

HUMAN HEALTH RISK ASSESSMENT FOR CONSUMPTION OF MICROPLASTICS AND PLASTICIZING SUBSTANCES THROUGH MARINE SPECIES

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Plastics start to degrade until reaching sizes in the scale of micrometers and nanometers, this is smaller-size structures, but don't disappear from the environment.



Plastic particles, sized under 5 mm are known as microplastics (MP) they are not water-soluble, and their degradability is low, lasting from weeks to thousands of years to decompose, depending on the conditions to which they are exposed.



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Rodprasert, W., Toppari, J., Virtanen, H.E., 2021. Endocrine disrupting chemicals and reproductive health in boys and men. In: Frontiers in Endocrinology, vol. 12. Frontiers Media S.A. https://doi.org/10.3389/fendo.2021.706532.



Rodprasert, W., Toppari, J., Virtanen, H.E., 2021. Endocrine disrupting chemicals and reproductive health in boys and men. In: Frontiers in Endocrinology, vol. 12. Frontiers Media S.A. https://doi.org/10.3389/fendo.2021.706 532. In the present investigation, isolation of MP was conducted as well as quantification of plasticizing substances in the same samples of marine species: mangrove cockle (Anadara tuberculosa), Stolzmann's weakfish (Cynoscion stolzmanni) and arched swimming crab (Callinectes arcuatus).







• Finally, a risk assessment was carried out and the dietary exposure to BPA to which consumers would be exposed with these foods was calculated; these values were compared with the tolerable intake dose (TDI) established by European Food Safety Authority (EFSA).

Materials and Methods

MP Extraction, quantification, and visualization

➤The marine species were collected directly from fishermen of the Gulf of Nicoya, Costa Rica during the year 2020. Work was done with 86 specimens of composite sample, (these samples were also used for the determination of plasticizing substances.



Quantification of BPA and Pthalates (DEHP and DBP).

It was performed identification and quantification using Gas Mass Chromatography Equipment (GC-MS with a spitless injection system (Thermo Scientific Trace 1310) with Mass Spectrometry Detector, triple quadrupole.



Toxicological risk analysis associated to consumption of arched swimming crab, mangrove cockle and Stolzmann's weakfish.

➢ For risk evaluation, dietary exposure to which consumers would be submitted was calculated. The result of food consumption in kg multiplied by concentration of the toxic found in µg/kg between the adult's body weights in kg, thus obtaining a dietary exposure as µg/kg bw/d. These values are compared to TDI established for each case by recommendation of EFSA (European Foods Safety Authority).





MP amount found

For this investigation, work was done with sieves allowing the passage of particles whose size oscillated between 0.5 μm - 106 μm,

>Average results:

 \succ for Arched swimming crab 4.0 ± 1.0 (SD) MP/g;

➢ Mangrove cockle the value corresponded to 3.3 ± 2.9 (SD) MP/g;

Stolzmann's weakfish, an average of 2.4 ± 1.3 (SD) MP/g



Fig 1 Amount of MP in composite samples; ASC: arched swimming crab, MC: mangrove cockle, SW: Stolzmann's weakfish. The blue points represent the average value of each marine species.



Fig 2. Pictures of isolated MP from marine species seen on the optical microscope at 4x; the different colors are shown.



Fig 3. Micrographs of MP found on samples of mangrove cockle. a, c, d, f particles; b, e fibers.



Table 1. MP characterization by SEM/EDS and Ramanof identified marine species.

Species	SEM/EDS	Wavelength (cm-1)Reference (Rebollar et al., 2014)		Possible identification	
Arched swimming crab	Ideal EDS	1720 1611 1287	C=O C-C benzene ring C-O	PET	
Mangrove cockle	Ideal EDS	1207 C-O 1572 ND 1311 C-H		PA or PE	
Mangrove cockle	Ideal EDS	1611 1486	С-С С-Н, С-ОН	PA	
Mangrove cockle	EDS with 7.7% Al.	EDS with 7.7% 1720 C=O Al. 1605 C-C benzene ring 1281 C-O		PET	
Mangrove cockle	Ideal EDS	605 435	ND ND	ND	
Mangrove cockle	EDS with 5.6% Ca.	1076 639	C-C C-Cl	PVC	
Mangrove cockle	Ideal EDS	1568 534	ND ND	ND	
Stolzmann's weakfish	Ideal EDS	1590 1315	N-H C-H	PA	
Stolzmann's weakfish	Ideal EDS	1723 1609 1283 853	C=O C-C benzene ring C-O C-H	PET	
Stolzmann's Ideal EDS weakfish		1533 1332 739	C-O-C C-H ND	ND	

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Fig 5. Graphs of EDS samples from MPs corresponding to a) polyethylene and b) polypropylene found in arched swimming crabs.



ig 6. Raman spectra of MP, corresponding to MP found in marine species, a) arched swimming ab, b) mangrove cockle, c) and d) <u>Stolzmann's</u> weakfish. 780nm Laser and 3mW power.



Fig 7. Elemental mapping of a particle correlating to microplast





Fig 8. A: corresponds to a detected BPA signal in a sample of arched swimming crab; the signal is triggered in 7.19 minutes; B: corresponds to a DEHP signal in a sample of mangrove cockle; signal is triggered in 17.15 minutes and C: corresponds to a DBP signal in mangrove cockle; the signal is triggered in 11.16 minutes.

Marine <u>species</u>	Composite	Analytes	Average	Range of
	samples		concentration (µg /g	concentrations
			sample) *	(µg /g)
Mangrove	15	BPA	0.014 ± 0.006	0.008 - 0.039
cockle				
Mangrove	15	DEHP	0.13 ± 0.01	0.01 - 1.41
cockle				
Mangrove	7	DBP	0.017 ± 0.002	0.013 - 0.025
cockle				
Arched	5	BPA	0.028 ± 0.006	0.007 - 0.076
wimming crab				
Arched	5	DEHP	0.03 ± 0.01	0.01 - 0.1
swimming crab				
Arched	1	DBP	0.059 ± 0.002	0.059 - 0.059
wimming crab				
Stolzmann's	7	BPA	0.009 ± 0.006	0.006 - 0.018
weakfish				
Stolzmann's	12	DEHP	0.04 ± 0.01	0.01 - 0.08
weakfish				
Stolzmann's	8	DBP	0.019 ± 0.002	0.013 - 0.022
weakfish				

Table 2. Plasticizers found in positive composite samples for marine species.

* LD: 0,002 $\mu g/g,$ LC: 0.006 $\mu g/g$ for BPA & DEHP and 0.008 $\mu g/g$ for DBP

Species	Analytes	Average concentration (µg/kg sample)	Dietary exposure (D. exp) per portion µg/kg/ bw/d	TDI food (EFSA, 2015) μg/kg/ bw/d	Relationship <u>D.exp</u> -TDI a Pregnant women	TDI n b (New value proposed EFSA) 2021
Mangrove cockle	BPA	14	0.015	4	D.exp < TDI	D.exp >>TDI
Mangrove cockle	DEHP	130	0.139	50	N.D c	N.D
Mangrove cockle	DBP	17	0.018	10	N.D	N.D
Stolzmann's weakfish	BPA	9	0.023	4	D.exp < TDI	D.exp >>TDI
Stolzmann's weakfish	DEHP	40	0.10	50	N.D	N.D
Stolzmann's weakfish	DBP	19	0.049	10	N.D	N.D

Table 3. Dietary exposure and TDI relation for adults according to values obtained in the study.

aTDI pregnant women for BPA 0.33 ug/kg/bw/d (ANSES, 2014)

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b TDI n New value proposed 0.004 ng/ kg bw/d of BPA (European Food Safety Authority, 2021) for EDCs damages.

<u>c</u> N.D: No updated data available (EFSA Panel on Food Contact Materials, Enzymes and Processing Aids (CEP) et al., 2022).

Conclusions

- According to the data obtained it can be stated that from the plasticizers found, if well it can't be affirmed coming exclusively from plastic residues found as (MP), their origin may not be dismissed; since the work consisted of determining microparticles and plasticizing substances in the same samples, such samples were acquired directly from artisan fishermen.
- Beyond doubt if can be affirmed that the plasticizers, hazardous substances and especially important such as BPA, DEHP and DBP, have reached the highest levels of the trophic chain, It must be expressed that 34% of the samples were positive for the 3 plasticizers, which suggests a toxic mixing effect, in a synergistic way; urgent measures should be established to protect the marine resource from pollution by plastics, and hence, public health.

- Although it is true that plasticizers have a ubiquitous global distribution, it takes special importance respect to the risk when these substances are present in food or water for human consumption, being especially sensitive population children and pregnant women. Other, especially prospective studies, can be carried out to establish safe doses of these substances in these population.
- According to the type of substance found, it is suggested pregnant women do not ingest seafood during the gestation period, considering the low quantity suggested for BPAs in food, currently being under the scientific criteria of EFSA; under acceptance by TDI of 0.004 ng/ kg bw d; given the estrogenic effect of this substance in the fetus' gestation period and consumption by children be also limited.

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