

Reactivity to sorbitan sesquioleate affects reactivity to fragrance mix I

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Summary

Background. Fragrance mix I (FM I) and its single constituents contain 5% and 1% sorbitan sesquioleate (SSO), respectively. SSO is a rare sensitizer and a potential irritant.

Objectives. To determine whether the outcome of the FM I breakdown test is affected by positive patch test reactivity to SSO.

Methods. A retrospective analysis of data from the Information Network of Departments of Dermatology, 1998–2013, was performed.

Results. The full FM I breakdown test including SSO was tested in 2952 patients. Of these, 154 (5.2%) had a positive patch test reaction to SSO 20% pet. and 2709 (91.8%) had a negative patch test reaction. Positive reactions to one or more of the single fragrances contained in the mix were significantly more common (82.5% versus 57.3%) in SSO-positive patients, who also had more multiple reactions than FM I-positive patients with negative SSO reactions (61.5% versus 21.3% patients with reactions to two or more fragrances).

Conclusions. Our results indicate that reactivity to SSO markedly affects the outcome of patch testing with FM I and its single constituents. SSO must be an obligatory part of the full FM I breakdown test, and should ideally be included in the baseline series.

Key words: fragrance allergy; fragrance mix; patch testing; sorbitan sesquioleate.

Fragrance mix I (FM I), which is used for screening for contact sensitization to fragrances and, in particular, to its eight ingredients, is included in almost all patch test baseline series throughout the world (1–3). FM I was developed in the late 1970s, based on the work of Larsen (4, 5). The qualitative composition of FM I has been unchanged since its introduction. It consists of amyl

cinnamal, cinnamal, cinnamyl alcohol, eugenol, geraniol, hydroxycitronellal, isoeugenol, and oakmoss absolute (*Evernia prunastri*), all at a concentration of 1% since 1984. During the 1990s, 5% sorbitan sesquioleate (SSO) was added as an emulsifier in order to ensure a stable, homogeneous distribution of the fragrance compounds in the petrolatum vehicle (5, 6). Test preparations of the single fragrance components, which are used to identify the responsible allergens in cases of positive reactions to FM I, also contain SSO, however at 1% (6).

SSO has been described as a relevant contact allergen in cosmetics and body care products, medical products, and corticosteroid ointments (7–12). Patch testing with SSO is mostly performed at 20% in pet. With this test preparation, 0.5–0.7% positive reactions were observed in > 5500 consecutive eczema patients in Finland in 1979–1987 (13, 14). Irritant reactions were observed in 0.3% (13). A repeated open application test (ROAT) with SSO 20% pet. gave positive results in 5 of 5 patients

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with positive patch test reactions to SSO 20% pet., and in 3 of 4 patients with doubtful patch test reactions to SSO 20% pet. (15). When patch tested as part of an ointment base series in 1872 patients in the Information Network of Departments of Dermatology (IVDK) in 1990–1991, SSO 20% pet. elicited 7 (0.4%) positive reactions, 44 (2.4%) doubtful reactions, and 3 (0.2%) irritant reactions (16). In a recent report from the Tuft Medical Center, Boston, MA, USA, positive reactions to SSO 20% pet. were observed in 23 of 591 (3.9%) consecutive dermatitis patients tested in 2008–2010; the frequency of doubtful or irritant reactions was not reported (17). In the same clinic, positive reactions to SSO 20% pet. were observed in 12 of 112 patients (10.7%) patch tested with a cosmetic series in 2006–2007 (9). There is only one report of a larger group of patients patch tested with SSO at a lower test concentration (SSO 2%). In this study, 5 of 340 (1.5%) leg ulcer patients had positive reactions to SSO 2% pet. (17).

Considering these reports, it can be expected, and it is in fact well known, that the presence of SSO in fragrance patch test preparations affects the patch test outcome. In the original European Environmental and Contact Dermatitis Research Group (EECDRG) study on this subject, 5 of 709 (0.7%) patients patch tested with FM I and its constituents reacted positively to SSO 20% pet., and 2 patients (0.3%) showed doubtful or irritant reactions (6). Among those reacting to SSO, the frequencies of both positive and doubtful or irritant reactions to single mix constituents were increased. Therefore, the authors stated that SSO should be added to the European baseline series (6), but this has not yet been done (18). Against this background, we analysed data of the IVDK in order to describe the impact of positive SSO reactivity on patch test reactions to FM I and its single components.

Materials and Methods

The retrospective data analysis is based on IVDK data from 1998 to 2013. The IVDK is a network of departments of dermatology in Germany, Switzerland, and Austria, dedicated to the epidemiology of contact allergy; its objectives, methods, quality control and routine procedures are described elsewhere (19, 20). All IVDK members are also members of the German Contact Dermatitis Research Group (Deutsche Kontaktallergie-Gruppe; DKG).

Patch tests are performed according to international and DKG guidelines (21, 22). Positive reactions are graded as follows: erythema, infiltration and possibly papules (+), plus vesicles (++), and plus coalescing vesicles (+++). For the present data analysis, patch test reactions at day 3 were evaluated. In a few cases, when no reading could be

performed on day 3, but reading was performed on day 4 instead, this reading was selected.

The patch test preparations mentioned in this article were purchased from Almirall Hermal (Reinbek, Germany). As mentioned above, FM I (8% pet.) contains SSO at 5%. Test preparations of its single fragrance components (1% pet.) from this manufacturer contain 1% SSO. SSO was patch tested at 20% in pet.

Statistical analysis was performed according to published standards (23, 24), and data management was performed with SASTM (SAS 9.4; SAS Institute, Cary, NC, USA).

Results

During the study period (1998–2013), FM I was patch tested as part of the DKG baseline series in 141 372 patients, of whom 13 074 (9.25%) reacted positively. The breakdown test, that is, patch testing with the single mix components, is usually performed either if fragrance allergy is suspected from the patient's history from the start, or if the mix is positive in a second patch testing round. As part of a temporary special surveillance project, the FM I components were patch tested in parallel with the baseline series, irrespective of the patients' histories and the outcome of the FM I patch tests, in 7460 consecutive patients in 21 participating centres from August 2008 to September 2011. Of these, 643 patients reacted positively to FM I. Data of these patients were excluded from the present analysis, because the different selection criterion may have affected the analysis. All of the FM I components, including SSO, were not patch tested in all of the remaining 12 431 patients who reacted to the mix, but in 2952 patients (23.7%) only. In most cases, the reason for not performing the breakdown test was lack of compliance, because many patients do not want to return at least three more times to the clinic after a positive FM I reaction. Reactions to SSO 20% pet. are shown in Table 1. As can be seen from Table 1, 154 patients (5.2%) reacted positively to both FM I and SSO. The frequency of positive reactions to SSO differed to some extent among the 55 departments of dermatology contributing to this data analysis. The number of patients contributed by each centre ranged from 1 to 268. The percentages of positive reactions observed in each centre ranged from 0% to 21.4%, with a lower limit of 0 of 74 patients (0%; 95%CI: 0–4%), and an upper limit of 3 of 14 patients (21.4%; 95%CI: 4.7–50.8%). Concomitant reactivity to FM I and SSO, dichotomized into + and ++/+++ reactions, is shown in Table 2. There was some association between strong/extreme positive reactions in this analysis (odds ratio 3.7, 95%CI: 1.8–7.5); however, significantly more patients had a strong/extreme positive reaction to

Table 1. Reactions to sorbitan sesquioleate 20% pet. in 2952 patients with positive reactions to fragrance mix I

Reaction	n	%
Negative	2709	91.8
?	78	2.6
+	104	3.5
++	44	1.5
+++	6	0.2
Irritant	11	0.4
Total	2952	100.0

Table 2. Concomitant reactivity to sorbitan sesquioleate 20% pet. (SSO) and fragrance mix I (FM I) in 154 patients reacting positively to both

		FM I		Total
		+	++/+++	
SSO	+	68	36	104
	++/+++	17	33	50
	Total	85	69	154

FM I but not to SSO than vice versa ($p = 0.01$, McNemar test).

Of the 2952 patients reacting to FM I who underwent the full breakdown test including SSO, who constitute the clinical sample analysed further, 58.3% reacted to at least one of the eight fragrances contained in the mix, whereas 41.7% showed no reaction to any of these fragrances. With increasing strength of reaction to FM I, the proportion of patients reacting to at least one fragrance increased. The corresponding percentages were 45.9% in patients with a weak positive reaction (+), 74.4% in patients with a ++ reaction to FM I, and 90.6% in patients with a +++ reaction, as can be concluded from Table 3. As can also be seen in Table 3, the proportion of patients reacting to more than one fragrance also increased with the strength of the FM I reaction.

Tables 4 and 5 show the corresponding data from FM I-positive patients with positive reactions to SSO ($n = 154$; Table 4) and those with negative reactions to SSO ($n = 2709$; Table 5); patients with doubtful or irritant reactions to SSO were excluded from these two analyses. Of the patients reacting to FM I and SSO, 82.5% reacted to at least one of the fragrance preparations, whereas this proportion was only 57.3% in SSO-negative patients reacting to FM I. In addition, the proportions of patients with +, ++ or +++ reactions, respectively, to FM I who reacted to at least one single constituent were in a much narrower range among the SSO-positive patients (81.2–87.5%) than among the SSO-negative

patients (44.3–91.0%). Furthermore, it can be seen from Tables 4 and 5 that, among SSO-positive patients, there were significantly more patients with positive reactions to two or more fragrance test preparations (61.7% versus 21.3%; χ^2 -test, $p < 0.0001$).

Table 6 shows the patch test results in patients reacting to FM I and SSO, which are shown in Table 4, from a different perspective: in contrast to Table 4, patients reacting to FM I are subdivided according to their reaction to SSO in Table 6 (and not according to their reaction to FM I, as in Table 4). The percentage of patients reacting to one or more of the fragrances contained in FM I did not differ significantly between those patients with a weak positive (+) reaction to SSO (41/50, 82.0%) and those with a strong positive (++ or +++) reaction to SSO (86/104, 82.7%). However, the number of positive reactions was significantly higher in the subgroup with strong/extreme positive reactions to SSO ($p = 0.03$, Wilcoxon test), and, among those with strong positive reactions to SSO, there were significantly more patients with positive reactions to all of the eight FM I fragrances than among those with weak positive reactions to SSO [18/50 (36.0%) versus 17/104 (16.3%); χ^2 -test, $p < 0.006$].

The results of the breakdown tests, that is, the percentages of positive reactions to each single fragrance component of FM I in patients with positive reactions to FM I, are shown in Table 7. Again, the results are shown separately for the whole study group and for patients with positive and negative reactions to SSO, respectively. From the rightmost column (FM I-positive patients with negative reactions to SSO), it can be seen that oakmoss absolute was the most frequent fragrance allergen of FM I (27.4%), followed by isoeugenol (19.0%), hydroxycitronellal (10.8%), cinnamal (10.6%), cinnamyl alcohol (8.5%), eugenol (7.3%), geraniol (5.2%), and amyl cinnamal (1.5%). Among SSO-positive patients (middle column), the corresponding percentages were much higher, ranging from 67.5% for oakmoss absolute to 34.4% for amyl cinnamal. Differences in the frequencies of positive reactions to the single fragrances were much smaller among SSO-positive patients. Here, the most frequently positive fragrance preparation elicited approximately twice as many positive reactions than the least frequently positive one (67.5% versus 34.4%), whereas, among SSO-negative patients, this factor was ~ 18 (27.4% versus 1.5%).

Discussion

Our data provide evidence that reactivity to SSO markedly affects the outcome of patch testing with FM I and its single constituents, which was to be expected after corresponding investigations in much smaller groups of FM

Table 3. Percentages (with 95% CIs) of patients with positive reactions to fragrance mix I who reacted to none, one, two or more fragrance mix I components in the breakdown test, independently of their reaction to sorbitan sesquileate

Number of single fragrance mix I components that gave positive reactions	Reaction to fragrance mix I and patient count			
	+	++	+++	+, ++, or +++
	n = 1812	n = 875	n = 265	n = 2952
0	54.1 (51.8–56.4)	25.6 (22.7–28.6)	9.4 (6.2–13.6)	41.7 (39.9–43.5)
1	32.3 (30.1–34.5)	41.5 (38.2–44.8)	31.7 (26.1–37.7)	35.0 (33.2–36.7)
2	9.0 (7.7–10.4)	20.1 (17.5–22.9)	27.5 (22.3–33.3)	14.0 (12.7–15.3)
3	2.0 (1.4–2.7)	5.5 (4.1–7.2)	15.8 (11.7–20.8)	4.3 (3.6–5.1)
4	1.0 (0.6–1.6)	3.5 (2.4–5.0)	9.4 (6.2–13.6)	2.5 (2.0–3.1)
5	0.2 (0.0–0.5)	0.9 (0.4–1.8)	2.3 (0.8–4.9)	0.6 (0.3–0.9)
6	0.3 (0.1–0.7)	0.5 (0.1–1.2)	1.9 (0.6–4.3)	0.5 (0.3–0.8)
7	0.3 (0.1–0.6)	0.3 (0.1–1.0)	0.4 (0.0–2.1)	0.3 (0.1–0.6)
8	0.8 (0.5–1.4)	2.1 (1.2–3.2)	1.5 (0.4–3.8)	1.3 (0.9–1.7)

Table 4. Percentages (with 95% CIs) of patients with positive reactions to fragrance mix I and positive reactions to sorbitan sesquileate who reacted to none, one, two or more fragrance mix I components in the breakdown test

Number of single fragrance mix I components that gave positive reactions	Reaction to fragrance mix I and patient count			
	+	++	+++	+, ++, or +++
	n = 85	n = 53	n = 16	n = 154
0	18.8 (11.1–28.8)	17.0 (8.1–29.8)	12.5 (1.6–38.3)	17.5 (11.9–24.5)
1	28.2 (19.0–39.0)	9.4 (3.1–20.7)	18.8 (4.0–45.6)	20.8 (14.7–28.0)
2	14.1 (7.5–23.4)	13.2 (5.5–25.3)	25.0 (7.3–52.4)	14.9 (9.7–21.6)
3	2.4 (0.3–8.2)	0.0 (0.0–5.5)	6.3 (0.2–30.2)	1.9 (0.4–5.6)
4	7.1 (2.6–14.7)	13.2 (5.5–25.3)	12.5 (1.6–38.3)	9.7 (5.6–15.6)
5	2.4 (0.3–8.2)	3.8 (0.5–13.0)	0.0 (0.0–17.1)	2.6 (0.7–6.5)
6	3.5 (0.7–10.0)	5.7 (1.2–15.7)	0.0 (0.0–17.1)	3.9 (1.4–8.3)
7	5.9 (1.9–13.2)	5.7 (1.2–15.7)	6.3 (0.2–30.2)	5.8 (2.7–10.8)
8	17.6 (10.2–27.4)	32.1 (20.0–46.3)	18.8 (4.0–45.6)	22.7 (16.4–30.2)

I-positive patients in the 1990s (6, 25). According to our data, patients with positive patch test reactions to SSO far more often also react to one or more of the single fragrances contained in the mix (82.5% versus 57.3%), and have far more multiple reactions in the breakdown test than patients with negative SSO reactions (61.7% versus

21.3% patients with reactions to two or more fragrances). Owing to confounding by SSO reactivity, the well-known differences in frequencies of reactions to single fragrances are drastically reduced (albeit at a markedly increased level). Because the fragrance mix contains 5% SSO, and the single fragrance patch test preparations contain 1%

Table 5. Percentages (with 95% CIs) of patients with positive reactions to fragrance mix I and negative reactions to sorbitan sesquileate who reacted to none, one, two or more fragrance mix I components in the breakdown test

Number of single fragrance mix I components that gave positive reactions	Reaction to fragrance mix I and patient count			
	+	++	+++	+, ++, or +++
	n = 1661	n = 803	n = 245	n = 2709
0	55.7 (53.3–58.2)	26.0 (23.0–29.2)	9.0 (5.7–13.3)	42.7 (40.8–44.6)
1	32.8 (30.5–35.1)	43.6 (40.1–47.1)	32.7 (26.8–38.9)	36.0 (34.1–37.8)
2	8.8 (7.5–10.3)	20.5 (17.8–23.5)	28.2 (22.6–34.2)	14.0 (12.7–15.4)
3	1.9 (1.3–2.6)	6.0 (4.4–7.8)	16.3 (11.9–21.6)	4.4 (3.7–5.2)
4	0.6 (0.3–1.1)	2.9 (1.8–4.3)	9.4 (6.0–13.8)	2.1 (1.6–2.7)
5	0.1 (0.0–0.3)	0.7 (0.3–1.6)	2.0 (0.7–4.7)	0.4 (0.2–0.8)
6	0.2 (0.0–0.5)	0.1 (0.0–0.7)	2.0 (0.7–4.7)	0.3 (0.2–0.6)
7	0.0 (0.0–0.2)	0.0 (0.0–0.4)	0.0 (0.0–1.2)	0.0 (0.0–0.1)
8	0.0 (0.0–0.2)	0.1 (0.0–0.7)	0.4 (0.0–2.3)	0.1 (0.0–0.3)

Table 6. Percentages (with 95% CIs) of patients with positive reactions (+, ++, or +++) to fragrance mix I and positive reactions to sorbitan sesquileate (SSO) who reacted to none, one, two or more fragrance mix I components in the breakdown test

Number of single fragrance mix I components that gave positive reactions	Reaction to SSO and patient count		
	+	++/+++	+, ++, or +++
	n = 104	n = 50	n = 154
0	17.3 (10.6–26.0)	18.0 (8.6–31.4)	17.5 (11.9–24.5)
1	25.0 (17.0–34.4)	12.0 (4.5–24.3)	20.8 (14.7–28.0)
2	17.3 (10.6–26.0)	10.0 (3.3–21.8)	14.9 (9.7–21.6)
3	2.9 (0.6–8.2)	0.0 (0.0–5.8)	1.9 (0.4–5.6)
4	8.7 (4.0–15.8)	12.0 (4.5–24.3)	9.7 (5.6–15.6)
5	1.9 (0.2–6.8)	4.0 (0.5–13.7)	2.6 (0.7–6.5)
6	4.8 (1.6–10.9)	2.0 (0.1–10.6)	3.9 (1.4–8.3)
7	5.8 (2.1–12.1)	6.0 (1.3–16.5)	5.8 (2.7–10.8)
8	16.3 (9.8–24.9)	36.0 (22.9–50.8)	22.7 (16.4–30.2)

SSO, the most probable explanation for this phenomenon is contact sensitization to SSO. Irritant reactions to SSO are theoretically possible, and may contribute to the observed association to some extent. However, one would expect irritant reactions to SSO to occur preferentially with higher test concentrations, for example the 20%

pet. concentration as used when patch testing with SSO, which may have led to some false-positive reactions. In only a few patients reacting to SSO was clinical relevance documented. Hence, the source of sensitization remains unclear. Patients who were patch tested for the second or third time did not show a significantly higher frequency of

Table 7. Percentages (with 95% CIs) of positive reactions to components of fragrance mix I in patients with positive reactions to fragrance mix I (FM I)

Fragrance	Subgroup of patients		
	FM I-positive; any reaction to SSO; n = 2952	FM I-positive; positive reaction to SSO; n = 154	FM I-positive; negative reaction to SSO; n = 2709
Oakmoss absolute (<i>Evernia prunastri</i>)	29.3 (27.7–31.0)	67.5 (59.5–74.8)	27.4 (25.8–29.1)
Isoeugenol	20.4 (19.0–21.9)	51.3 (43.1–59.4)	19.0 (17.5–20.5)
Hydroxycitronellal	12.6 (11.5–13.9)	42.9 (34.9–51.1)	10.8 (9.7–12.0)
Cinnamal	12.2 (11.0–13.4)	41.6 (33.7–49.8)	10.6 (9.5–11.9)
Cinnamyl alcohol	10.0 (9.0–11.2)	39.6 (31.8–47.8)	8.5 (7.5–9.6)
Eugenol	9.0 (8.0–10.1)	41.6 (33.7–49.8)	7.3 (6.3–8.3)
Geraniol	7.0 (6.1–8.0)	35.7 (28.2–43.8)	5.2 (4.4–6.1)
Amyl cinnamal	3.3 (2.6–4.0)	34.4 (27.0–42.5)	1.5 (1.1–2.0)

SSO, sorbitan sesquileate.

All fragrance allergens were patch tested at 1% pet.

positive reactions to SSO than those patients patch tested for the first time (data not shown in detail). Therefore, active sensitization to SSO by patch testing seems unlikely.

Although the proportion of SSO-positive patients was only 5.2% in our selected study population, this affected the outcome of patch testing with FM I, as can be seen by comparing the data in Tables 3 and 5, and in the left-most and the rightmost columns of Table 7. These data illustrate the differences between the total study population and the 91.8% without SSO reactions. In particular, the proportions of patients with multiple fragrance reactions and of patients reacting to rarer fragrance allergens are overestimated if SSO reactivity is not taken into account.

In 41.7% of all patients reacting to FM I, no reactions to any of its fragrance constituents could be found (Table 3). Among patients with weak positive reactions to FM I (+ only), this percentage was 54.1%. Reported frequencies of negative breakdown test results in patients reacting to FM I range from 46% to 57% (26–28), which is in line with our data. However, no study has hitherto analysed this proportion according to the strength of reaction to FM I. In our recent publication on changes in the results of the FM I breakdown test in the years 1998–2013 (29), we discussed three possible explanations, in accordance with the literature (27, 30):

- 1 Many of the weak positive reactions (+) to FM I are false-positive, that is, irritant reactions, owing to the

comparably high overall allergen concentration of 8% plus 5% SSO, whereas patch testing of its constituents at only 1% does not elicit such reactions.

- 2 A weak positive reaction to FM I, without a positive reaction to any of the single fragrances (at 1% pet.), indicates a low-grade sensitization. However, co-exposure to other fragrance materials lowers the elicitation threshold in these patients, so that a visible reaction occurs. It has been shown that combined fragrance exposure enhances both induction and elicitation responses (31, 32). In the present setting, it could be hypothesized that mutual augmentation of the elicitation response of/by SSO and the fragrance(s) could have occurred in patients with SSO sensitization. However, without verification, for example by ROAT, such a hypothesis remains entirely speculative.
- 3 The patch test concentration of some of the single fragrances is too low, leading to false-negative test reactions. In his original study on perfume dermatitis, Larsen tested isoeugenol at 2%, hydroxycitronellal at 4% and 5%, eugenol at 2% and 5%, cinnamal at 1%, cinnamyl alcohol at 4% and 5%, and amyl cinnamal at 2% in pet. (4). In 1993, de Groot et al. proposed patch testing with the FM I ingredients at 5%, except for cinnamal, for which they recommended 2%, owing to its irritancy (33). In view of the present knowledge about the potent sensitizers in oakmoss (34, 35), lowering its current

patch test concentration of 1% could be considered, because of the suspected risk of active sensitization by patch testing (36). However, for several other FM I fragrance compounds, it could be true that 1% is too low a test concentration, particularly for amyl cinnamal, which is tested at one-tenth of the hexyl cinnamal concentration. For geraniol, Hagvall et al. showed that even 11% could be a suitable patch test concentration (37). Remarkably, in one of the first studies on patch testing with FM I at 8%, EECDRG members found negative breakdown test results in only 25 of 78 FM I-positive patients (32%) (38). They had used test concentrations of 2% and 5% for several of the mix components. Hence, the patch test concentration of 1% used currently (in the Hermal material) for all of the eight single FM I constituents should be reconsidered. An increase could also be based on (i) the notion that lower induction doses lead to a higher elicitation threshold – and, with this, a higher patch test concentration necessary for elicitation – and (ii) the (non-binding) International Fragrance Association standards, for example for isoeugenol, having led to such a putatively lower induction level in the population in the last couple of years.

Somewhat independently of the present topic, a recent study from St John's, London has shown, by patch testing consecutive patients both with FM I and with all of its single constituents (at double concentration, except for cinnamal), that false-negative reactions to FM I seem to occur quite frequently, and, moreover, that an increase in the patch test concentration of the single fragrances will not substantially diminish the proportion of patients reacting positively to FM I and negatively to all single constituents (39). However, the authors did not take reactivity to SSO into consideration.

Conclusions

A (weak) positive patch test reaction to FM I does not always indicate sensitization to one of the single constituents of FM I. As one explanation for false-positive FM I reactions, patients with contact allergy to SSO may react positively to FM I and its components without being fragrance-allergic. Therefore, we can only agree with, and repeat, the following two requirements, which were proposed by Frosch et al. (members of the EECRDG) (6) in 1995 and by Orton and Shaw in 2001 (40): (i) it is mandatory to patch test with SSO as part of the FM I breakdown test; and (ii) ideally, SSO should be included in the baseline series, because it helps in interpreting FM I reactions (41), and SSO sensitization is possibly not as rare

as it seemed (8). Additionally, one has to be aware that the test concentrations of most of the single FM I constituents are probably too low.

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