Reasons for Withdrawal of Microplastics from Abrasive Cosmetics

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Microplastics have been widely used in cosmetics and, among other things, very often as an abrasive component in peelings. This type of additive is not the main cause of environmental microplastic contamination, but it can pose a significant threat to the environment and to people. Manufacturers are increasingly taking the decision to withdraw microplastics from cosmetics, replacing them with alternatives, and this is also happening because of legal requirements.

microplastic abrasive cosmetics waste plastic particles

1. Microplastics in Cosmetics

Since the 1950s, microplastic has been added to cosmetic products in order to achieve the desired properties of the formulation. It can be found in both rinse-off cosmetics, such as shower gels, and non-rinse-off cosmetics, such as body lotions or eye shadows. Cosmetic manufacturers have favored plastic microbeads because they have proven safe to use and effective in removing dead skin cells. Compared to naturally derived ingredients, they are cheaper, less harsh, compatible with other product ingredients, wash off easily and do not cause damage to packaging containers.

In cosmetics, microspheres of different sizes and shapes are used for a variety of purposes [1]:

- In abrasive cosmetics formulations to remove dead cells of the stratum corneum;
- In toothpastes;
- In bath liquids, soaps, etc., for cleansing the skin of the body and face;
- They have decorative functions, such as glitter, in some preparations.

In facial cleansers, the microbeads used are smaller, whereas, in body scrubs, their size is larger in order to more effectively abrade the epidermis. In toothpastes, the microbeads are up to 100 times smaller, for very gentle cleansing, whereas, in face washes, they are 2 to 4 times smaller than in body scrubs [1].

Microplastics, when rinsed away, make their way into domestic sewage systems, and then to wastewater treatment plants, where large quantities of them are retained. Unfortunately, due to the small size of microplastics, many of them enter the environment. In underdeveloped countries, where there is no access to wastewater treatment plants, yet the usage of microplastics-containing formulations is very high, most of the flushed microplastics end up directly in the environment. Data from 2015 show that European Union countries, together with Switzerland, use 4130 tons of microplastics in cosmetics annually, whereas data from 2017 show that, in mainland China alone, an average of 306.9 tons of microplastics enter the aquatic environment annually [1][2][3].

2. Reasons for Withdrawal of Microplastics from Abrasive Cosmetics

Pollution caused by the production of plastics is one of the most important environmental problems today. Annual global production of plastic materials is about 300 million tons. This value has increased more than 20 times in the last sixty years. Only 30% of plastic is recycled in Europe. About 10% of the plastic produced enters the oceans each year, while about 8 million pieces of plastic enter the oceans daily, mainly from waters carried by river currents. Plastics are highly durable, making it possible for them to take hundreds of years to decompose [4].

From the moment it is produced, the plastic is broken down into smaller particles. The mechanism may include mechanical and chemical decomposition (depolymerization), e.g., under the influence of sunlight, microbes and water. Plastic fragments that are less than 5 mm are defined as microplastics. Nanoplastics are particles that do not exceed <1 µm [4][5].

Plastic microparticles can be divided into primary and secondary types. The first ones are produced for a specific purpose and are found, for example, in the form of microspheres in personal care products, as plastic pellets used in industrial production or as plastic fibers in synthetic textiles. Secondary microplastics are formed from the degradation and fragmentation of larger plastics and from the degradation of synthetic fibers. Nanoplastic is the product of further degradation of both mentioned microplastic types [4][6].

Nanoplastic particles present in the environment are characterized by irregular shape and size, heterogeneity of composition and a wide variety of physical properties. Nanoplastics are not neutral to human health. Daily exposure, most often in occupational environments, to air contaminated with plastic nanofibers can lead to chronic diseases of the respiratory system and other organs. Three routes can be distinguished for the entry of this material into the body. Inhalation is the first of these and is most often associated with the pollution of the air with aerosols that contain nanoplastics. The second pathway is transdermal absorption (through hair follicles, sweat glands or through damaged skin), which occurs through contact with contaminated air, with contaminated water, and when using cosmetics containing nanoplastics, such as abrasive cosmetics. The third route for nanoplastic penetration into the human body is through the gastrointestinal tract, where plastic nanoparticles most often enter with fish-meat, seafood and contaminated water [7].

In response to increasing pollution from polymer materials, the European Union has developed the concept of a circular economy for plastics, which implies that, once produced and put into circulation, products, raw materials and materials must remain in the system for as long as possible. This reduces the release of polymer plastics into the environment, as well as the production of new waste [8]. With concern about microplastics in the water environment, which can directly and indirectly affect human health, Directive 2020/2184 of the European Parliament and the Council (EU) was endorsed to improve the availability of safe drinking water [8]. The European Chemicals Agency (ECHA), in 2019, proposed restricting the use of polymeric plastics in cosmetic products, due to the fact that they can be a potential source of primary microplastics. The list in the ECHA document included 19 such compounds [9]:

- Polyethylene (INCI: Polyethylene): abrasive, film-forming, viscosity-regulating;
- Polypropylene (INCI: Polypropylene): viscosity-regulating;
- Polymethyl methacrylate (INCI: Polymethyl methacrylate): film-forming, sorbent to deliver active ingredients;
- Poly (tetrafluoroethylene) (INCI: Polytetrafluoroethylene acetoxypropyl betaine): improves hair condition, filler, slip enhancer, binding agent, improves skin condition;
- Polyurethane crosspolymer-1 (INCI: Polyurethane crosspolymer-1): binding;
- Polyurethane crosspolymer-2 (INCI: Polyurethane crosspolymer-2): film-forming;
- Polyamide (nylon) (INCI: Polyamide-5): improves skin condition;
- Polyamide (nylon) 6 (INCI: Nylon-6; Nylon 6/12): softening/moisturizing, improves skin condition, viscosity-regulating, filling agent;
- Polyamide (nylon) 12 (INCI: Nylon-12, Nylon-12 fluorescent brightener 230 Salt Nylon 12, Nylon 6/12): filling, darkening, viscosity-regulating;
- Styrene-acrylic copolymer (INCI: Styrene/acrylates copolymer): darkening, film-forming;
- Poly (ethylene terephthalate) (INCI: Polyethylene terephthalate): film-forming;
- Poly (ethylene isotereftalate) (INCI: Polyethylene isoterephthalate): filling, bonding, film-forming, hair fixative, viscosity-regulating, aesthetic agent;
- Poly (butylene terephthalate) (INCI: Polybutylene terephthalate): film-forming, viscosity regulating;
- Polyacrylates, acrylates copolymer (INCI: Acrylates copolymer acrylates crosspolymer): antistatic, binding, film-forming, hair fixative, suspending agent;
- Copolymer of ethylene and acrylic acid (INCI: Ethylene/acrylic acid copolymer): film-forming, gelling agent;

- Polystyrene (INCI: Polystyrene): film-forming;
- Crosspolymer of methyl methacrylate (INCI: Methyl methacrylate crosspolymer): film-forming;
- Polymethylsilsesquioxane (INCI: Polymethylsilsequioxane): darkening;
- Polylactide (INCI: Polylactic acid): abrasive.

Many cosmetic manufacturers have stopped using the polymers included in this list in their products, with the environment and consumers in mind [8].

Impact of Microplastics on the Water Environment

From year to year, the content of waste plastic particles in the seas and oceans is steadily increasing, posing quite a threat to ecosystems. The marine environment is most vulnerable to pollution of anthropogenic origin, which, together with chemical pollutants, contaminates the seabed, deep water and surface waters of all oceans, as well as beaches. Waste plastics reach the ocean with the flow of rivers, with surface and deep-sea water surges, from ships, during catastrophes, from the atmosphere and from various objects present at sea, such as oil rigs. Plastic bags and bottles, as well as fishing equipment, are the most common waste discarded by fishing boats, and this has been a huge problem for more than 50 years. Plastic waste contributes to the death of many organisms: it causes damage to their bodies, poisons the organisms by emitting harmful substances and restricts their growth by their becoming entangling in it [10][11].

As mentioned earlier, waste plastics are being fragmented into micrometer or millimeter-sized particles by:

- Ultraviolet radiation (UV) exposure;
- Waves;
- Salinity;
- Oxygen availability.

The presence of microplastics has been reported all over the world: from the intertidal zone to deep-sea sediments and from the polar regions to the equator. Millimeter-sized plastics were first noticed in the marine environment as early as the 1970s. Now, the scale of the problem is huge, as the amount of microplastics in the marine environment has been estimated to be 12.5 to 125 billion particles, according to data. Their main sources are wastewater treatment plants and overflowing drainage systems. Each year, 21% of all primary microplastics and 79% of all secondary microplastics enter marine systems. Water pollution from primary microplastics comes mainly from household chemicals (e.g., detergents and fertilizers, which are the source of the smallest plastic microbeads) and from its addition to cosmetic preparations, such as toothpastes, masks, shower gels, creams and exfoliants [6][10][12][13]. Secondary microplastics are also a significant water pollutant [6][10][13].

The presence of microplastics in the marine environment has a negative impact on fauna and flora. Its presence in marine biota is reported at all trophic levels—from phytoplankton and zooplankton to fish [14][15]. Owing to their small size and low density, they easily spread in water. The size of microplastics is a contributing factor to their ability to harm organisms—the smaller the size of the microplastic, the more often it is consumed by organisms throughout the food chain. The color of microplastics is also of great importance, as those similar in color to biological foods are more likely to be consumed, whereas the shape of microplastics affects bioaccumulation and toxicity in organisms. Depending on their shape, they can be absorbed differently. Microplastics that have accumulated in the intestines of fish can cause a range of toxic effects, which include inflammation and metabolic disorders, mucosal damage and increased mucosal permeability [16].

The generation of new environmental hazards is a result of the structure and composition of microplastics. Toxic organic pollutants found in water can be locally accumulated on the surface of microplastics, resulting in a local increase in their concentration. In addition, plastics present in the aquatic environment often release toxic compounds used in their production process (plasticizers). The biological effect of introducing toxins into the body through the ingestion of microplastics is the accumulation of them in the tissues of animals, leading to disease or even death. It is also worth noting that microplastics consumed by smaller animals are transported up the nutritional chain and can eventually end up in the body of fish consumed by humans. This means that the problem directly affects the entire human population, and not just by posing threat to the environment, as it can negatively affect the health and life of any person [14].

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