Küçükçekmece Lagünü’nde (Marmara Denizi, Türkiye) Kişisel Bakım Ürünlerinin Daphnia magna Üzerindeki Oluşu Toksik Etkilerinin Araştırılması

V. Zülal SÖNMEZ1,2,* Nevra ERCAN3 Nüket SİVRİ1
1 Department of Environmental Engineering, Istanbul University-Cerrahpasa, TURKEY
2 Department of Environmental Engineering, Duzce University, TURKEY
3 Department of Chemical Engineering, Istanbul University-Cerrahpasa, TURKEY

Abstract: Polyethylene glycols (PEGs) used in personal care products (PCPs) are preferred in a wide range of fields thanks to their solubility, viscosity properties, and low toxicity levels which were detected on mammals nearly 60 years ago. This study was aimed to determine the effect of acute toxicity of personal care products and PEGs which are used particularly in personal care and pharmaceutical products on aquatic ecosystems. In this scope, this study was determined the individual acute toxicities of PEGs; the acute toxicity of baby shampoo and body lotion which are among personal care products containing PEGs; and the possible acute toxicity of these products when they reach the surface waters. Daphnia sp. Acute Immobilisation Test was used to determine the toxic effect on aquatic organisms. The acute toxicity class of PEGs was identified as non-toxic (Class 0). While the body lotion was highly toxic (Class 5) at the end of the 48-hour exposure time without being applied to any surface water, it was non-toxic (Class 0) for all stations when applied to surface water. While the baby shampoo was practically non-toxic (Class 1) at the end of the 48-hour exposure time without being applied to any surface water, it was slightly toxic (Class 2) for station 1 and station 2 when applied to surface water. When PCPs including these liquid plastics, which are found to have non-toxicity characteristics, is obvious that different toxic effects can emerge apart from the individual toxicity on surface waters.

Keywords: Acute toxicity, Daphnia magna, Personal Care Products (PCPs), Polyethylene glycol (PEG), Surface waters.

Öz: Kişisel bakım ürünlerinde kullanılan polietilenglikoller (PEGler), çözünürlük, viskozite özellikleri ve yaklaşık 60 yıl önce memelilerde tespit edilen düşük toksisite seviyeleri sayesinde çok çeşitli alanlarda tercih edilmektedir. Bu çalışmanın amacı, kişisel bakım ürünlerinin ve özellikle kişisel bakım ve eczacılık ürünlerinde kullanılan PEGlerin sucul ekosistemler üzerindeki akut toksisitesini etkisini tespit etmektir. Bu kapsamda, bu çalışmada PEG’lerin bireysel akut toksisiteleri; PEG içeren kişisel bakım ürünlerı arasından yer alan bebek şampuanı ve vácut losyonunun akut toksisitesi; ve bu ürünlerin yüzey sularına ulaştıklarında oluşan akut toksisitesi belirlenmiştir. Sucul organizmalar üzerindeki toksik etkileri belirlenmek için, Daphnia sp. Akut Hareketsizlik Testi kullanılmıştır. PEG’lerin akut toksisitesi sıfırdı, toksik olmayan olarak belirlenmiştir (Toksitسة Sınıfı 0). Şamponun, 48 saatlik maruziyet süresinin sonunda herhangi bir yüzey suyu uygulananmdan yüksek derecede toksik (Toksitسة Sınıfı 5) iken, yüzey suyu uygulandığında tüm yüzeysel su numuneleri için toksik değil (Toksitسة Sınıfı 0) olarak belirlenmiştir. Bebek şampuanı, 48 saatlik maruziyet süresinin sonunda herhangi bir yüzey suyu uygulandan pratik olarak toksik olmayan (Toksitсь Sınıfı 1) iken, yüzey suyu uygulandığında istasyon 1 ve istasyon 2 için haif toksitktır (Toksitсь Sınıfı 2). Toksik olmayan özelliklere sahip olduğu tespit edilen bu sıvı plastikleri içeren PCPs, yüzey sularındaki bireysel toksisitesi dışında farklı toksik etkileri ortaya çıkabileceğini açıklar.

Anahtar kelimeler: Akut toksitke, Daphnia magna, Kişisel Bakım Ürünleri, Polietilen glikol (PEG), Yüzeysel sular.

*Corresponding author’s: V. Zülal SÖNMEZ
Istanbul University-Cerrahpasa, Department of Environmental Engineering, Istanbul, Turkey.
E-mail: zulal.kiremitci@istanbul.edu.tr
Mobile telephone: +90 (530) 153 89 99
Fax: +90 (212) 473 71 80

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INTRODUCTION

Personal care products (PCPs) comprise a wide range of products such as skin, hair, body care, oral health and dental care, and makeup products. The amount of pharmaceuticals and active ingredients in personal care products, which are used in large quantities around the world, is almost at the same level as the number of agricultural chemicals (Daughton & Ternes, 1999). The interest in these products has increased in recent years due to the frequency of use and chemical structure of them (Liu & Wong, 2013), because personal care products, unlike drugs, are not subject to metabolic changes in the human body. Therefore, large quantities of PCPs are mixed directly into the receiving environment without going through any change.

PCPs journey may start from sewage and end in surface water, even in drinking water basins and/or soil (Kim et al., 2009). This results from the disposal of the wastes in treatment plants which cannot be performed by conventional methods (Çetinkaya Karafaktı, 2018). These products may be threatening since they are potentially permanent, bio accumulative, biologically active, and continuously discharged into the aquatic environment (Brausch & Rand, 2011). PCPs are among the most frequently detected compounds among primary pollutants in surface water, even at nanogram levels (Pablos et al., 2015).

Today, another remarkable danger in personal care products are microplastics. Polyethylene microbeads, which are mostly encountered in skin cleaning products, are 10−700 µm in diameter and generally below 500 µm. In such particle sizes, they can easily access the digestive systems of aquatic organisms and may be fatal to them (Wardrop et al., 2016). Microbeads found in personal care products and cosmetics have been recently banned in the USA, Canada, and the European Union. However, it is still widely used in many countries, including Turkey (Hernandez et al., 2017; Ustabası & Baysal, 2019). However, microbeads are not the sole plastic-type found in personal care products.

Different polymeric structures are used as solvent, thickener, plasticizing agent, softener and surfactant in personal care products today. In particular, hydrophilic PEGs having different molecular weights are found in almost all cosmetic product compositions. Depending on the molecular weight, PEGs are used in liquid, waxy solid and solid forms in cosmetic, pharmaceutical and food industries. Food and Drug Administration (FDA), based on the Inactive Ingredient Database (FDA, 2019) declared that the maximum amount used of PEG decreased in line with increasing molecular weight PEG 400, 4000, 6000 and 8000 are 960.48, 449.6, 450 and 100 mg per dosage form, respectively.

There are studies conducted on sources, fate, and effects of microplastics in aquatic and terrestrial environments; their uptake by organisms and possible effects on them (Cheung & Fok, 2016; Duis & Coors, 2016; Kalčíková et al., 2017; Lei et al., 2017). In the literature review, therefore, it is difficult to come across a study conducted on the fate and effects of water-soluble liquid plastics contained in these products. Previous studies investigated the intended use of various PEG compounds and concluded that their use in cosmetics is relatively safe for public health (CIR Expert Panel, 2004; Fruijtier-Pölloth, 2005; Jang et al., 2015; Lanigan et al., 2001). The number and variety of PEGs studied remained limited due to the wide range of PEGs. Considering the importance of PCPs, the addition of new products, the advancement of technology and public health as well as environmental health, it is believed that the current studies fall short to reflect the future picture.

Chronic and acute tests conducted with Daphnia magna are among the most common studies in the field of aquatic toxicology (Martins et al., 2007; Sönmez et al., 2016). D. magna has been an essential organism for ecotoxicology due to its ease of reproduction in the laboratory and its place in the food chain (Imhoff et al., 2017). It also makes it possible to use these organisms to determine the toxicity of liquid plastics because they are fed by filtering water.

This study was aimed to determine the effect of acute toxicity of personal care products and PEGs which are used particularly in personal care and pharmaceutical products on aquatic ecosystems. In this scope, this study was determined the individual acute toxicities of PEGs; the acute toxicity of baby shampoo and body lotion which are among personal care products containing PEGs; and the possible acute toxicity of these products when they reach the surface waters. Samples of surface waters with seawater, freshwater and brackish water composition were taken to determine the toxic effect of PCPs in surface waters.

MATERIAL AND METHOD

In this study, PEG was selected as polymer material and subjected to acute toxicity tests at different concentrations. As PEG products are present alone, two different PCP products containing PEG were selected and their acute toxicity was studied. Finally, a scenario was created for the discharge of selected PCPs to the surface waters (seawater, freshwater and brackish water) with 3 different compositions and the acute toxicity test was applied in the prepared sets.

Selection of PEGs: Polyethylene glycols 200, 300, 400 and 600 are fluid and 1000, 2000, 4000, 6000 and 10.000 are solid. The number demonstrates the mean molecular weight of polyethylene glycols in a given product. Table 1...
presents the PEGs selected within the scope of the present study and their use in PCPs. In the experimental studies, PEGs of Sigma-Aldrich brand were used.

Table 1. PEGs selected within the scope of the present study and their use in PCPs (Jang et al., 2015).

| Polymer     | Description as cosmeticingredients                                           |
|-------------|------------------------------------------------------------------------------|
| PEG 600     | Humectant, Shower and bath products, creams and lotions, shampoo, shaving products and liquid soaps. Perfume fixative, softener, non-greasy lubricant. Moisture stabilizing effect in creams. Leaves a pleasant feel on the skin. Intoxication, acts as a cleansing agent. |
| PEG 1500    | Stabilizing effect in creams. Leaves a pleasant feel on the skin. Intoxication, acts as a cleansing agent. |
| PEG 2000    | Non-ionic, moisturizing, lubricating softener, moisture-stabilizing effect in creams. Leaves a pleasant feel on the skin. |
| PEG 6000    | Non-ionic, binder, lubricant, suspending agent Slip and mold-release agent, water soluble carrier substance, |
| PEG 10000   |                                                                                                                                 |

Selection of PCPs: Two different products, baby shampoo, and body lotion were selected as personal care products having the common feature of containing PEG. In addition to having PEG in common, both products have the potential to be eco-friendly/greener than other products.

The first product, baby shampoo is widely used in Turkey, its chemical content is formed for relatively sensitive skins due to its usage area. The product is stated to be in line with the Cosmetic Act no. 5324 and Cosmetic Regulation in force in Turkey which were modelled and prepared in accordance with the Regulation (EC)No 1223/2009 of the European Parliament and of the Council on Cosmetic Products. It contains mix of PEG esters (as polyethyleneglycol oleate and polyethyleneglycol stearate) along with different chemicals.

The other product, body lotion is produced by an environmentally sensitive company. It is sold at higher prices since it is known to be more sensitive to its equivalents in the Turkish market. It contains the compound of PEG esters (polyethyleneglycol stearate) along with different chemicals.

Selection of Surface Waters: It is observed that water quality has deteriorated as pollution levels increased over time in the Kucukcekmece Lagoon where seawater, freshwater, and brackish water compositions coexists in Istanbul province (Sivri et al., 2012). Both the connection of the lake to the Sea of Marmara and the pollution carried by rivers to the lake further increased the pressure on it. The sample of the surface water was collected to identify the toxicity of personal care products, the toxicity of which was determined in surface water. Samples were taken from 3 different stations from surface water with different composition on the southwest coast of Istanbul.

Special attention was paid to the dispersibility of PCPs at different salinity rates while selecting the stations. Therefore, the Avciar Coast, which is connected with the lagoon, with seawater composition (Station 1), the channel of Kucukcekmece Lagoon, which has a channel for transitional waters between the lake and sea, with brackish water composition (Station 2), and Kucukcekmece Lagoon with a composition close to freshwater (Station 3) were selected. The information obtained regarding these stations is presented in Table 2. The general view of the stations is presented in Figure 1.

Table 2. Sampling Stations and compositions of surfacewaters’.

| Stations     | Name of Stations | Composition of water (‰) | Coordinates         |
|--------------|------------------|--------------------------|---------------------|
| Station 1    | Avciar Coast     | Seawater (22‰)           | 40° 58' 47,11” N  28° 46' 8,07” E |
| Station 2    | Kucukcekmece Channel | Brackish water (11‰)   | 40° 58' 51,13” N  28° 46' 22,01” E |
| Station 3    | Kucukcekmece Lake | Freshwater (6‰)          | 40° 54' 48,8” N  28° 46' 45,80” E |

In accordance with Water Pollution Control Instruction Methods of Sampling and Analysis, surface water samples taken from each station were brought to Microbiology Research Laboratory (CEMIK) in Department of Environmental Engineering at Istanbul University-Cerrahpasa.

The test was based on the OECD guideline Daphnia magna Acute Immobilisation Test (OECD, 2004). Daphnids not older than 24 hours were exposed to the sample concentration. The vessels were completely filled with appropriate volumes of dilution water and samples. First of all, individual acute toxicity of PEGs was studied (Figure 2). Preliminary tests were performed to determine the concentration range. Afterwards, 100, 80, 40, 20, 10, 5, 1 and 0.1 g L⁻¹ concentrations at which immobility/immortality was observed for each PEG.

In the second step, preliminary tests were performed to detect the concentrations of baby shampoo and body lotion (Figure 2). According to the data obtained, the concentrations of body lotion to be studied were determined as 20 g L⁻¹, 10 g L⁻¹, 5 g L⁻¹, 1 g L⁻¹, 0.5 g L⁻¹, 0.25 g L⁻¹, 0.10 g L⁻¹, 0.05 g L⁻¹, and 0.01 g L⁻¹, respectively. For baby shampoo, the toxicity test was performed at concentrations;
1 g L\(^{-1}\), 0.8 g L\(^{-1}\), 0.6 g L\(^{-1}\), 0.5 g L\(^{-1}\), 0.4 g L\(^{-1}\), 0.25 g L\(^{-1}\), 0.2 g L\(^{-1}\), and 0.05 g L\(^{-1}\). In the final step, the body lotion and baby shampoo were applied to surface water samples (Figure 2).

Then, Daphnids were placed into test beakers. Minimum 2 mL of test solution was needed for each test organism; hence 50 mL test media was studied for 10 daphnids. The organisms were unfed and did not go through the aeration during the test. The temperature, pH and DO values were checked. The controls were kept under the same conditions. Studies were performed in parallel for each set. In addition, low-speed (60 rpm) rinsing movement was applied to ensure adaptation to natural conditions.

Any immobility and abnormal behaviour were recorded after 24 and 48 hours. Each beaker was checked for immobilized daphnids at the 24th and 48th hours. For each period (24 and 48 hours) during which the observations were recorded, the test result was expressed as EC\(_{50}\) with the Probit Analysis method as proposed by EPA to express the dose-response relationship (EPA, 1991).

Any immobile/dead daphnids were counted at either concentration of 1 g L\(^{-1}\) or 0.1 g L\(^{-1}\) studied for both exposure periods. For PEG 6000 and PEG 10000, the mortality rate was found to be 50% or more after the 48-hours of exposure. During acute exposures, daphnids observed to be immobilized were taken from the test environment. At the end of the experiment, immobilized/dead daphnids in each beaker were analysed in KRUSS brand-MBL 2000 binocular microscope environment; physical integrity of organisms was analysed and photographed.

**Classification of Acute Toxicity:** It is possible for products containing PEGs, and PEGs to mix in surface waters unless they are satisfactorily or appropriately dissolved at wastewater purification plants. Therefore, this study grounds on the toxicity classification which is based on toxicity in wastewaters (Table 3).

Table 3. Classification of toxicity (adapted from GESEAMP (2017)).

| Classification | EC\(_{50}\) (mg L\(^{-1}\)) | Acute Toxicity |
|----------------|----------------------------|----------------|
| 0              | > 1000                     | Non-Toxic      |
| 1              | >1000 ≤1000                | Practically Non-toxic |
| 2              | >10 ≤100                   | Slightly Toxic |
| 3              | >1 ≤10                     | Moderately Toxic |
| 4              | >0.1 ≤1                    | High Toxic     |
| 5              | >0.01 ≤0.1                 | Very High Toxic|
| 6              | ≤0.01                      | Extremely Toxic |

**RESULTS AND DISCUSSION**

No mortality/immobility was observed in the control group after the 24- and 48-hour exposure time for all sets. Findings of each set are presented below under separate titled.

**Acute Toxicity Classification of PEGs:** Figure 3 presents the immobilization rate (%) at the end of 24- and 48-hours exposure of the acute toxicity test performed with *D. magna* for PEG 600, 1500, 2000, 6000 and 10.000. Generally, mortality rates increased with increasing exposure time (expect PEG 600). Considering the 24-hour exposure, in general, mortality rates reduced as the number of PEG molecules increased (expect PEG 6000). No immobile/dead daphnids were counted at either concentration of 1 g L\(^{-1}\) or 0.1 g L\(^{-1}\).

Table 4 presents the acute toxicity value of the PEGs studies as (EC\(_{50}\)) g L\(^{-1}\) and the related acute toxicity class. Accordingly, PEG 600, 1500, 2000, 6000 and 10.000 did not have any acute toxicity effect on *D. magna* and were identified as non-toxic. Studies on the toxicological and physiological effects of PEGs have been published in a few journals several years ago. Acute toxicity of different PEGs ranging from PEG 200 to PEG 10.000 on Guinea pig and rabbit, was studied especially between 1938 and 1949. In a study conducted by Synth et al., (1950), the findings obtained were in parallel with the previous studies showing that acute oral toxicity and dermal toxicity were very low. In a review by Fruittier-Pölloth, (2005), it was also found that most of the PEGs and their derivatives studied so far cause very low toxicity after single or repeated exposure to mammals.

At the end of the 24-hour exposure time, a linear relationship was found between EC\(_{50}\) (g L\(^{-1}\)) and PEG molecular weight, just as in mortality (%). However, EC\(_{50}\) values at and above 1000 mg L\(^{-1}\) are classified as non-toxic. Therefore, the relationship has no effect on the toxicity class. In the study conducted by Synth et al. (1950), clear tendency towards a slight decrease in acute toxicity was interpreted with large increases in molecular weight. The statement of reduced toxicity as molecular weight increases is also
reported in review of Fruijtier-Pölloth (2005) on polyethylene glycols (PEGs) and derivatives used in cosmetic products.

Table 4. Acute toxicity rates and classes of PEGs.

| Exposure Time | EC50 (g L\(^{-1}\)) | Classification of acute toxicity | EC50 (g L\(^{-1}\)) | Classification of acute toxicity |
|---------------|----------------------|---------------------------------|----------------------|---------------------------------|
| Sample        | 24 h                 | 48 h                            | 24 h                 | 48 h                            |
| PEG 600       | >10000               | 0                               | >10000               | 0                               |
| PEG 1500      | 20.917               | 0                               | 22.861               | 0                               |
| PEG 2000      | 65.216               | 0                               | 25.280               | 0                               |
| PEG 4000      | >100000              | 0                               | >1000000             | 0                               |
| PEG 8000      | >10000               | 0                               | >1000000             | 0                               |
| PEG 6000      | >10000               | 0                               | >1000000             | 0                               |

Apart from calculating EC\(_{50}\) values affiliated to mortality rates, dead/immobilized daphnids were examined with a microscope to see the effect of exposure. A microscopic image of D. magna in control is presented in Figure 4 for a more solid comparison. Negative effects of the exposure were detected on daphnids in PEG 600, unlike other PEGs, at the 24th hour (Figure 5-a, b). At the 48th hour of exposure, the effects of PEG 2000 (Figure 6) and PEG 6000 (Figure 7) were detected on Daphnids in addition to PEG 600 (Figure 5-c, d) at the highest concentrations studied (100 and 80 g L\(^{-1}\)). This effect, particularly emerging at high concentrations, is due to the fact that daphnids’ digestion systems decrease in volume. In the literature, no related finding has been found, so this behaviour is important.

This finding is important to indicate that the effect on the aquatic organisms may differ by the chemical structure of the polymer type studied. However, this negative effect is thought to be due to the difference in density of working PEGs, which are distinctive features of the polymer, rather than chemical bonds. It is believed more polymers are taken by the daphnids since they are fed by draining water and the density of PEG 600 is relatively lower than PEG 2000 and PEG 6000 (PEG 600 (1.126 g cm\(^{-3}\)), PEG 2000 (1.21 g cm\(^{-3}\)), and PEG 6000 (1.2 g cm\(^{-3}\)) respectively.

Figure 6. The effects of PEG 2000 on daphnids after the 48-hour exposure a) 100 g L\(^{-1}\) (Magnification power, respectively = 4x10 and 10x10) b) 80 g L\(^{-1}\) (Magnification power, respectively = 4x10 and 10x10).

Figure 7. The effects of PEG 6000 on daphnids after the 48-hour exposure-100 g L\(^{-1}\) (Magnification power, respectively=4x10 and 10x10).

Acute Toxicity Classification of PCPs: For body lotion, the EC\(_{50}\) value was found to be 1547 mg L\(^{-1}\) at the end of the 24-hour test period while it was found 0.039 mg L\(^{-1}\) at the end of the 48-hour test period. In terms of acute toxicity classification, the class of body lotion changed from 0 (non-toxic) to 5 (very high toxic). The body lotion toxicity value (0.039 mg L\(^{-1}\)) obtained at the end of 48 hours was found to be higher than the 24-hour test period, and there was a major alteration among the acute toxicity class. Although the concentration of this active substance remained constant, it led to an increase in toxicity with the increase in contact time with the organism. Famous toxicologists like Peter Wells stated that toxicity depends on both concentration and exposure time and presents on a comprehensive basis (Wells, 1984; Lessard & DeMarco, 2000). For a healthy interpretation of the results, 24 and 48 hour EC\(_{50}\) values, EC\(_{50}\) (mg L\(^{-1}\)) and acute toxicity classification are presented in Table 5 for body lotion and baby shampoo. For baby shampoo, the EC\(_{50}\) value was found to be 316.35 mg L\(^{-1}\) at the end of the 24-hour test period while it was 177.47 mg L\(^{-1}\) at the end of the 48-hour test period. There was no change in acute toxicity class in the 24- and 48-hour exposures.

Studies in the literature are mainly carried out on the individual toxicity of the chemicals contained in personal...
care products (Daughton & Ternes 1999). Safety Data Sheets (SDS), prepared by each brand, show information about the ecotoxicity of the ingredients. In the SDS study, it was found that the mean result of acute toxicity test of the chemical having the highest percentage in hand&body lotion products of different brands performed with D. magna, varied between 1.955mg L\(^{-1}\) (48 h) and > 500 mg L\(^{-1}\) (24 h). Results of the acute toxicity test performed D. magna for chemicals contained in the baby shampoo of a certain brand varied between 0.12 mg L\(^{-1}\) and 2564 mg L\(^{-1}\). The literature review shows that the toxicities of the chemicals usually contained in each PCP are studied individually and not evaluated on a product basis (Brausch & Rand, 2011).

The study supports the difference in toxicity found at 24 and 48 hour exposure time. Acute toxicity test results of a brand with D. magna for chemicals in baby shampoo contents vary between 0.12 mg L\(^{-1}\) and 2564 mg L\(^{-1}\). When the literature is evaluated, it is seen that the toxicities of the chemicals usually included in each PCP are studied individually and not evaluated on a product basis.

**Table 5.** The mean of acute toxicity test result of body lotion and baby shampoo.

| Exposure Time | 24 h | 48 h |
|---------------|------|------|
| Sample        | EC\(^{50}\) (g L\(^{-1}\)) | Classification of acute toxicity | EC\(^{50}\) (g L\(^{-1}\)) | Classification of acute toxicity |
| Body Lotion   | ≤5541 | 0 | ≤5539 | 0 |
| Baby Shampoo  | 316.35 | 1 | 177.47 | 1 |

**Table 6.** Acute toxicity classification of surface waters and PCPs interaction with surface waters.

| Exposure Time | EC\(^{50}\) (g L\(^{-1}\)) | Classification of acute toxicity | EC\(^{50}\) (g L\(^{-1}\)) | Classification of acute toxicity |
|---------------|-----------------------------|---------------------------------|-----------------------------|---------------------------------|
| Sample        | Surface waters              | Baby Lotion                     | Baby shampoo                |
| Station 1     | 46.37, 100 mg L\(^{-1}\)    | 2                               | 4927                        | 6.267                           | 2 |
| Station 2     | 567.8, 100 mg L\(^{-1}\)    | 1                               | 1100                        | 85.18                          | 2 |
| Station 3     | 211.54, 100 mg L\(^{-1}\)   | 1                               | 4927                        | 118.62                         | 1 |

Depending on the concentrations studied in the determined toxicity of the body lotion, 20000 mg L\(^{-1}\), 1000 mg L\(^{-1}\), 100 mg L\(^{-1}\), 10 mg L\(^{-1}\) concentrations were selected. Depending on the concentrations studied in the determined toxicity of the baby shampoo, 1000 mg L\(^{-1}\), 500 mg L\(^{-1}\), 100 mg L\(^{-1}\), 50 mg L\(^{-1}\) concentrations were selected to study. 48-hour toxicity test results of the application of the body lotion and baby shampoo to surface water are presented as EC\(^{50}\) and classification of acute toxicity in Table 4. While the body lotion was highly toxic (Class 5) at the end of the 48-hour exposure time without being applied any surface water, it was non-toxic (Class 0) for all stations when applied to surface water. When PEG-containing PCPs are applied to surface waters, it is possible to claim that even PEG-containing non-toxic products can cause toxicity in the aquatic ecosystem because surface waters (especially seawater) are composed of different chemical structures. While the baby shampoo was practically non-toxic (Class 1) at the end of the 48-hour exposure time without the being applied to any surface water, it was slightly toxic (Class 2) for station 1 and station 2 when applied to surface water. In addition, baby shampoo application to surface waters changed the toxicity class of the station 2 (from Class 1 to Class 2). The baby shampoo was practically non-toxic only for station 3.

**CONCLUSION**

To our knowledge, this is the first study to examine PEGs, which are known to be non-toxic, in natural waters. This study proves the non-toxic feature of only PEGs (600, 1500, 2000, 6000 and 10000) on were on D. magna. In summary, PEGs are non-toxic, but PEGs are not used alone in PCPs. Different chemical structures (mists and sulfate structures) contained in PEG-containing products may cause toxicity. In particular, structures that are toxic, carcinogenic to the environment and public health should be strictly excluded from PCPs formulations of these products. To conclude, even specific assessments on each chemical mixture do not mean that those personal
care products are completely safe for the environment. When the personal care products including these liquid plastics, which are found to have non-toxicity characteristics, it is obvious that different toxic effects can emerge apart from the individual toxicity.

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