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ARTICLE

Incidence Study of Two UV Filters (Octocrylene and Octinoxate) and the Synthetic Fragrance Galaxolide in Commercial Yellow Clam (*Amarilladesma mactroides*)

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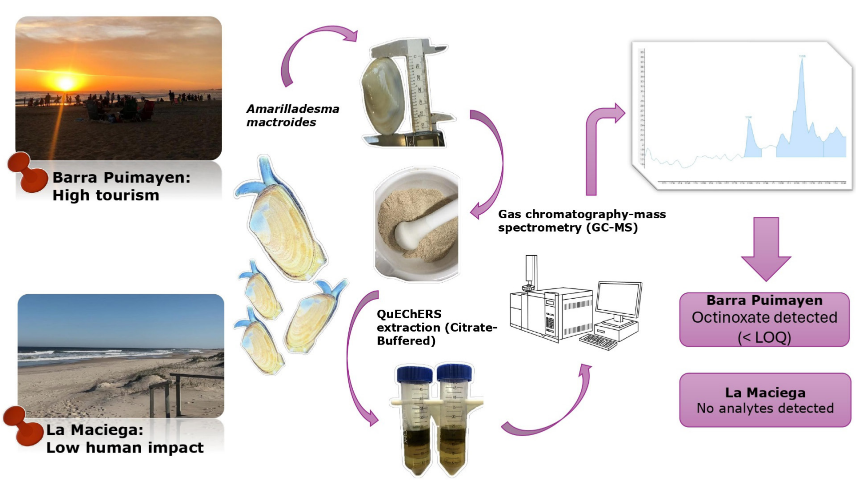

In this work, we study two UV filters (octocrylene and octinoxate) and the synthetic fragrance galaxolide in the yellow clam (*Amarilladesma mactroides*). Two beaches were strategically selected based on their contrasting population density, level of tourism and recreational activity. The clam samples used in this study originate from two distinct sub-populations. Samples from each beach were separated into 4 sizes (<54 mm, 55-56 mm, 57-58 mm and >59 mm); then, a modified citrate buffered QuEChERS method was used for subsequent evaluation in gas chromatography-mass spectrometry (GC-MS). The recoveries for all analytes were in the range between 70 to 102%, the RSD oscillated between 1 to 18%, and the limit of quantification was defined as the lowest recovery level with a value of 50 µg Kg^{-1} for all three analytes. As a result, the presence of the UV filter octinoxate was detected in the size of 55-56 mm on *Barra Puimayen* beach, being lower than the limit of quantification (50 µg Kg^{-1}). However, the evaluation indicated the absence of analytes from the individuals belonging to *La Maciega* beach, which presents a minimal anthropogenic impact.

Keywords: UV filters, synthetic fragrances, GC-MS, QuEChERS, bivalve mollusks

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INTRODUCTION

Pharmaceutical and personal care products (PPCPs) range from medicines used in humans and animals' health, to sunscreens, fragrances and cosmetics.[1] They enter aquatic and terrestrial environments through multiple pathways, including domestic and industrial wastewater, hospital effluents, agricultural runoff, and direct inputs from recreational coastal activities.[2] While some PPCPs can be degraded or transformed by physical, chemical, or biological processes, others are considered pseudo-persistent due to continuous discharge,[3] leading to long-term accumulation and potential adverse effects on both aquatic and terrestrial organisms,[4] as well as human health.[5,6]

Within the PPCPs there is the personal care products group, in which the two subgroups selected for this purpose are found: synthetic fragrance and UV filters.[7] These compounds reach the marine environment indirectly via wastewater discharges or directly through recreational activities.[8] Their lipophilic nature facilitates bioaccumulation in the muscle and adipose tissues of marine organisms,[9] and several studies have documented their potential for both bioaccumulation and biomagnification through marine food webs.[10] Bivalve mollusks, given their filter-feeding behavior and sedentary lifestyle, serve as effective bioindicators for monitoring these substances.[11] Previous studies have applied QuEChERS extraction followed by GC-MS analysis to detect UV filters and synthetic fragrances in marine bivalves, demonstrating the feasibility of this approach.[10,12] However, compound and matrix-specific validation data remain scarce, and the overall use of QuEChERS-GC-MS in aquatic organisms is still limited.

Building on these advances, the present study evaluates the performance of this methodology for the detection of selected UV filters and synthetic fragrances in marine bivalves, thereby contributing to the development of reliable analytical tools for environmental monitoring.

The *Amarilladesma mactroides* fishery in Uruguay opens their authorization during the summer season, under the co-management process among fishermen (39 clam farmers with permits) and the National Directorate of Aquatic Resources (*Dirección Nacional de Recursos Acuáticos*, DINARA, Uruguay) since 2009. In 2012 a "Fishing Counsil" for the yellow clam was formed, with the purpose of generating a consultative space for the management of this resource.[13,14] DINARA annually assesses its biomass for the opening of the fishery, establishing a "Total Extractable Commercial Biomass" which is distributed in equal quotas among the authorized fishermen.[15] The consumption of yellow clams has been highly valued over the years, becoming a coveted gastronomic product in the coastal area.[16] Therefore, the consumption of *Amarilladesma mactroides* contaminated by UV filters and fragrances might represent a threat to human health in the future. The objective of this study is to broaden the understanding of the yellow clam's behavior toward these contaminants, to guarantee a better management in the fishery and to provide safer consumption of *Amarilladesma mactroides* as a national resource.

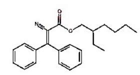
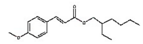
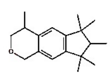
To the best of our knowledge, the only studies to date specifically addressing *Amarilladesma mactroides* focus on the effects of the UV filter benzophenone-3 (BP3) on various biomarkers of the species.[17,18] Therefore, based on the available literature, this is the first study to investigate the occurrence of octocrylene, octinoxate and galaxolide in the yellow clam. This study expands the current understanding of the presence of personal care products in bivalve species by exploring compounds not previously evaluated in *Amarilladesma mactroides*. These findings contribute to the frontier of knowledge on the occurrence of emerging contaminants in commercially valuable marine resources, supporting both environmental monitoring and food safety initiatives.

MATERIALS AND METHODS

Chemicals

The compounds selected for this study were three organic pollutants belonging to two different categories: UV filters and fragrances. The UV filters were: octinoxate (EHMC) and octocrylene (OC). The fragrance was: galaxolide. Their structure and physicochemical properties are presented in Table I. Octocrylene and octinoxate were selected due to their widespread use as organic UV filters and their frequent detection in aquatic environments, which raises concerns about persistence and ecotoxicological impacts.[19] Notably, octinoxate has been banned in Key West and Hawaii owing to its recognized toxic effects on marine ecosystems.[20] Additionally, galaxolide (a synthetic polycyclic musk commonly used in personal care products) was included due to its widespread presence in the environment, potential for bioaccumulation, and documented adverse effects on marine organisms.[21,22] Together, these compounds represent relevant targets for assessing contamination and ecological risk in coastal areas, as chemicals with Log Kow values between 3 and 5 are generally considered likely to bioaccumulate.[23] Notably, the three analytes examined in this study have log Kow values exceeding 5, indicating an even higher potential for bioaccumulation.

Table I. Physicochemical properties of the three standards

Substance	Structure	Molecular weight (g/mol)	CAS	Log Kow
Octocrylene		361.5	6197-30-4	6.88
Octinoxate		290.4	5466-77-3	5.2
Galaxolide		258.4	1222-05-5	5.90

Type I water was obtained using a Smart2Pure 3 UV ultrapurifier system (Thermo Scientific). Ethyl acetate (HPLC grade) was supplied by J.T. Baker (Avantor). Anhydrous sodium sulfate and sodium choride were purchased from Dorwil and Merck, respectively. Sodium citrate dihydrate and sodium hydrogen citrate trihydrate were obtained from Emsure and Sigma-Aldrich. The target compounds – octocrylene, octinoxate and galaxolide – were acquired from HPC Standards. ExtraBond C18 and PSA bulk adsorbent were provided by Scharlau.

Sample collection

The yellow clam fishery (*Amarilladesma mactroides*) in Uruguay is located between *La Coronilla* city and the *Barra del Chuy* city in the state of *Rocha*, covering a coastal strip of 20 km.[24] All the clams used for this work were purchased alive on the market in May 2023 from the artisanal fishing plant *Almejas Palmares*, authorized by DINARA.[25] All samples are considered part of the adult population, as they exhibit a shell length greater than 43 mm, which corresponds to the size at first sexual maturity;[26] whereas the commercial biomass consists of individuals with a shell length greater than 50 mm.[26] Belonging to two different subpopulations on the coasts of *Barra del Chuy* (*Rocha*), these beaches differ in the intensity of anthropogenic pressures and recreational activities conducted on them (Figure 1).

The sampling design of this study aims to determine whether there are significant differences in the impact of UV filters and fragrances on yellow clam populations located in areas with contrasting levels of anthropogenic influence. Two beaches were strategically selected that contrast due to their interaction with tourism and the recreational activities, with site selection agreed in consultation with the staff of the *Almejas Palmares* artisanal fishing plant, who have known the area for several generations.[25] The *Barra Puimayen* beach is in *Barra del Chuy* with a population of 370 inhabitants,[27] and an extension of 4.5 Km. The selection of this beach was based on its proximity to the *Barra del Chuy* city, and the attendance of tourists and locals for recreational use. The *Barra Puimayen* is mainly exposed to two major polluted discharges: the mouth of the *Chuy* stream (border between Uruguay and Brazil) which has had pollution problems for more than 20 years and the lack of wastewater treatment plant in the city of *Barra del Chuy*, which generates various sources of wastewater that reach the coast.[28] *La Maciega* beach is located in front of the small town of *Palmares de la Coronilla*, with a population of 10 inhabitants.[29] It is located approximately 6 km south of *Barra del Chuy* and 7 km north of the town of *La Coronilla*. *La Maciega* has an extension of 5 km and is characterized by being a sport fishing area and low tourist attendance for different recreational activities due to its distance from both cities.

Figure 1. Sample zone of both subgroups of yellow clams (*Barra Puimayen* and *La Maciega*).

Sample preparation

The clams were subjected to: (a) 72-hour purification process, aerated, in 20 L containers at a salinity of 30 g L^{-1} and a temperature of 19 °C. (b) Both subpopulations were measured for total length (TL) with calliper and grouped by size in the following measurements: <54 mm, 55-56 mm, 57-58 mm, >59 mm. Each size group was composed of 15 individuals per beach, totalling 60 individuals evaluated at each beach and 120 individuals overall. The individuals were weighed to obtain the total body mass (including shell and muscle) (TBM) of each individual, then the valves were removed, and the wet muscle mass (WMM) was obtained. The samples were stored in zip-lock bags and taken to the freezer at -18 °C until they were freeze-dried. (c) The samples were frozen at -50 °C for 24 hours and then freeze-dried until constant mass. (d) The samples from both subgroups were weighed again to obtain the dry muscle mass (DMM) of each size group (4 groups defined before) and based on WMM and DMM the percentage of water lost (%WL) was calculated. The mean weight per individual (MWI) was calculated by dividing the total weight of each group by the number of individuals in that group (Table II). (e) The samples were then ground with a mortar. (f) The samples were stored in 50 mL centrifuge tubes (Figure 2).

Figure 2. Process for treating yellow clam samples. (a) Purchase and purification process, (b) length measurement and grouping, (c) freeze-drying, (d) weighing of the dry muscle mass, (e) dry muscle mass mortared and (f) storage.

Table II. Summed values of TBM, WMM, DMM, MWI and %WL for each size group (< 54 mm, 55-56 mm, 57-58 mm and > 59) from *Barra Puimayen* and *La Maciega* beaches

Barra Puimayen				
TL (mm)	**TBM**	**WMM (g)**	**DMM (g)**	**%WL**
< 54	192.2720	45.3863	12.6263	72.18
MWI	12.0170	2.8366	0.8417	
55-56	222.9812	55.6546	11.1230	80.01
MWI	13.9363	3.4784	0.7415	
57-58	253.8309	62.4515	13.1574	78.93
MWI	15.8644	3.9032	0.8771	
> 59	263.8631	67.0444	13.7003	79.56
MWI	17.5908	4.4696	2.0271	

(continues on next page)

Table II. Summed values of TBM, WMM, DMM, MWI and %WL for each size group (< 54 mm, 55-56 mm, 57-58 mm and > 59) from *Barra Puimayen* and *La Maciega* beaches (continuation)

La Maciega				
TL (mm)	**TBM**	**WMM (g)**	**DMM (g)**	**%WL**
< 54	183.6297	48.5177	8.9086	81.63
MWI	12.2419	3.2345	0.5939	
55-56	238.9608	64.4261	12.4050	80.74
MWI	14.9315	3.9787	0.8270	
57-58	251.2778	68.3873	13.0134	80.97
MWI	15,7401	4.2577	0.8955	
> 59	276.5727	76.8660	13.4333	82.52
MWI	17.3283	4.8283	1.8950	

For the determination of UV filters and fragrances in yellow clam, a modified citrate QuEChERS (quick, easy, cheap, effective, rugged and safe) extraction was performed,[30] adapted from Picot-Groz et al. 2014[31] and Martinez-Bueno et al. 2013.[32] Both studies were conducted on mussels (*Mytilus galloprovincialis*),[31,32] considering that they share the same feeding system as clams, as both species are non-selective filter feeders. Picot-Groz et al. (2014)[31] investigated the presence of the three analytes examined in the present work, among others, whereas Martinez-Bueno et al. (2013)[32] focused exclusively on two anticonvulsants. Nonetheless, both studies utilize the QuEChERS extraction method. In this study, the QuEChERS method was selected because octinoxate and octocrylene are ester-based UV filters that can undergo hydrolysis when exposed to strongly acidic or basic conditions. Such degradation would compromise their stability during sample preparation and potentially lead to an underestimation of their actual concentrations. The use of a buffered QuEChERS approach allows the maintenance of a stable pH throughout the extraction process, thereby preserving the chemical integrity of these analytes and ensuring reliable quantification.[33] Briefly, 2 g of freeze-dried sample from each size group of both subgroups of yellow clam were weighed in a 50 mL polypropylene centrifuge tube. 10 mL of Type 1 water was added, and the mixture was vortexed for 30 seconds. Then, 10 mL of ethyl acetate (AcOEt) was added, and the mixture was shaken manually for 2 minutes. After shaking, 4 g of anhydrous Na_2SO_4, 1 g of NaCl, 1 g of $Na_3Cit{:}2H_2O$ and 0.5 g of $Na_2HCit{:}3H_2O$ were added, and the mixture was shaken manually for 1 minute and centrifuged at 3500 rpm for 5 minutes. 2 mL of the upper layer was taken and transferred to a new 15 mL centrifuge tube for clean-up, with 750 mg Na_2SO_4, 125 mg ExtraBond C18 and 125 mg PSA bulk adsorbent. Subsequently, it was manually shaken for 1 minute and centrifuged for 5 minutes at 4000 rpm. 1 mL was filtered through a 0.45 µm PTFE syringe filter and transferred to a vial.

Recovery experiments were carried out by adding the analytes to the freeze-dried blank sample, followed by the extraction procedure, analogous to that applied to the real samples. For the matrix-matched calibration points, the blank sample was first extracted, and the analytes were then added directly into the vial at the indicated concentrations before analysis.

GC-MS Analysis

The above extracts were analyzed by GC-MS, using an Agilent Technologies 7890B GC coupled to an Agilent Technologies 5977B MS, and a Thermo Scientific GC TraceGOLD TG-5MS capillary column

(30 m × 0.25 mm and 0.25 µm). 1 µL was injected in splittles mode at 150 °C and helium was used as a carrier gas with a flow at 1 mL/min. The starting temperature was maintained at 150 °C for 2 minutes, increasing 10 °C per minute until reaching 310 °C, maintaining the temperature for 5 minutes, with a run time of 23 minutes. The mass detector was operated in electron impact ionization mode with an ionization energy of 70 eV. The GC-MS was used in "Selective Ion Monitoring" (SIM) mode. A source temperature of 250 °C and a quadrupole temperature of 150 °C were used for all analyses. The identification of compounds using GC-MS followed the SANTE guideline criteria for QA/QC. This required the use of three ions, with the ion ratio from sample extracts falling within ±30% (relative) of the average from calibration standards in the same sequence. Additionally, the analyte peaks for all three ions had to be fully overlapping.[34] The limit of quantification (LOQ) was defined as the lowest recovery level where recoveries ranged between 70% and 120%, with a maximum relative standard deviation (RSD%) of 20%.[34]

The quantification and qualification ions for all standards and the retention times for the peaks were defined (Table III).

Table III. Analytical parameters for the three standards

Substance	Quantification ion (*m/z*)	Qualification ion 1 (*m/z*)	Qualification ion 2 (*m/z*)	Retention time (min)	Window time (min)
Octocrylene	232	360	248	15.65	14.2–17.0
Octinoxate	178	161	290	12.84	12.0–14.2
Galaxolide	243	213	258	8.61	7.5–9.4

An external calibration curve of 50 µg Kg^{-1}, 100 µg Kg^{-1}, 200 µg Kg^{-1}, 300 µg Kg^{-1} and 500 µg Kg^{-1} was used for all standards. As quality control and quality assurance (QA/QC) criteria, a curve point was injected every 10 samples. Calibration curves were performed twice, once at the beginning and once at the end of the sequence. The second calibration confirmed the instrument´s repeatability over the course of the analysis.[35]

The matrix effect was evaluated according to the next three categories: weak < 25%, moderate 25-50% and strong > 50%. And it was calculated according to Equation 1.[36]

$$\%\, matrix\ effect = \frac{Slope_{matrix-solvent}}{Slope_{solvent}}\, x\ 100 \qquad \text{Equation 1}$$

For QA/QC purposes, both procedural blanks and blank samples were analysed to assess potential contamination and background interferences. Recovery studies were conducted at two levels (50 and 100 µg Kg^{-1}) in triplicate, by spiking the target analytes into blank samples prior to the extraction procedure. These experiments were performed to evaluate the accuracy of the method and to ensure its reliability under the selected analytical conditions.

RESULTS AND DISCUSSION

The standardized sample preparation, including depuration, size classification, freeze-drying, and calculation of %WL and MWI, ensured comparability among individuals and minimized variability due to size and water content.

Quality Assurance and Quality Control

The comparison of the corresponding levels of both curves showed recoveries within 83% to 113%, meeting the criteria established by the SANTE guidelines.[34] For the samples' evaluation, calibration curves were made in matrix of both beaches as a single matrix, having been verified that they presented comparable matrix effect. External curves were performed for galaxolide, octocrylene and octinoxate at the following concentrations: 50 µg Kg^{-1}, 100 µg Kg^{-1}, 200 µg Kg^{-1}, 300 µg Kg^{-1}, 500 µg Kg^{-1} (Figure 3).

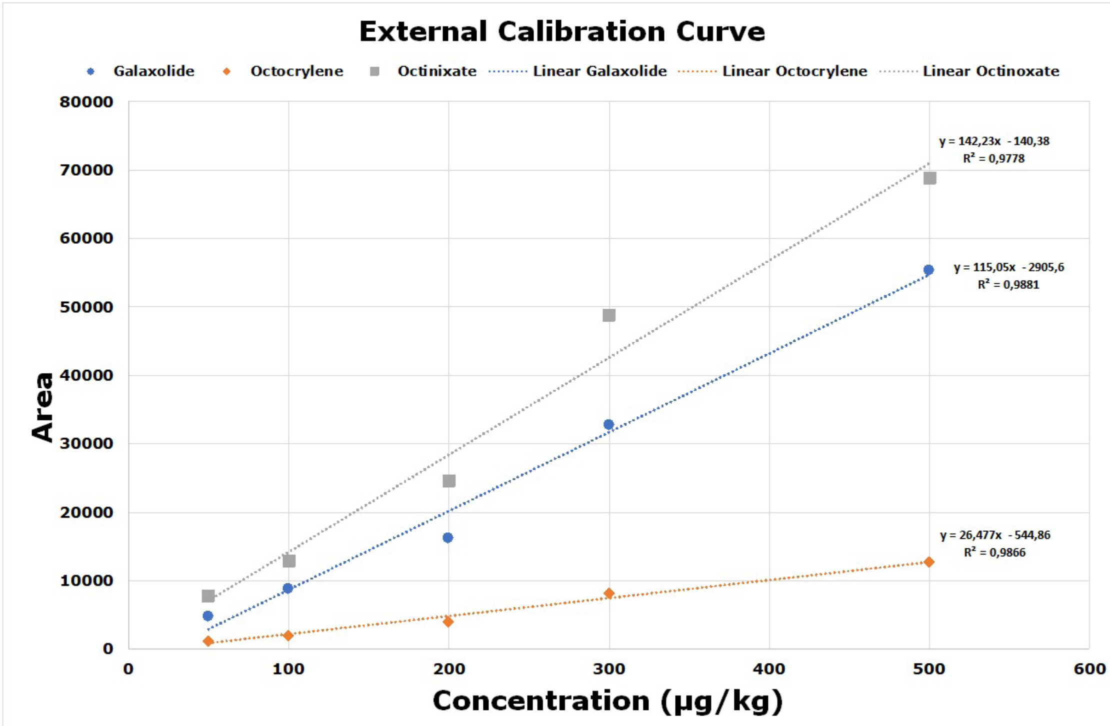


Figure 3. External calibration curves for galaxolide, octocrylene, and octinoxate at concentrations of 50, 100, 200, 300, and 500 µg Kg^{-1}.

All analytes were successfully recovered at the levels tested, with recoveries ranging from 72% to 102%, thereby meeting the acceptance criteria established by the SANTE guidelines (70–120%); the limit of quantification was defined as the lowest level with effective recovery. The relative standard deviation (%RSD) ranged from 1% to 18%, also in compliance with the SANTE criterion of ≤20%.[33] Full recovery data are presented in Table IV.

Our findings are consistent with previous studies on bivalve mollusks. Petrarca et al. (2022)[12] and Lestido-Cardama et al. (2023)[10] reported the bioaccumulation of galaxolide and octinoxate in mussels (*Mytilus galloprovincialis*) and clams (*Ruditapes philippinarum*), detecting both analytes with LODs between 0.5–50 µg Kg^{-1} dw and LOQs between 1–50 µg Kg^{-1} dw. Similarly, Picot-Groz et al. (2014)[31] evaluated octocrylene in mussels, reporting the highest concentrations among UV filters (up to 3992 µg Kg^{-1} dw) and LOQs ranging from 0.5–50 µg Kg^{-1}. Together, these works demonstrate the suitability of the QuEChERS method for assessing bioaccumulation of UV filters and synthetic fragrances in bivalves. The LOQ obtained in the present study (50 µg Kg^{-1}) is comparable to those previously reported, supporting the applicability of this approach for the determination of these compounds in clam samples.

It is important to note that studies combining QuEChERS extraction with GC-MS for the assessment of these contaminants in aquatic organisms remain limited, which hinders an in-depth comparative analysis across different works. Nevertheless, the available evidence consistently demonstrates that QuEChERS is a reliable and robust method for evaluating the presence of these compounds in marine bivalves.

To evaluate the matrix effect and compare the behavior of the analytes across different matrices, calibration curves were prepared both in solvent and in matrix-matched samples from both beaches (*Barra Puimayen* and *La Maciega*). As a result, octocrylene, octinoxate and galaxolide showed a positive matrix effect. Analytes showed comparable matrix effects on both beaches, showing a strong effect for octocrylene, a moderate effect for octinoxate and finally a weak effect for galaxolide (Table IV). Therefore, it was verified that the matrices of both beaches had comparable behaviors for the realization of the same matrix curve.

Table IV. Matrix effect of all standards and recoveries of the three standards performed for triplicate and the average of both concentrations for the three standards

				Matrix effect	
Substance	**Concentration ($\mu g\ Kg^{-1}$)**	**Recovery (%)**	**% RSD**	***La Maciega***	***Barra Puimayen***
Octocrylene	50	85	7	**Strong**	
	100	72	18	60	57
Octinoxate	50	92	11	**Moderate**	
	100	102	7	49	36
Galaxolide	50	82	5	**Weak**	
	100	100	1	18	10

The three analytes were evaluated for the *Barra Puimayen* and *La Maciega* beaches for all clam sizes (<54 mm, 55-56 mm, 57-58 mm and >59 mm) in duplicate. No contaminants were detected in the clam samples collected from *La Maciega* beach. This could be attributed to the low number of houses that contribute to the wastewater discharges and the low number of inhabitants. Due to its difficult access, both because of the distance from *Barra Puimayen* and the absence of lifeguards, recreational activities by families are virtually absent. Only a few local residents use the area for activities such as sport fishing, according to information provided by the staff of “*Almejas Palmares*”. The only analyte found in the clams was the UV filter octinoxate, from samples from *Barra Puimayen* beach measuring 55-56 mm (Figure 4). The concentration was detectable according to the detection parameters established by SANTE but was below the limit of quantification (LOQ) for this analyte (50 $\mu g\ Kg^{-1}$).

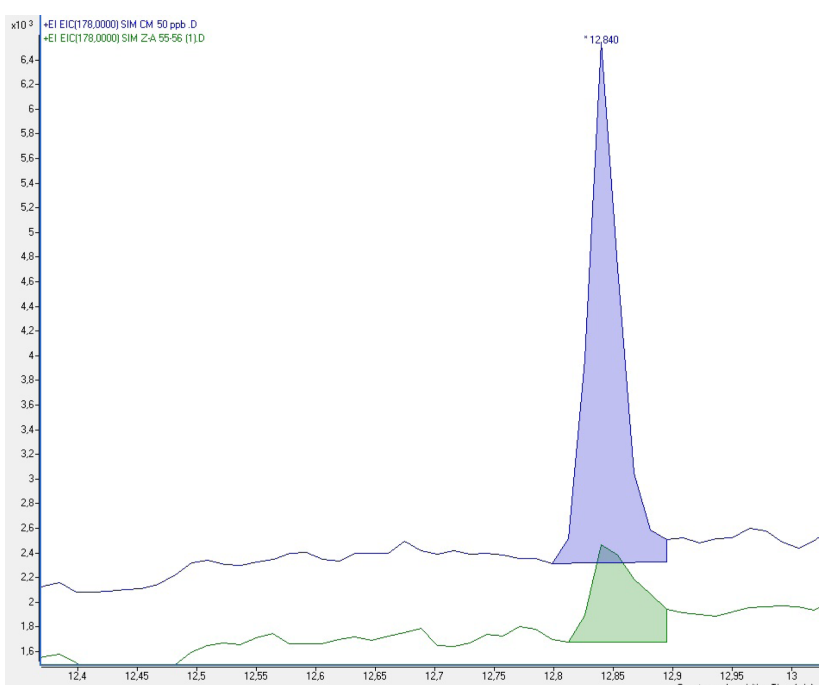


Figure 4. Extracted ion chromatogram (SIM, *m/z* 178) showing the detection of octinoxate in clam samples (55–56 mm) collected from *Barra Puimayen* beach.

The higher anthropogenic pressure at *Barra Puimayen* beach compared to *La Maciega* beach may explain the presence of octinoxate in the samples from this location, while no traces were detected in those from *La Maciega*. The presence of octinoxate in the samples collected in May, despite the reduced anthropogenic pressure compared to the summer season, suggests that *Amarilladesma mactroides* may bioaccumulate this UV filter. The detection of octinoxate in clams from *Barra Puimayen* beach is particularly relevant considering that this compound has already been banned in Hawaii and Key West due to its adverse effects on marine ecosystems.[21] Its presence in filter-feeding bivalves from Uruguay highlights the potential for bioaccumulation and raises concerns regarding ecological risks in coastal environments where no such regulatory measures are currently in place. The half-life of UV filters in the environment depends on various physical and chemical factors.[37] For octocrylene and octinoxate, among other UV filters, the reported half-lives suggest that their persistence in aquatic environments is typically less than one day.[37] This could tell us that the detection of octinoxate in the yellow clams in this study, represents the possibility that the contaminant had already accumulated in the individuals from the months prior to their purchase. In addition, there is a possibility that contaminants continue to enter the system during the low season.

The potential bioaccumulation of UV filters and fragrances detected in clams may not reflect the actual concentration levels to which individuals are exposed. In fact, the metabolic biotransformation and/or biodegradation processes occurring within the organism or in the marine environment should also be considered.[38] Furthermore, assessing emerging contaminants such as UV filters in combination with other stressors (e.g. elevated temperatures, salinity) is essential to gain a better understanding of both organismal responses and contaminant behavior.[39,40] Yellow clam present limited depuration capacity, retaining certain contaminants (e.g. microplastics) and pathogens even after standard depuration (48 hours).[41] To date, no studies have investigated the ability of the yellow clam to depurate the three analytes assessed in this study, nor any other similar compounds.

Regarding international regulatory restrictions, there is currently no legislation establishing maximum allowable concentrations of organic UV filters in marine waters or bivalves mollusks.[42] Worldwide there are different regulations concerning the UV filters allowed in Personal Care Products,[43,44,45] and all of them regulate the maximum amount of organic UV filters in personal care products and cosmetic products. Likewise, Uruguay is a member of the Southern Common Market (*Mercado Común del Sur*, MERCOSUR), and its current legislation on UV filters is governed by Decree No. 300/017.[47] This decree incorporates the provisions of MERCOSUR's Resolution No. 44/15, issued by the "Grupo Mercado Común", which approved the "MERCOSUR Technical Regulation on the List of Permitted Ultraviolet Filters for Personal Hygiene Products, Cosmetics, and Perfumes". As a result, Uruguay does not have specific regulations addressing the presence of pharmaceuticals and personal care products in bivalve mollusks.

In recent decades, yellow clam populations have suffered mass mortality, overfishing, and other anthropogenic pressures.[46]

The detection of the UV filter octinoxate in the present study suggests that current regulations on PPCPs may not adequately consider their potential effects on *Amarilladesma mactroides* and coastal ecosystems. The lack of previous studies in Uruguay on PPCPs in yellow clams prevents direct comparisons with our findings but highlights the need for future monitoring to support decision-making for the sustainable management of this fishery resource. Taken together, these results underscore the importance of incorporating emerging pollutants into monitoring programs and strengthening management strategies to ensure the conservation of this ecologically and socio-economically relevant species.

CONCLUSION

This study assessed the occurrence of octocrylene, octinoxate, and galaxolide in *Amarilladesma mactroides* from two Uruguayan beaches subject to contrasting anthropogenic pressures. The method, based on QuEChERS extraction followed by GC–MS, complied with SANTE guidelines and proved reliable for detecting UV filters and synthetic fragrances in bivalve mollusks. Octinoxate was detected in clams from *Barra Puimayen*, particularly in individuals above the commercial size threshold, suggesting a potential accumulation trend related to size and seasonality. In contrast, no target analytes were found in samples from *La Maciega*, a site with minimal human activity, supporting the role of local anthropogenic inputs in determining contaminant occurrence. These results highlight the need to investigate temporal trends and sources of PPCPs in coastal environments, especially where fishery resources are exploited.

The study also demonstrates the applicability of the QuEChERS-GC-MS approach for environmental biomonitoring in aquatic organisms, where its use remains limited. Expanding future research to include additional bivalve species, broader spatial and temporal sampling, and a wider range of contaminants will strengthen its relevance for ecological risk assessment and regulatory decision-making.

Conflicts of interest

The authors declare that there are no financial conflicts of interest related to any of the affiliations of the authors of this article, nor with any other affiliations.

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