

Evaluation of Consumers' Awareness of the Impact of UV Filters on Marine Ecosystems

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ABSTRACT: Increased public awareness of the negative effects of excessive exposure to UV radiation and concerns about the risk of skin cancer cause a growing interest in sunscreen products. This is especially true in tropical countries where exposure to ultraviolet radiation emitted by the sun is greater. The global use of UV filters results in the appearance of a new class of environmental pollution. This situation raises considerable concerns about the quality of the environment and the impact of these compounds on humans and other organisms. Therefore the aim of our study was to examining consumers' awareness of the threats to the marine environment, with particular emphasis on sunscreen substances (UV filters). The quantitative research was carried out on a group of 287 respondents, using the proprietary questionnaire that included questions about impact of selected UV filters on marine ecosystems. Respondents were also asked about their concern about marine environmental issues and actions they take to minimize their negative impact on the marine environment. The findings indicate that Polish consumers possess moderate awareness of marine environmental issues and low awareness of impact of UV filters on marine ecosystems.

1 INTRODUCTION

Sunscreen cosmetics are a group of cosmetic products that is particularly important for human health. The main function of sunscreen products is to protect the skin from the biological effects of exposure to UV radiation (sunburn, photodermatoses, pigmentations, skin photoaging, precancerous changes and cancer) [1, 7, 13, 15]. Sunscreen products are effective mainly due to the content of UV filters (physical and chemical), which absorb, reflect or scatter UV radiation. Annex VI of the Regulation of the European Parliament and of the Council of the European Union of 30 November 2009 on cosmetic products contains a total of 32 sunscreen substances allowed in cosmetic products, of which only 4 are inorganic substances: titanium dioxide, titanium dioxide in the form of nanoparticles, zinc oxide, zinc in the form of nanocomponents. UV

filters are also used in plastics, food packaging, textiles, paints, detergents, adhesives and other industrial products to protect materials from the harmful effects of UV radiation. Some UV filters are controversial. Their estrogenic, allergenic, irritating, photosensitizing and phototoxic effects were described in the literature [17]. Recently, the harmful effects of UV filters on the marine environment have been mentioned more and more often [5, 19].

Two main ways of introducing UV filters into the environment are described in the literature:

5. A direct route resulting from human activity. UV filters are released into the environment by washing off the skin and washing off clothing.
6. Indirect way, through industrial activity, sewage, runoff and household use.

UV filters, after getting into the sewage end up in the sewage treatment plant, but some of them can be transported to the sludge due to their high lipophilicity and poor biodegradability. This sludge can be used in agriculture, which is associated with the risk of groundwater contamination. Part of the treated wastewater containing UV filters or their residues will be discharged into natural water reservoirs and bioaccumulated there. Therefore UV filters have been detected in many elements of the natural environment, including: sewage treatment plants, surface waters, river and sewage sediments, seawater samples collected around the world, fish, as well as human milk and placenta. Studies confirm their presence in various concentrations in marine organisms: mussels, octopuses, crabs and fish fillets and other parts of fish. UV filters can be toxic to them: accumulate in their tissues, limit their growth, damage the immune and reproductive systems, damage DNA, have endocrine effects, etc. [4, 5, 11, 21]. Scientific studies also indicate an increase in the number of viruses in marine bacterioplankton due to the presence of UV filters in sea water, as well as a modification of the biogeochemical cycle of carbon, nitrogen and phosphorus [8]. By promoting viral infections sunscreens may also cause coral bleaching [9]. Of particular concern is the tendency of UV filters to accumulate in the food chain and the possibility of transferring them to humans through nutrition [2]. Some scientific studies also indicate that UV filters can be found in human secretions: breast milk, urine and plasma [16, 18].

The presence of UV-protective substances in the environment requires constant monitoring and analysis of their impact on the environment and human health, and this is only possible when people consciously use such preparations. Therefore the aim of our study was to examine consumers' awareness of the threats to the marine environment, with particular emphasis on sunscreen substances (UV filters).

2 METHODS AND STUDY POPULATION

The study was conducted in January 2023 using a questionnaire made available to respondents using the CAWI (Computer Assisted Web Interview) technique. The questionnaire was disseminated via e-mail and social networking sites with a link to the online survey. The selection of the research sample was purposeful - the study covered Polish consumers who are using sunscreen products at least occasionally. The survey used substantive, filtering and metric questions. Mostly closed questions were used in the form of a disjunctive cafeteria, one open question was proposed to identify the greatest threats to the marine environment. The research had three primary objectives:

1. examining consumers' awareness of threats to the marine environment, with particular emphasis on sunscreens (UV filters);
2. analysis of the sources used to obtain information on the impact of UV-protective substances on the marine environment;

3. examining the impact of concern for the marine environment on pro-ecological behaviour and activities undertaken by respondents - in the context of using sunscreen.

The questionnaire uses scales adapted from studies by Easman et al. [12] and statements made by the authors based on current knowledge in the scope of the discussed topic.

The results were presented as the number and share of answers to particular questions in the studied population.

The respondents constituted a group of the 287 adult consumers, 14% of respondents declared that they use sunscreen products occasionally, 49 % - sometimes, 21.5% - in the summer and during holidays, the rest - all year round. 92% of this group were women, 8% men. They were people of different ages: people aged 18-25 accounted for 42.5%, 36% of the respondents were in the age group of 26 to 35 years old and over 35 years old were 21.5 % of the people surveyed. The respondents also had different education (higher - 50%, secondary - 43.2%, vocational - 5.6% and primary - 1.2%) and place of residence (city - 41.5%, rural - 58.5%). Over 68% of respondents declared an income greater than or equal to the national average.

3 RESULTS AND DISCUSSION

The first two questions asked to the respondents concerned the type of sunscreen products they choose and the fact that when buying these products, they pay attention to their harmful effects on the environment. The vast majority of respondents (64.5%) indicated that they do not pay attention to the type of filters. The fewest of them choose (2%) products containing organic chemical filters, the others indicated products containing natural (9%), inorganic (mineral) filters (11%) as well as organic and inorganic filters (13.5%). Less than 7% of respondents, when purchasing sunscreens, always pay attention to their impact on the environment, almost 1/5 of respondents never pay attention to this aspect. Over 15% of respondents indicated that they are unable to verify what kind of filters contain the sunscreen products they bought. It is worth noting that most of them also declared that when buying sunscreen products, they do not pay attention to the type of filters. This proves not only the low awareness of the surveyed group of consumers about the potential effects of sunscreen products on the environment, but also a very low level of knowledge about sunscreen products themselves.

Answering the next question, respondents were asked to specify the degree of their concern regarding the pollution of the marine environment. Only 9 people (3% of the respondents) indicated that they were not interested in the problem of marine environment pollution at all, and half of the surveyed respondents indicated that they were highly and very highly concerned about the problem of marine environment pollution. Others expressed moderate interest in marine pollution issues. Respondents were also asked what actions they take out of concern for

the marine environment. Their answers to this question are presented in Fig. 1. According to the data obtained, most respondents (204) care about proper waste segregation and plastic recycling. These results indicate that they realize that the most important problem of marine environment pollution is the increasing contamination of plastics and microplastics. Only a quarter of respondents, when buying sun protection products, pay attention to their safety. Almost 20% of respondents declared that they pay attention to places of spending holidays and rest. A similar number of respondents indicated that they did not take any action out of concern for the marine environment.



Figure 1. Number of indications of actions resulting from care for the marine environment. Source: own research

Comparison of respondents' degree of concern with behaviours and actions resulting from concern of the marine environment may allow to assess the presence of a "gap between value and action", which occurs when individuals declare a high level of care, but their opinions do not translate into pro-ecological activities [3]. The vast majority of respondents who indicated that they were highly and very concerned about the pollution of the marine environment also indicated that they took various actions to protect this environment. Only a few people declared that they did not take any such actions. It can therefore be said that Polish consumers are aware of the various threats to the marine environment and actively act against its further pollution.

Then the respondents had to self-assess the level of knowledge about the harmful effects of sunscreen filters. Almost half of them (43.9%) described this level as low, and only 1.5% - as high. In order to verify the state of knowledge of respondents about the impact of UV filters on the marine environment, they were asked to indicate whether they agreed with the statements regarding UV filters. The respondents' answers are presented in Table 1. Almost half of them were unable to indicate whether UV filters have a positive impact on the marine environment, and only 40% indicated that this impact is negative. Over 60% of respondents were unable to indicate whether or not safe are natural substances with photoprotective properties for the marine environment. Less than half of the respondents indicated that UV filters can contaminate bathing water, accumulate in aquatic organisms and have a toxic effect on them. Most of the

respondents were unable to respond to more detailed questions regarding the impact of UV filters on the marine environment. Summing up the respondents' answers, it should be noted that most of them had little idea about the harmful effects of UV filters on the marine environment and marine organisms, which confirmed the compliance of their declarations about knowledge about the harmful effects of sunscreen filters. Unfortunately, due to the lack of publications on this subject, we cannot determine whether the lack of knowledge about the harmful effects of UV filters on the marine environment is widespread.

Table 1. Respondents' knowledge of the impact of selected UV filters on marine ecosystems [% of indications]

Statements	Yes	No	I do not know
UV filters have a positive impact on the marine environment	13	40	47
Sunscreen products have a negative impact on the quality of natural bathing water	49	12	39
Chemical/organic filters can be harmful to aquatic ecosystems	58.5	7.5	34
UV filters can bioaccumulate in fish, which are then eaten by humans	48	9	43
UV filters are released into the environment by washing off the skin and washing off clothing	57.5	10	32.5
UV filters are toxic to corals and marine life	38	4	58
UV filters affect the hormonal balance, development and reproduction of many marine organisms	38.5	5.5	56
Mineral filters in the form of nanoparticles are safe for the marine environment	22.3	13.2	64.5
Natural substances with photoprotective properties are safe for the marine environment	32	5	63

Source: own research

Respondents were also asked to list the biggest threats to the marine environment. The most frequently mentioned threats were litter, in particular, plastics - these were indicated by more than half of the respondents. This confirms our earlier observations that for this group the most important problem of marine environment pollution is the increasing contamination with plastics. This is because recently the harmful impact of microplastics and nano plastics on marine environment have been widely researched and discussed [6, 10, 20]. In order to counteract this phenomenon, the commonly recommended actions are to reduce the consumption of plastics, especially single-use plastics, and to recycle plastics. A dozen or so respondents each listed general human activities, overfishing, chemical pollution, oil and petroleum products spills, maritime transport and sewage inflow. None of the respondents mentioned eutrophication - the most important ecological problem of the Baltic Sea, or the acidification of sea waters. Several respondents indicated that they do not know what are the main threats to the marine environment.

Then the respondents were asked to indicate which of the following phenomena has the greatest negative impact on the marine environment (on a scale from 1 - no influence to 5 - very important). As

the Table 2 below shows, for respondents the greatest threats are oil spills, litter and the possibility of entanglement of marine animals. Renewable energy devices and noise were considered the least important. Pollution with UV filters was ranked third from the bottom and was rated as slightly more inconvenient than noise. Our results are comparable to those obtained by Easman et al. [12] when comparing public awareness of marine environmental threats and conservation efforts with the assumed well informed, professional sample. According to them members of the public surveyed identified oil spills as the greatest threat to the marine environment, while professionals identified overfishing and plastic packaging as the greatest threat. Climate changes featured frequently in responses from professionals and was in the top three most frequent responses, but just two public respondents mentioned this term [12].

Table 2. Scale of negative impact on the marine environment according to the respondents [number of indications and average ratings]

Type of threat	Assessment of the threat level					Rating
	1	2	3	4	5	
Oil spills	4	6	18	54	205	4,57
Drilling and mining raw materials from the seabed	15	46	96	91	39	3,32
Overfishing	12	23	112	83	57	3,52
Pollution with UV filters	23	64	124	49	27	2,97
Climate changes	9	26	87	74	91	3,73
Renewable energy devices	50	66	85	61	25	2,80
Noise	34	77	101	56	19	2,82
Entanglement and ingestion of litter by animals	8	7	47	67	158	4,25

Source: own research

It can be said that the awareness of surveyed consumers about the threats to the marine environment is moderate, perhaps this is due to the fact that they get the knowledge mainly from television, social media and the Internet. Only a few of them derive such knowledge from books and scientific journals or ecological organizations (Figure 2).

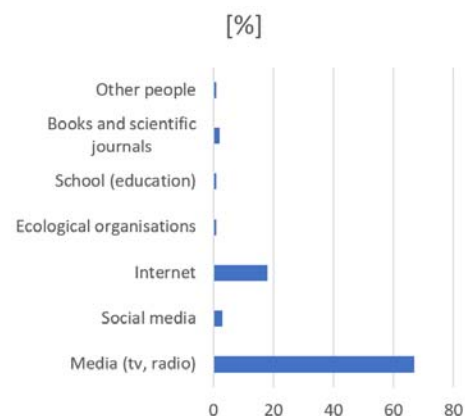


Figure 2. Sources of knowledge on threats to the marine environment. Source: own research

Such results are not surprising. As the study by Gelcich et al. [14] European citizens primarily rely on television (82%) and the Internet (61%) as sources of

information about marine impacts. They showed that the level of concern regarding marine impacts is closely associated with the level of informedness and that pollution and overfishing are two areas prioritized by the public for policy development.

4 CONCLUSIONS

The overall impression is that our respondents have very general awareness of marine environmental issues, however, less than half of them were aware of the harmful effects of UV filters on the marine environment. More than half respondents declared that they are highly concerned about the problems of marine environment pollution and takes actions related to reducing the adverse impact on the marine environment. The most mentioned threats to the marine environment were oil spills, litter and the possibility of entanglement of marine animals. But just few of them was able to correctly indicate the harmful impact of UV filters on marine organisms. Probably it is because the availability of information on harmful impact of UV filters is limited - this topic is rarely covered on TV and social media. Experience in marine-related activities and knowledge about harmful impact of UV filters are important in fostering awareness of the threats to the marine environment, which then translates into consumers' behaviour. Consumer education is essential to ensure that they consider the environmental impact of sunscreen use and to enable consumers to make informed choices about the products they use and how they are used. Therefore it is important to disseminate information about harmful impact of UV filters.

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