GIORNATE dell'ELETTROCHIMICA ITALIANA 2022 ORVIETO

Palazzo del Capitano del Popolo
September 11th - 15th, 2022

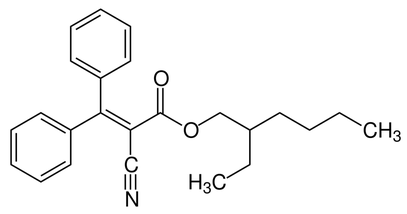
VOLTAMMETRIC METHODS FOR MONITORING UV FILTERS IN SUNSCREENS

P. Inaudi[1], M. Rocci[1], L. Favilli[1], A. Diana[2], S. Bertinetti[2], M. Malandrino[2], O. Abollino[1], A. Giacomino[1]

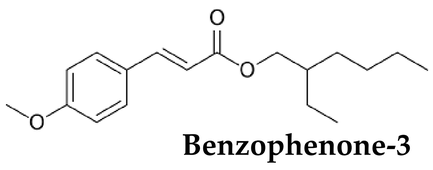
[1] *Department of Drug Science and Technology, Università degli Studi di Torino, Via Pietro Giuria 9, 10125, Torino*
[2] *Department of Chemistry, Università degli Studi di Torino, Via Pietro Giuria 7, 10125, Torino*

INTRODUCTION

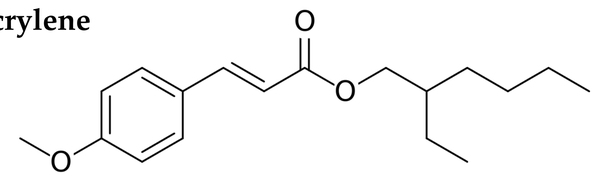
UV filters play a fundamental role in protecting the skin against UV-A and UV-B radiations.
It is important to monitor the concentrations of filters themselves, because some of them have an adverse effect on the environment and are therefore considered as contaminants of emerging concern (CEC). For these reasons it is very important to create a method that allows a rapid screening for the monitoring of their presence of in ecosystems, in particular the marine one.
Globally, the maximum permitted limits for UV filters in sunscreens are very different. In particular regarding the chemical filters, those on which our work has focused.



Octocrylene



Benzophenone-3



Octyl methoxycinnamate

Figure 1 – UV Filters

OBJECTIVES

The aim was the development of a simple analytical screening method that permits to identify UV filters in different matrices using voltammetry.

Evaluating the applicability of this method:
- to check sunscreen quality and composition
- to monitor the presence of residues of sunscreen agent in seawater

- Samples and analytes –

UV filters (figure 1), namely octocrylene (OC), benzophenone-3 (BP-3) and octyl methoxycinnamate (OMC) were determined in different sunscreens purchased in pharmacies and supermarkets in the province of Turin.

ANALYTICAL TECHNIQUE

A glassy carbon electrode (GCE) was used as working electrode to check the presence of UV filters in different products.
0.01 g of each sample were added to 50mL 0.1M NaCl and a concentration of 0.03M cetyltrimethylammonium bromide (CTAB), the addition of the surfactant to the solution was demonstrated to improve the sensitivity of the response.
0.01 g of samples were added to 20 mL of seawater to test the applicability of the method on a real samples.
The analysis was performed first using a laboratory potentiostat, the PGSTAT 10 potentiostat (Eco Chemie, Utrecht, the Netherlands) coupled to a 663 VA Metrohm (Herisau, Switzerland) stand. The potentiostat was interfaced to a personal computer and the software GPES 4.9 was used.
After the development, the method was tested with a portable procedure using a Palmsens 4 (Houten, Netherlands) connected to a PC using the program PStrace 5.9, in order to evaluate the possibility of perform analysis directly in field.
Subsequently, for a pilot study a Carbon Paste Electrodes (CPEs) obtained mixing graphite powder and an aliquot of sunscreen were used as working electrodes.
All the profiles of the investigated sunscreens were recorded by square wave voltammetry (SWV) using the reported parameters (table 1).

Deposition time	60 s
Deposition potential	- 0.4 V
Potential scan	– 0.4 V; - 1.6 V
Frequency	20 Hz
Wave amplitude	0.018 V
Step potential	0.012 V

Table 1 – SWV parameters

STEPS OF INVESTIGATION

Before proceeding with the analysis of sunscreens, tests were carried out on standard solutions of OC, BP-3 and OMC in 20 mL of 0.1 M NaCl supporting electrolyte to assess the performance of the technique. The effect of CTAB on the analytical response of the method was tested. Sunscreens in seawater samples were analyzed.
Comparison between different products were made.

RESULTS AND CONCLUSIONS

The results obtained in synthetic solutions were very good in terms of linearity (R^2= 0.9981, 0.9978 and 0.9997 respectively for OC, BP-3 and OCM) for screening for the presence or absence of these filters both in synthetic solutions (figure 2) and in sea water.
CTAB has proven to be an excellent reagent for this type of analysis, thanks to the increase of the response sensitivity.
Tests by dissolving samples in seawater have allowed us to understand that it is possible to apply SWV with GCE to monitor the residues of these substances in water ecosystems.
The presence of filters in commercial sunscreens was also detected (see figure 3 as an example).
Also, the tests made using the portable methodology gave a good response, comparable to that of the laboratory. Preliminary tests with CPEs modified with sunscreen showed that it is possible to think about a future use of this technique for rapid screening.
Voltammetry has proved to be an excellent technique to compare different sunscreens containing different UV filters. Therefore, the technique showed good potentialities for sunscreen analysis, to assess their quality and stability, for human safety purposes; its main advantages are low costs, ease of use and the possibility of carrying out measurements on site.

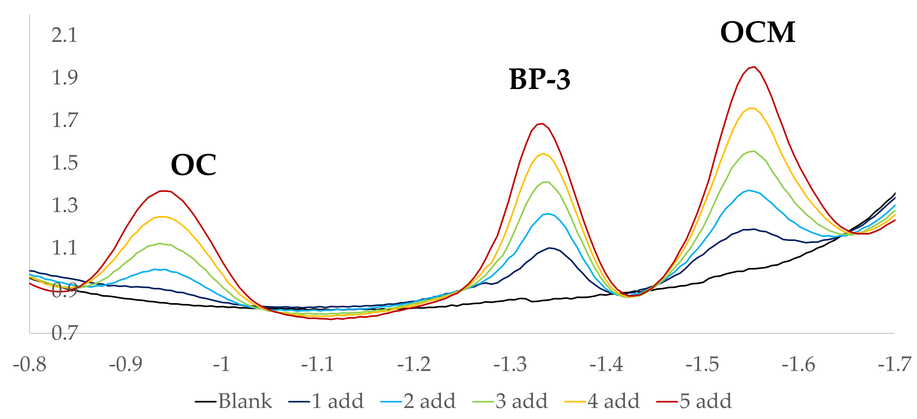


Figure 2 – Performance of the method, 5 additions of OC (18.5 µM each), BP-3 (5.8 µM each) and OCM (5.8 µM each)

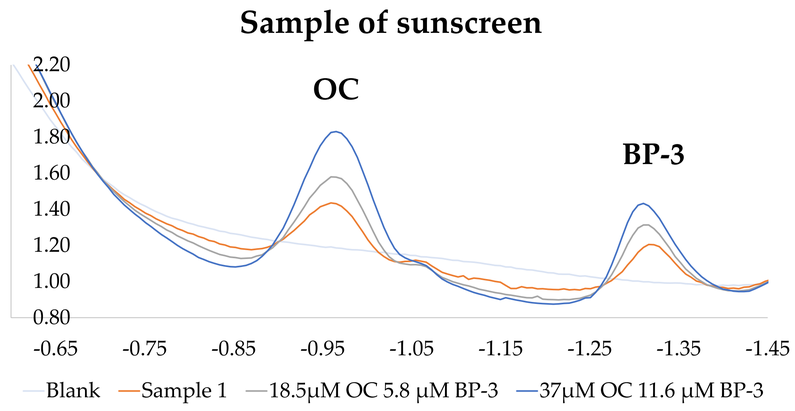


Figure 3 – SWV of a commercial sunscreen sample containing OC and BP-3

UNIVERSITÀ DI TORINO

SusWater

DSTF Dipartimento di Scienza e Tecnologia del Farmaco UNIVERSITÀ DI TORINO