Managing PMT/vPvM substances in consumer products through the concepts of essential-use and functional substitution

A case study for cosmetic products

Joanke van Dijk, Romain Figuière, Stefan C. Dekker, Annemarie P. van Wezel, Ian Cousins

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The essential-use concept: a new approach to manage hazardous chemicals?

«controlled substance should qualify as "essential" only if:

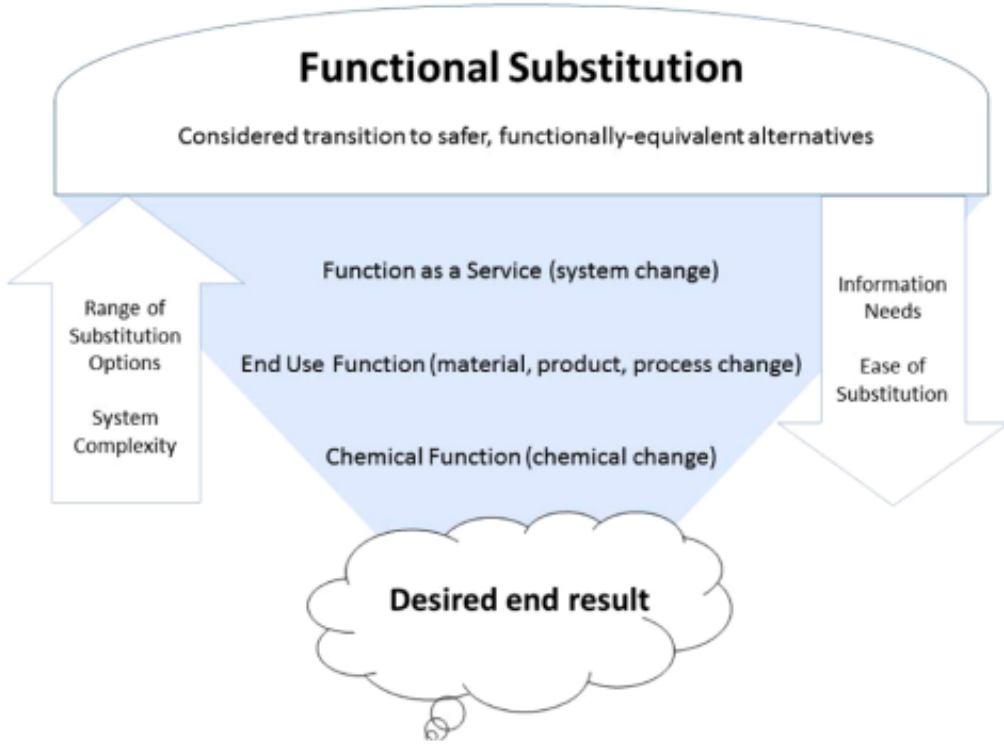
(1) it is necessary for the health, safety or is critical for the functioning of society (encompassing cultural and intellectual aspects); and

(2) there are no available technically and economically feasible alternatives or substitutes that are acceptable from the standpoint of environment and health»

Montreal Protocol, 1987

Functional substitution: a new approach to chemical alternative assessment?

- Alternatives assessment focused on the function provided by the chemical of concern
- Simultaneous consideration of chemical function, end-use function and function as a service



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Advancing Safer Alternatives Through Functional Substitution

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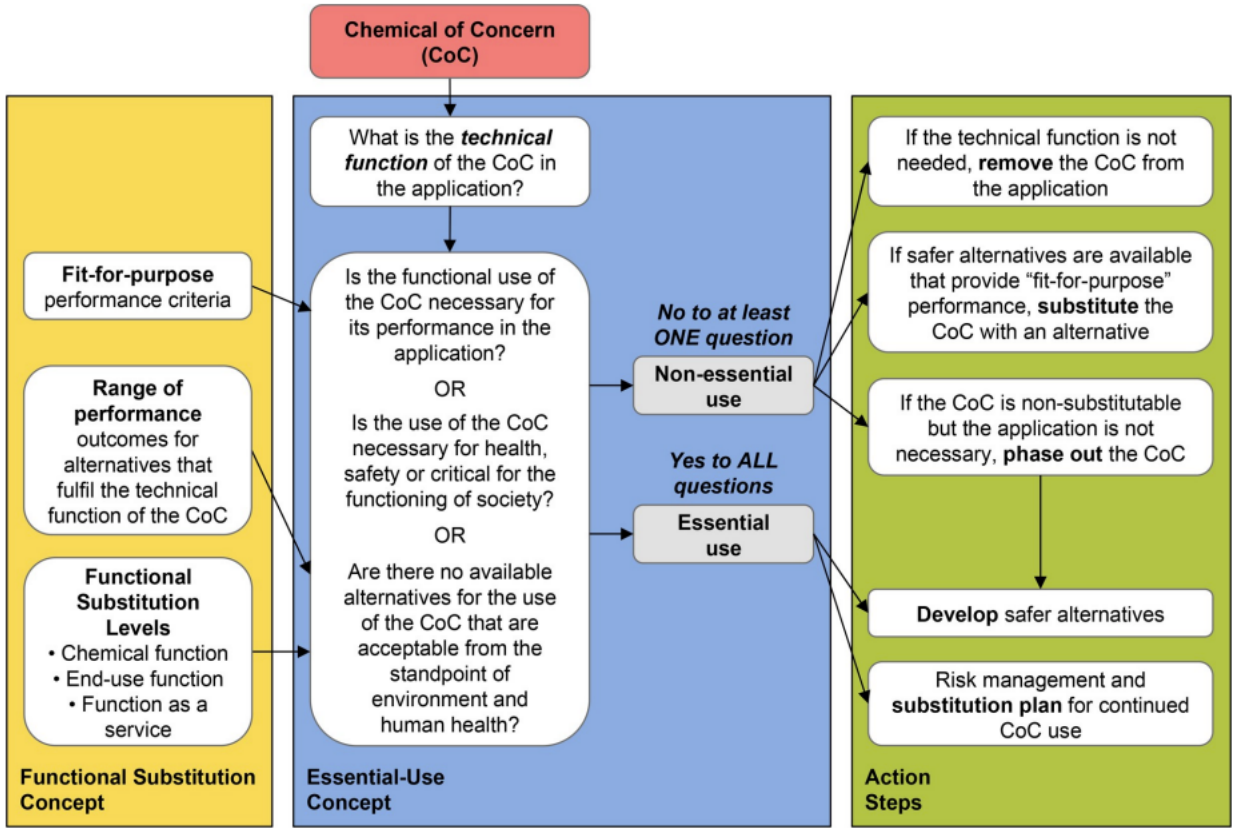
Source: Tickner et al. (2015)

The combination of the essential-use and functional substitution concepts



Source: Roy et al. (2022)

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Combined Application of the Essential-Use and Functional Substitution Concepts: Accelerating Safer Alternatives

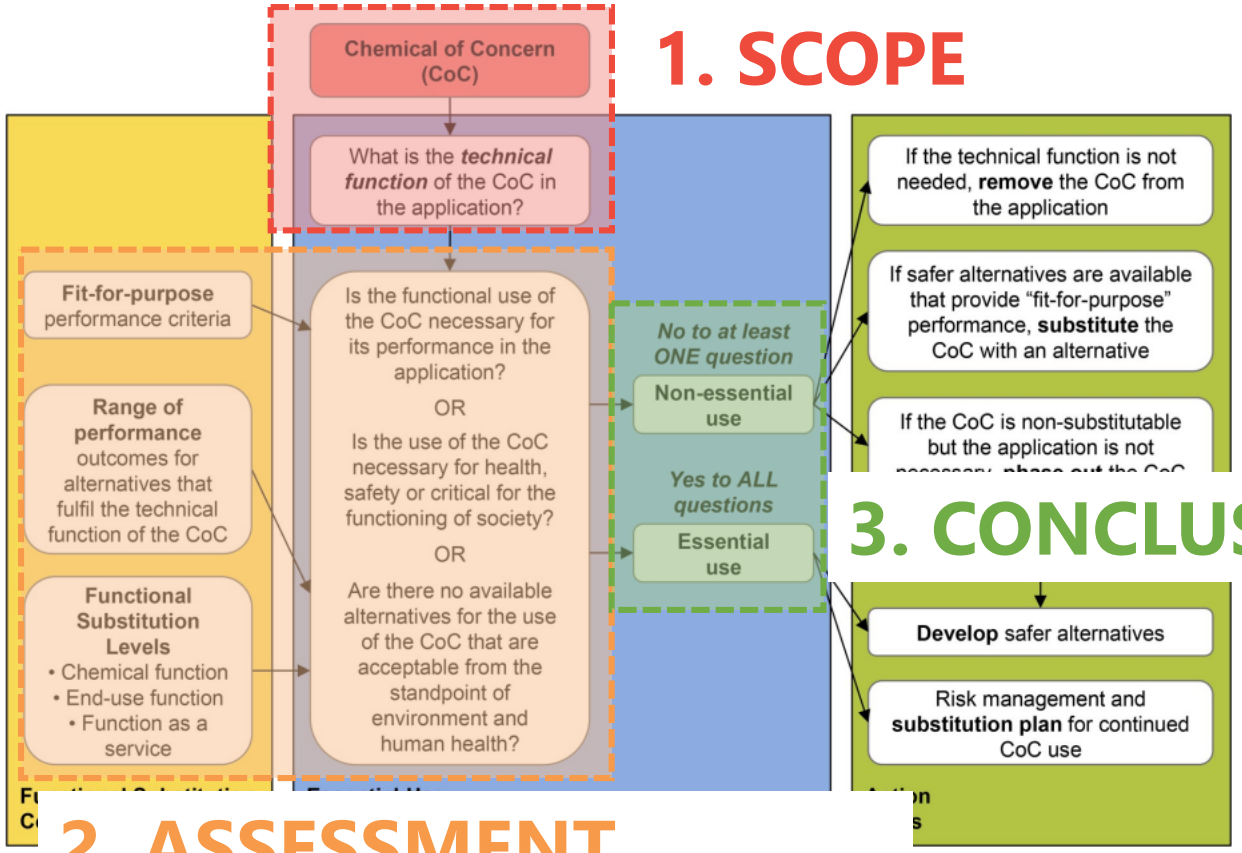
Monika A. Roy, Ian Cousins, Elizabeth Harriman, Martin Scheringer, Joel A. Tickner,* and Zhanyun Wang

Objectives of the project

- Explore the potential of essential-use and functional substitution concepts to phase-out PMT/vPvM substances
- Case study for cosmetic products

Source: Unsplah

Overview of the method



1. SCOPE

2. ASSESSMENT

3. CONCLUSION

Source: Roy et al. (2022)

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Combined Application of the Essential-Use and Functional Substitution Concepts: Accelerating Safer Alternatives

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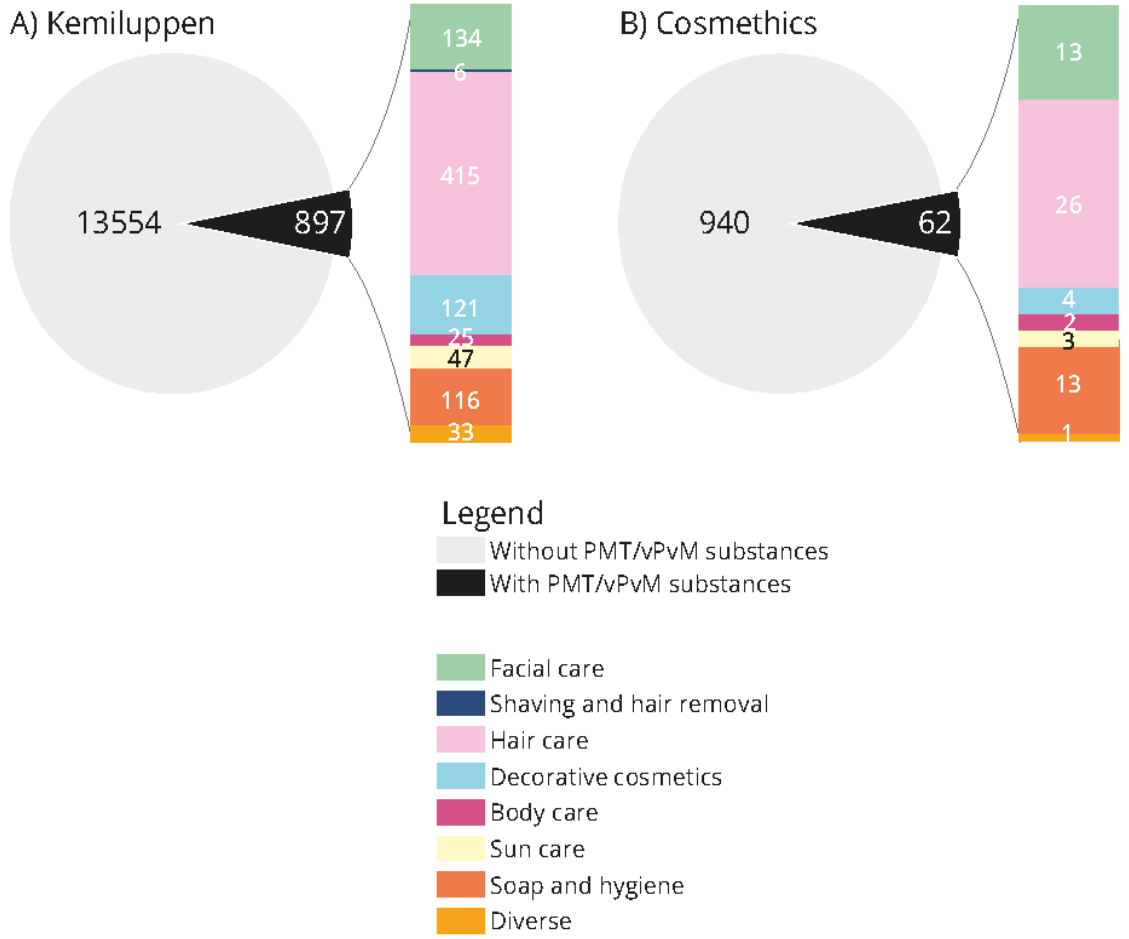
Identification of the chemical of concern

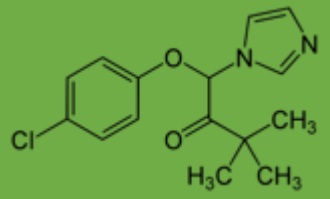
- 10 000 substances listed in Cosing database
- 50 substances potential PMT/vPvM
- ~6% of cosmetics products contained PMT/vPvM substances



Definition of the technical function

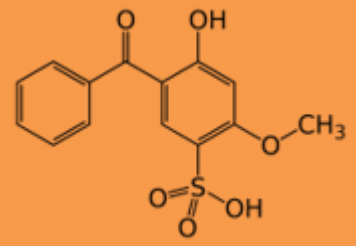
CLIMBAZOLE

CAS Number: 38083-17-9
Technical function: Preservative and anti-seborrheic agent
Type of products: Shampoos (as anti-dandruff agent)



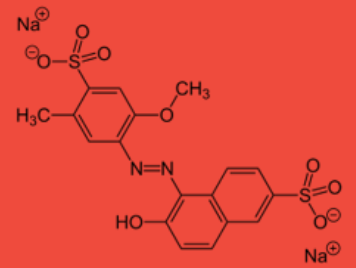
BENZOPHENONE-4

CAS Number: 4065-45-6
Technical function: UV filter and UV absorber
Type of products: All types of cosmetic products



ALLURA RED

CAS Number: 25956-17-6
Technical function: Pigment
Type of products: All types of cosmetic products



Is the function necessary for the performance in the application?

CLIMBAZOLE

Anti-dandruff agent

Anti-dandruff properties

YES

Is the function necessary for the performance in the application?

BENZOPHENONE-4

UV filter

Protection from skin diseases

YES

UV absorber

Improve duration of use

YES

Is the function necessary for the performance in the application?

ALLURA RED

Pigment

Provide color to the surface

YES

Pigment

Marketing purposes

NO

Assessment of the alternatives

Source: ECHA (2011)

- **I** Identification of potential alternatives
- **IIa** Technical feasibility
- **IIb** Economical feasibility
- **IIc** Hazard assessment of alternatives
- **III** Comparison of the alternatives

Identification of the alternatives

Identifying potential alternatives

- CosIng database
- SpecialChem (cosmetic ingredient database from the industry)
- Lists of authorised food additives (for the pigment)

Shortlisting potential alternatives

- The Subsport database (collection of 33 lists of restricted chemicals)
- Annex III to the cosmetic product regulation (restricted substances)
- ECHA database: C&L notification, PACT and Annex III inventory to REACH

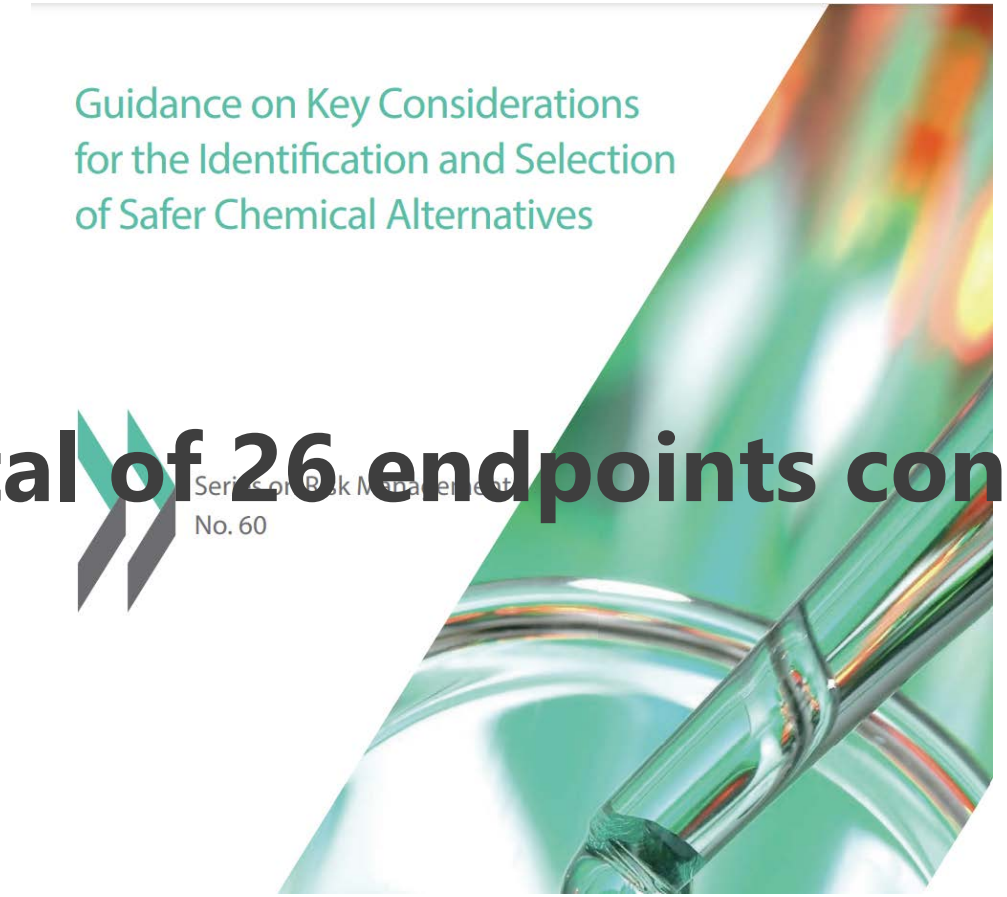
Technical and economical feasibility

- **Technical feasibility**
  - Case-by-case basis, so difficult to properly assess outside of the industry
  - *"~25% of cosmetics products reformulated every year"*

  → All potential alternatives with same chemical function considered technically feasible

- **Economical feasibility**
  - Very difficult to assess outside of the industry

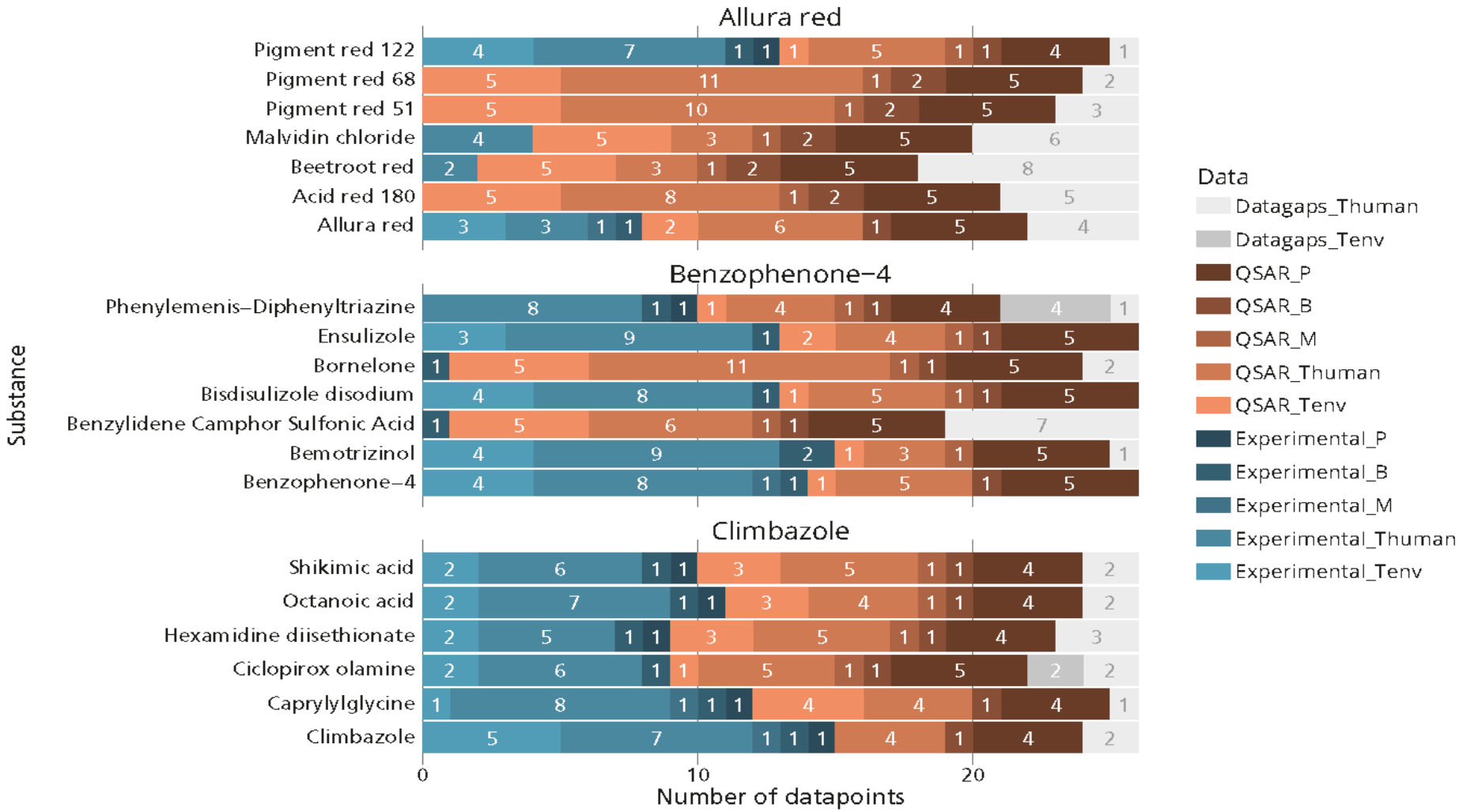
Hazard assessment



→ **Total of 26 endpoints considered**

Source: OECD, 2021

Hazard assessment



Comparison of the alternatives

- Comparison of alternatives with MCDA methods based on hazard profile
  - Heat map
  - MAUT
  - ELECTRE III
- Safer alternatives available for all case study

Use case	Chemical name	Ranking		
		Heatmap	MAUT	ELECTREIII
Pigment	**Allura red**	**3**	**4**	**3**
	Malvidin chloride	6	2	2
	Beetroot red	**1**	**1**	**1**
	Pigment red 51	3	5	5
	Pigment red 68	2	6	3
	Acid red 180	**7**	**7**	**7**
	Pigment red 122	5	3	5
UV- filter	**Benzophenone-4**	**2**	**4**	**3**
	Ensulizole	**1**	**1**	**1**
	Benzylidene camphor sulfonic acid	**5**	**5**	**7**
	Bisdisulizole disodium	2	3	5
	Bemotrizinol	4	2	2
	Bornelone	7	6	5
	Phenylemenis-diphenyltriazine	6	7	3
Anti-seborrheic	**Climbazole**	**6**	**6**	**5**
	Octanoic acid	**3**	**2**	**1**
	Caprylylglycine	**2**	**3**	**2**
	Shikimic acid	**1**	**1**	**4**
	Ciclopirox olamine	**4**	**4**	**2**
	Hexamidine diisethionate	5	5	6

Necessity for health, safety and functioning of society

Substance name	Chemical function	Is the use of the chemical justified?	No safer alternative available?	Necessary for health and safety?
Benzophenone 4	UV absorber or UV filter	YES	NO	Assessment not needed
Allura Red	Pigment	NO, if for marketing purposes YES otherwise	NO	Assessment not needed
Climbazole	Anti-dandruff agent	YES	NO	Assessment not needed

Conclusion on essentiality

Substance name	Chemical function	Is the use of the chemical justified?	No safer alternative available?	Necessary for health and safety?	Conclusion
Benzophenone 4	UV absorber or UV filter	YES	NO	Assessment not needed	NON-ESSENTIAL
Allura Red	Pigment	YES NO, if use for marketing purposes	NO	Assessment not needed	NON-ESSENTIAL
Climbazole	Anti-dandruff agent	YES	NO	Assessment not needed	NON-ESSENTIAL

Main message of the study

- Essentiality of a use mostly depends on availability of safer alternatives
- Chemical alternative assessments are crucial to avoid regrettable substitution
- Functional substitution approach allows to identify uses for which a detailed chemical alternatives assessment is not necessary

Outlook

- Further work on the evaluation of the reliability of the hazard data is needed
- Further work on assessment of technical and economical feasibility is needed
- Here, focus only on use phase of the substance, further work should take into account the whole life cycle of the products (e.g. Is change of packaging indeed safer?)

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Questions?

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