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Cita:

De-la-Torre, Gabriel Enrique, Mendoza-Castilla, Lisseth y Laura, Rosa Pilar (2019). *Microplastic contamination in market bivalve Argopecten purpuratus from Lima, Peru*. *Manglar*, 16 (2), 85-89.

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Microplastic contamination in market bivalve *Argopecten purpuratus* from Lima, Peru

Contaminación con microplásticos en el bivalvo comercial *Argopecten purpuratus* de Lima, Perú

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Abstract

Microplastics (< 5 mm) are ubiquitous contaminants in the marine environment. Many marine commercial species, among fish, mollusks and crustaceans, are subject to microplastic exposure through ingestion. The aims of the present study were to determine microplastic contamination in scallops from fishery markets of Lima and if microplastics are more likely to adhere to certain parts of the scallop. *Argopecten purpuratus* specimens were bought from fishery markets in Lima. Soft tissues were digested using 10% KOH and incubated at 60 °C overnight. An optical microscope was used to observe microplastics after vacuum filtration of the supernatant solution. Microplastic concentration, color and type were recorded. ATR-FTIR analysis determined the specific polymer types. The overall mean microplastic concentration was 2.25 ± 0.54 MP.ind⁻¹. Fibers were the most abundant microplastic type, while red and blue were dominant colors. Mann Whitney U test indicated no significant differences ($P > 0.05$) of microplastic content between gonads and muscle. Microplastics in seafood and foodstuff could pose a threat to food security and human health. Still, information regarding microplastic pollution is scarce.

Keywords: Microplastic; *Argopecten purpuratus*; contamination; Peru; scallop.

Resumen

Los microplásticos (<5 mm) son contaminantes ubicuos en el medio marino. Muchas especies marinas comerciales, entre peces, moluscos y crustáceos, están sujetas a la exposición a microplásticos por ingestión. Los objetivos del presente estudio fueron determinar la contaminación por microplásticos en las vieiras de los mercados pesqueros de Lima y si es más probable que los microplásticos se adhieran a ciertas partes de la vieira. Muestras de *Argopecten purpuratus* se compraron en mercados pesqueros de Lima. Los tejidos blandos se digirieron usando 10% KOH y se incubaron a 60 °C durante la noche. Se usó un microscopio óptico para observar microplásticos posterior a la filtración al vacío de la solución sobrenadante. Se registró la concentración de microplásticos, color y tipo. El análisis ATR-FTIR determinó los polímeros específicos. La concentración de microplásticos media fue $2,25 \pm 0,54$ MP.ind⁻¹. Las fibras fueron el tipo de microplástico más abundante, mientras que el rojo y el azul fueron los colores dominantes. La prueba U de Mann Whitney no indicó diferencias significativas ($P > 0,05$) del contenido microplástico entre las gónadas y el músculo. Los microplásticos en los mariscos podrían representar una amenaza para la seguridad alimentaria y la salud humana. Sin embargo, la información sobre la contaminación con microplásticos es escasa.

Palabras clave: Microplásticos; *Argopecten purpuratus*; contaminación; Perú; vieira.

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Recibido: 17-06-2019.
Aceptado: 20-08-2019.

Introduction

Microplastics are plastic fragments smaller than 5 mm in diameter (**Andrady, 2017**). They are classified as primary or secondary. While primary microplastic are manufactured (*e.g.* preproduction pellets and exfoliant microbeads), secondary microplastics degrade over time from larger plastics (*e.g.* fragments, films or fibers). Continental microplastics reach the oceans through water streams, wind, direct plastic littering or wastewater discharge (**Cózar *et al.*, 2014**). Ingestion of microplastic particles have been reported by many previous studies (**Hernandez-Gonzalez *et al.*, 2018**; **Provencher *et al.*, 2018**; **Zhu *et al.*, 2019**). It is also possible for microplastics to transfer through the food chain (**Guzzetti *et al.*, 2018**), resulting in a high risk of exposure to humans.

Although microplastic effects and distribution in the environments have been subject

of extensive research, its implications to human health and food security are still to be investigated. The presence of microplastics in market shellfish has been reported around the globe (**Cho *et al.*, 2019**; **Li *et al.*, 2015**; **Li *et al.*, 2018**; **Rochman *et al.*, 2015**; **Van Cauwenberghe y Janssen, 2014**). Nevertheless, there is no available information regarding seafood contamination in Peru. Indeed, information regarding plastic pollution in Peru is scarce (**De-la-Torre y Laura, 2019**; **Purca y Henostroza, 2017**).

Under this context, the aims of the present study were to (1) determine if commercial scallops from fishery markets of Lima were contaminated with microplastics, and to (2) determine whether microplastics are more likely to adhere to the scallop muscle or gonads.

Materials and methods

Sampling and preparation

Popular Peruvian scallops *Argopecten purpuratus* specimens (n = 16) were bought from fishery markets of Lima, Peru, in April, 2019. Scallops were delivered in plastic bags and taken to the laboratory in a cooler. After dissection using a scalpel, valve length and wet weight of the gonads and muscle were measured and recorded separately. Samples were then frozen at -20 °C until further analysis.

Digestion treatment

For the digestion of the soft tissues, Protocol 1b (**Dehaut *et al.*, 2016**) was followed with minor changes. In brief, a pool of two gonads and muscles were placed in 30 ml screw cap test tubes and 10% (w/v) potassium hydroxide (KOH) was added. The tubes were sealed and shaken for a few seconds. They were then incubated overnight at 60 °C.

Microplastic separation and identification

The supernatant solutions of the digested material in the tubes were vacuum filtrated through a 20 µm pore glass fiber filter paper

using a 5 cm in diameter Büchner funnel.

Filters were then observed using a microscope (Krüss MBL2000) under 4 and 10 × magnification. To differentiate microplastics from glass fibers, description by **Davidson y Dudas (2016)** was followed. Microplastic content, color and type (fiber, microbead, fragment and film) were recorded. All confirmed microplastics were photographed.

Quality control

Latex gloves and natural cotton lab coats were worn at all times. Glass equipment was rinsed with distilled water and surfaces were wiped clean. Plastic materials were avoided completely. A distilled water blank and 10% KOH blank were prepared, vacuum filtrated and analyzed for every sample batch.

ATR-FTIR Analysis

To identify the specific polymer type of the microplastics and discard false positives, 10 microplastics were selected at random and analyzed through Attenuated Total Reflectance Fourier Transform Infrared Spectroscopy (ATR-FTIR). Some samples were initially too small for the ATR-FTIR

(Perkin Elmer Frontier™) to analyze them, thus different filters were selected.

Statistical analysis

Data was expressed in microplastics per individual (MP.ind⁻¹) and microplastics per gram of wet weight (MP.g⁻¹) ± standard error of the mean (SEM). To determine the normality of the data, both Kolmogorov-Smirnov and Shapiro-Wilk tests were

conducted, invalidating its normal distribution ($P < 0.05$). To determine whether microplastics rather adhere to the gonads or the muscle tissues, non-parametric Mann Whitney U test was conducted. Significance level was set to 95% for all the analyzes. Statistical analyzes and graphs were performed using GraphPad Prism (version 7.00 for windows).

Results and discussion

A. purpuratus biometrics (valve length and wet weight of the gonads and muscle) were presented in **Table 1**. Quality control measures prevented external contamination of the treatment, no microplastics were found in any of the blanks.

Microplastics were found in 87.5% of the pooled samples. The overall mean microplastic concentrations were 2.25 ± 0.54 MP.ind⁻¹ and 0.13 ± 0.03 MP.g⁻¹.

Table 1. Biometrics of the sampled scallops. Length was expressed in cm and mass in grams. VML = Valve mean length; GMW = Gonad mean weight; MMW = Muscle mean weight; and TM = Total mass

	VML	GMW	MMW	TM
MEAN	7.74	5.34	12.36	17.71
SEM	0.06	0.37	0.46	0.72
SD	0.23	1.49	1.84	2.89

Fibers (**Figure 1**) were the most abundant microplastic type (61.11%), followed by fragments (33.33%) and microbeads (5.56%). No films were found.

Regarding color, red particles amounted 36.11% of the total microplastics, followed by blue (27.78%), green (19.44%) and black (16.67%) microplastics.

Mann Whitney U test indicated no significant difference ($P = 0.1810$) of microplastic content between gonads and muscle in terms of microplastics per individual. In terms of microplastics per grams of wet weight, no significant difference ($P = 0.6444$) was observed. These results evidence that microplastics adhere to the surface indistinctively on the soft tissues surface of *A. purpuratus* (**Figure 2**).

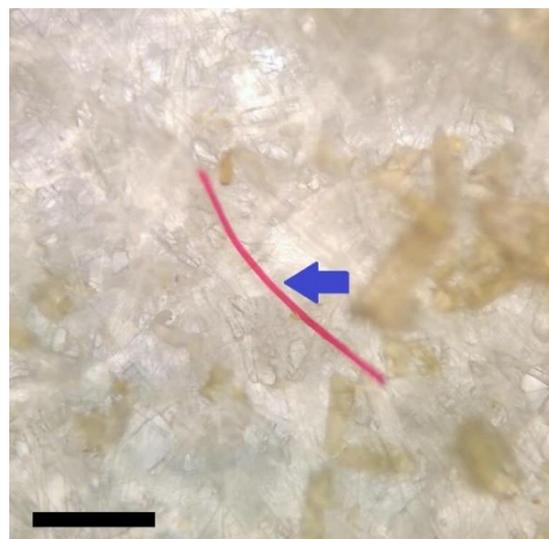


Figure 1. Photograph of a red fiber in a scallop from a fishery market. Scale bar indicate 100 μ m.

ATR-FTIR spectra determined the polymer type of the selected microplastics. Most fibers were identified as polyester and polypropylene, fragments were identified as high-density polyethylene, polystyrene and isotactic polypropylene.

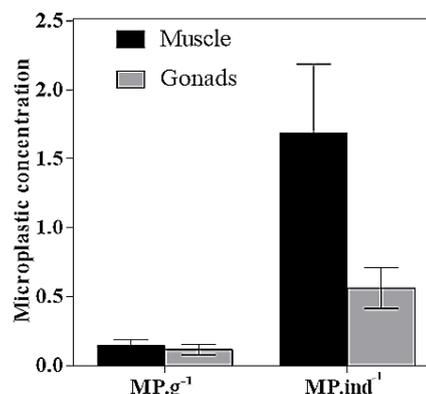


Figure 2. Column graph showing microplastic content between muscle and gonads in MP.ind⁻¹ and MP.g⁻¹. Error bars indicate SEM.

Supermarket live mussels (*Mytilus edulis*) from the UK contained 0.9 MP.g⁻¹ (Li *et al.*, 2018), considerably higher concentrations than those found in the present study. On the contrary, scallops and oysters from South Korean fishery markets, presented 0.08 ± 0.08 MP.g⁻¹ and 0.07 ± 0.06 MP.g⁻¹ respectively (Cho *et al.*, 2019). Fibers are among the most abundant microplastic types in mollusks from various studies (Catarino *et al.*, 2018; Li *et al.*, 2015; Li *et al.*, 2018; Naji *et al.*, 2018). Color could be of significant importance to organisms with selective feeding behavior.

Nevertheless, bivalves are known to be filter feeders, thus microplastic color may be correlated to those in the medium. Recent review articles (Barboza *et al.*, 2018;

Rainieri y Barranco, 2019) have presented microplastic contamination as a threat to food security, food safety and human health. Whether microplastics could significantly damage human health is still under debate and requires more research.

The results of the present study indicated ubiquitous but small concentrations of microplastics adhered to the surfaces of *A. purpuratus* from fisheries of Lima.

Determining the precise source of microplastic pollution requires extensive monitoring and research with quality standards. In the case of seafood and food stuff contaminated with microplastics, it is likely to come from marine pollution and lack of hygiene standards along the supply chain.

Conclusions

In the present study, microplastic contamination of scallop *A. purpuratus* from fishery markets of Lima was assessed. Microplastic physical and chemical characteristics were presented. Results indicate that microplastic content on different parts of *A. purpuratus* are significantly equal. The present study

evidenced a high risk of microplastic ingestion by locals. There is still scarce information regarding whether microplastics could pose a serious threat to human health through ingestion. Further research should focus on monitoring microplastics along the supply chain and elimination methods.

Aknowledgements

The authors would like to thank Prof. Sandra Casimiro, Head of Research and Teaching Laboratories, for allowing the research to be conducted in the research laboratories of San Ignacio de Loyola Uni-

versity and providing the authors with high grade reagents and proper instruments.

This research was conducted by members of the Red Universitaria Ambiental (RUA) nodo USIL.

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