precision 12% Within-run accuracy 99% Within-run precision 12%
Between-run accuracy	100% to 103%	100% to 104%	96% to 102%
Between-run precision	2% to 5%	1% to 6%	5% to 11%
Within-run accuracy	98% to 108%	99% to 109%	97% to 103%
Within-run precision	1% to 3%	1% to 2%	5% to 13%
Matrix effect (IS normalized)	LQC: 1.02 (%CV: 3) HQC: 1.00 (%CV: 1)	LQC: 1.05 (%CV: 3) HQC: 1.00 (%CV: 1)	LQC: 1.02 (%CV: 10) HQC: 0.99 (%CV: 11)
Dilution integrity	Concentration 1500.00 ng/mL Diluted 5-fold: Accuracy 98%, Precision 1% Diluted 10-fold: Accuracy 102%, Precision 1% Diluted 50-fold: Accuracy 101%, Precision 4% Diluted 100-fold: Accuracy 107%, Precision 8%	Concentration 1500.00 ng/mL Diluted 5-fold: Accuracy 96%, Precision 1% Diluted 10-fold: Accuracy 102%, Precision 1% Diluted 50-fold: Accuracy 95%, Precision 4% Diluted 100-fold: Accuracy 87%, Precision 7%	Concentration 900.00 ng/mL Diluted 5-fold: Accuracy 96%, Precision 11% Diluted 10-fold: Accuracy 93%, Precision 9% Diluted 50-fold: Accuracy 107%, Precision 6% Diluted 100-fold: Accuracy 106%, Precision 11%
Recovery of analyte	90% -92%	91% -92%	85% -94%
Recovery of IS	102%	102%	100%
Auto-sampler storage stability	Confirmed up to 41 hours at 5°C nominal Accuracy 108% for LQC and 100% for HQC	Confirmed up to 41 hours at 5°C nominal Accuracy 106% for LQC and 99% for HQC	Confirmed up to 41 hours at 5°C nominal Accuracy 99% for LQC and 97% for HQC

Description	Homosalate	Octisalate	Octinoxate
Freeze thaw stability	Confirmed up to IV cycles Accuracy 109% for LQC and 103% for HQC	Confirmed up to IV cycles Accuracy 109% for LQC and 104% for HQC	Confirmed up to IV cycles Accuracy 104% for LQC and 104% for HQC
Bench top stability	Confirmed up to 6 hours on ice water bath Accuracy 111% for LQC and 100% for HQC	Confirmed up to 6 hours on ice water bath Accuracy 109% for LQC and 102% for HQC	Confirmed up to 6 hours on ice water bath Accuracy 102% for LQC and 105% for HQC
Injector Carryover	Not significant (0.00%)	Not significant (0.00%)	Not significant (0.00)
Co-administration drug effect	Accuracy 110% for LQC and 100% for HQC	Accuracy 108% for LQC and 99% for HQC	Accuracy 90% for LQC and 98% for HQC
Long term Stability in 80% Acetonitrile in Water (Extracted Samples)	Confirmed up to 39 days at -80°C % Stability 105% for LQC and 100% for HQC	Confirmed up to 39 days at -80°C % Stability 98% for LQC and 101% for HQC	Confirmed up to 39 days at -80°C % Stability 104% for LQC and 100% for HQC
QC: Quality Control; LQC: Low Quality Control; HQC: High Quality Control; CV: Coefficient of variance			

eDictionary. Data Dictionary for Participant Data Listings

A full listing of participant data, including demographics and concentration by product and analyte at each time point are included with this study. Column names and definitions are provided below:

Variable	Definition
Participant	Participant ID
Product	Administered product. One of Lotion, Aerosol spray, Nonaerosol spray, or Pump spray
Analyte	Measured analyte. One of Avobenzone, Oxybenzone, Octocrylene, Homosalate, Octisalate, or Octinoxate
Time	Nominal sampling time (unit = hours)
Concentration	Reported concentration with BLQ values set to zero. (unit = ng/mL)
Matrix	Denotes whether the sample was from plasma or skin
Conc Units	Units for the reported 'Concentration' variable. Units are ng/mL for plasma and ng/cm^2 for skin
BLQ	Denotes samples below the limit of quantitation. Limits were 0.2 ng/mL for Avobenzone, 0.4 ng/mL for Oxybenzone, 0.4 ng/mL for Octocrylene, 0.4 ng/mL for Homosalate, 0.4 ng/mL for Octisalate, and 0.4 ng/mL for Octinoxate
Age	Age of the participant (unit = years)
Sex	Sex of the participant (one of 'Female' or 'Male')
Ethnicity	Ethnicity of the participant (one of 'Hispanic or Latino' or 'Not Hispanic or Latino')
Race	Race of the participant (one of 'Asian', 'Black or African American', or 'White')
Height	Height of the participant (unit = cm)
Weight	Weight of the participant (unit = kg)
BMI	Body mass index of the participant (unit = kg/m^2)
BSA	Body surface area of the participant (unit = m^2)
Fitzpatrick Skin Type	Fitzpatrick Skin Type (one of I, II, III, IV, V, or VI)