

UV filters in sunscreen products – a survey

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The contents of 18 permitted chemical UV filters in 75 sunscreen products have been determined to check the compliance of these products with the EU Cosmetic Directive, as well as to generate data for quantitative exposure assessments. 81% of the products were found to contain 14 of the target chemical UV filters. The remaining products contained only the physical UV-filters titanium oxide and zinc oxide, which were not determined in the present study. Maximum content (29.3%) of chemical UV filters was found in a product that contained 6 of the target UV filters. Octyl methoxycinnamate (1.4–4.7%) and butyl methoxydibenzoylmethane (0.4–4.8%) were the most frequently used UV filters, present, respectively, in 49% and 44% of the investigated products. Correlation between declared sun protection factor (SPF) and the contents of chemical UV filters in the respective products was not significant (correlation coefficient 0.5362). The content of UV filters in all products complied with the maximum allowed concentration of these according to EU Cosmetic Directive.

Key words: compliance testing; cosmetics; EU Cosmetic Directive; sun protection factor; sunscreen products; UV filters. © Blackwell Munksgaard, 2002.

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To avoid the harmful effects of ultraviolet (UV) radiation during sunbathing or cosmetic tanning using artificial tanning devices, it is recommended that sunscreen products be used. Sunscreen products contain UV filters, i.e. chemicals which absorb UV radiation (chemical UV filter) or reflect and scatter UV radiation (physical UV filter). The inorganic compounds titanium oxide and zinc oxide are commonly used as physical UV filters in sunscreen products. However, a wider range of organic compounds is used as chemical UV filters.

Besides the beneficial effects of UV filters in cosmetic products, irritant, allergic and photoallergic contact dermatitis from the regular application of sunscreen products to the skin have been reported (1–3). However, the conclusion of a recently published retrospective study was that photoallergic contact dermatitis was uncommon (4). For consumer safety from the unwanted effects of chemical UV filters in cosmetic products marketed in the European Union (EU), the content of these substances in cosmetic formulations is regulated by the EU Cosmetic Directive (5). This regulation also requires labeling of the ingredients in cosmetic products. The present study was undertaken to check the compliance of sunscreen products with the EU Cosmetic Directive and to generate data for quantitative exposure assessments of chemical UV filters currently used in sunscreen products.

Materials and Methods

Sunscreen products

75 sunscreen products, creams and lotions, from 30 cosmetic manufacturers in Europe and the USA were analyzed in the present study. 5 of the products were special formulations for application on children's skin. The products were collected from Danish retail outlets in the period May–June 2001.

Target UV filters

Of the 24 permitted chemical UV filters in cosmetic products according to EU Cosmetic Directive (5), contents of 18 UV filters (Table 1) in the sunscreen products were analyzed in the present study. All these chemicals of highest purity available were obtained either through international chemical suppliers or cosmetic manufacturers. 5 of the remaining 6 permitted UV filters could not be obtained as standard chemicals. The last UV filter, para-aminobenzoic acid (PABA), was not analyzed because it created interference in the analysis.

Analysis

A screening analysis of chemical UV filters present in the sunscreen products was performed by a pre-

Table 1. Target UV filters

UV filter	CAS Reg. No.	Maximum allowed concentration % (m/m)
benzophenone-3	131-57-7	10
benzophenone-4	4065-45-6	5
benzylidene camphor	56039-58-8	6
3-benzylidene camphor	15087-24-8	2
butyl methoxydibenzoylmethane	70356-09-1	5
camphor benzalkonium methosulfate	52793-97-2	6
drometrizole trisiloxane	155633-54-8	15
homosalate	118-56-9	10
isoamyl p-methoxycinnamate	71617-10-2	10
4-methylbenzylidene camphor	36861-47-9	4
octocrylene	6197-30-4	10 (as free acid)
octyl dimethyl PABA	21245-02-3	8
octyl methoxycinnamate	5466-77-3	10
octyl salicylate	118-60-5	5
octyl triazone	88122-99-0	5
PEG-25 PABA	116242-27-4	10
phenylbenzimidazole sulfonic acid and ts salts with potassium, sodium and triethanolamine	27503-81-7	8 (as free acid)
terephthalylidene dicamphor sulfonic acid and its salts	90457-82-2	10 (as free acid)

Table 2. Content of UV-filters in the investigated products

UV-filter	Products containing the UV-filter		Content percentage (m/m)		
	n	%	Range	Mean	Median
benzophenone – 3	14	18.7	0.010–5.256	2.715	2.433
butyl methoxydibenzoylmethane	33	44.0	0.415–4.806	1.654	1.349
drometrizole trisiloxane*	12	16.0	0.075–7.409	1.506	0.822
homosalate	3	4.0	3.721–6.118	5.116	5.510
isoamyl p-methoxycinnamate	4	5.3	2.637–4.105	5.387	5.373
4-methylbenzylidene camphor	17	22.7	0.916–5.735	2.958	3.285
octocrylene	17	22.7	1.248–10.359	7.706	9.223
octyl dimethyl PABA	1	1.3	2.661	–	–
octyl methoxycinnamate	37	49.3	0.014–9.078	5.367	5.831
octyl salicylate	8	10.7	1.350–4.709	3.371	3.458
octyl triazone	3	4.0	0.897–1.390	1.226	1.390
PEG-25 PABA	1	1.3	0.343	–	–
phenylbenzimidazole sulfonic acid and ts salts with potassium, sodium and triethanolamine	2	2.7	1.429, 2.488	–	–
terephthalylidene dicamphor sulfonic acid and its salts	16	21.3	0.020–3.788	1.625	1.198

*This compound could not be determined in one of the products due to interference.

viously described method (6). Quantification of the identified filters in the products was performed by high performance liquid chromatography (HPLC) employing a slightly modified method that has been proposed as an EU standard method for the analysis of UV filters in cosmetic products (7).

Results

The chemical UV filters in the sunscreen products were identified by HPLC with diode array detection, where HPLC retention time (RT) as well as UV spectrum of unknowns (chromatographic peaks) was matched with the RT and UV spectrum of known compounds (6). The identification of

chemical filters was further confirmed while quantifying these substances by another HPLC method (7). The recoveries of the UV filters from the samples spiked with standard compounds were 96–103% for all UV filters analyzed. The detection limits of the investigated UV filters were 0.002–0.010%, and the relative standard deviation of the determination was < 10% for all of the UV filters.

None of the target UV filters was found in 14 (19%) of the investigated sunscreen products. The remaining products (81%) were found to contain 14 of the 18 target UV filters (Table 2). Octyl methoxycinnamate (0.01–9.0%) and butyl methoxydibenzoylmethane (0.4–4.8%) were the most frequently used UV filters in the sunscreen formu-

Table 3. Content of chemical UV filters in two sunscreen products with SPF 60 and 30

Product SPF	UVF filter	Content % m/m
60	butyl methoxydibenzoylmethane	1.35
	drometrizole trisiloxane	1.12
	octocrylene	10.29
	terephthalylidene dicamphor sulfonic acid	3.78
30	benzophenone -3	4.76
	butyl methoxydibenzoylmethane	4.81
	homosalate	5.51
	octocrylene	1.25
	octyl methoxycinnamate	8.31
	octyl salicylate	4.71

Table 4. Content of chemical UV filters in 5 sunscreen products for children (one of the products did not contain any of the target UV filters)

UV filter	No. of products	Concentration % (m/m)
butyl methoxydibenzoylmethane	3	1.77–1.79
4-methylbenzylidene camphor	4	3.29–4.09
octocrylene	1	6.21
octyl methoxycinnamate	1	4.96
octyl triazone	1	1.39
terephthalylidene dicamphor sulfonic acid	1	1.24

lations investigated, found in 49% and 44%, respectively, of all products investigated. Octyl dimethyl PABA (2.6%) and PEG-25 PABA (0.3%) were present in 1 product each, phenylbenzimidazole sulfonic acid (1.4% and 2.5%) was present in 2 of the products, homosalate (3.7–6.1%) and octyl triazone (0.9–1.4%) were found in 3 products each, and 4 of the products contained isoamyl p-methoxycinnamate (2.6–4.1%). Other identified target UV filters were present in 10–23% of the products (Table 2). It was further noted that the total content of chemical UV filters in 22 (29%) products was 11–29%. As described before, the products were not analyzed for the content of PABA. 3 of the products were labeled as containing PABA.

Discussion

The EU list of permitted UV-filters in cosmetic products has been updated regularly in the last 2 decades. Although some of the permitted UV filters have remained on the current list (Annex VII of the EU Cosmetic Directive), several new UV filters have been added to the list. Thus, the UV filter exposure of the European population has been changing over the years. Current knowledge of exposure is relevant to quantitative risk assessments. The present study provides up-to-date

knowledge for exposure assessments of consumers to UV filters.

Of the 18 target UV filters, 14 were identified in 81% of the investigated products. The presence of PABA was labeled in 3 of the products. Of all the sunscreen products investigated, a relatively high content (11–29%) of chemical UV filters was found in 29% of them. A rather high content of chemical UV filters in products for regular use may be of some concern.

Target UV filters were not found in 19% of the investigated products. All these products were labeled as containing physical UV filters titanium oxide and/or zinc oxide. The physical UV filters were not analyzed in the present investigation. The presence of titanium oxide was labeled in 46 (61%) products and zinc oxide in 18 (24%) products. Both titanium oxide and zinc oxide were present in 8 (11%) of the investigated products. Thus, it seems that sunscreen products can solely be formulated with physical UV filters. However, it may be interesting to know whether such products can provide sufficient protection from solar radiation (similar to that from products containing chemical UV filters), because the physical UV filters, being micro particles, may not cover the skin completely.

The sun protection factor (SPF) labeled on the investigated products was 2–60. No correlation was found between the declared SPF and the contents of chemical UV filters in the products (correlation coefficient 0.5362). For example, a product containing 6 different chemical UV filters (total content 29.3%) was labeled SPF 30 and another product containing 4 different UV filters (total content 16.6%) was labeled SPF 60 (Table 3). Clearly, the type and amount of physical UV filter (s) together with the content of chemical UV filter (s) in a product are responsible for the measured SPF. The SPF of the products was not determined in the present study.

In recent years, special attention has been paid to children's health from consumer products. The sunscreen products investigated in the present study included 5 products specially formulated for children. The content of chemical UV filters in these products is described in Table 4. One of the products did not contain any of the target UV filters, 4 products contained 4-methylbenzylidene camphor, 3 products contained butyl methoxydibenzoylmethane; and octocrylene, octyl methoxycinnamate, octyl triazone and terephthalylidene dicamphor sulfonic acid was present in 1 product each.

The contents of all of the UV filters in the sunscreen products were within the maximum allowed concentration of these substances according to EU Directive. Labeling of UV filters on 2 of

the products did not conform to the UV filter content in these products. The manufacturers of these products corrected the labeling when informed.

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