The harmful effect of commercial powder detergent on water flea (*Daphnia* sp.)

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Abstract. Detergents are a chemical product that is commonly used in personal care and household product on a daily basis. Its huge consumption in human activities resulted in the increasing awareness of its toxicity in the aquatic environment due to their active ingredients. *Daphnia* is a planktonic invertebrate organism that usually found in freshwater ecosystems. It plays an essential part in the lower trophic level of food chains. Because of its sensitivity to various environmental changes, they are generally used as a model organism in toxicology. In the present study, we analyzed the toxic effect of household detergent exposure on *Daphnia* sp. Four different concentration of detergent (25, 50, 75, and 100 mg.L⁻¹) were prepared and the aquadest was used as control. The mortality of *Daphnia* was observed for 24 hours. The result showed that the mortality of *Daphnia* increased along with the increasing concentration of detergent exposures. LC₅₀-24 hours values obtained in this study was 28.89 mg.L⁻¹. This result described that the higher level of detergent in a water body can be harmful to the aquatic organism, especially on *Daphnia* sp. as predominant food for planktivorous fish.

1. Introduction

*Daphnia* or water flea are planktonic crustacean that belong to the Cladocera. It usually found at various type of freshwater ecosystem except at extreme habitats for instance hot springs. *Daphnia* consume small suspended particle in the water. They have known as filter feeders. *Daphnia* are predominant food for planktivorous fish. Therefore, larger species such as *Daphnia magna* will be hard to find at lakes which has lots of predatory fish [1]. *Daphnia* live well in the pH range of 6.5-9.5 and salinity below 5 g.L⁻¹. They can be easily cultured in laboratory condition. However, *Daphnia* are classified as a sensitive organism to the environmental changes. In consequence, they generally used as a model organism in toxicology [2].

One of the xenobiotic substances which affect the water quality is detergent. Detergents are chemical product that generally use in industrial and home cleaning applications. It consists of surfactants, builders, bleaching agents, enzyme, fillers, dispersing agents, fabric softening clay, dye-transfer inhibiting ingredients, optical brighteners, and perfumes [3]. Because its huge consumption in human activity, the large quantities of detergent are disposed and entered to the aquatic environment [4]. The presence of detergent in aquatic environment becomes the serious pollution problems because it was hard to degrade even after sewage treatment [5].

Surfactant is the main component of detergent that has dual nature or amphiphilic. It has hydrophilic or polar part and hydrophobic or non-polar part that facilitated the hydrophobic compounds being dissolved in water [6]. Linear alkylbenzene sulfonate (LAS) is one of the anionic surfactant that widely used as a replacement of alkylbenzene sulfonate (ABS) because it’s easier to
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degrade [7]. However, it also has toxic effect on the organism of aquatic ecosystem [8]. This current study was aimed to analyze the toxic effect of household detergent exposure to Daphnia sp. which is one of the food chain trophic level organism in an aquatic environment.

2. Methods
This study was conducted at laboratory of Campus Banyuwangi, Universitas Airlangga. Daphnia sp. Used in this study was obtained from the laboratory stock culture. The neonates were selected and separated from the adults using nylon sieve with a mesh 1 x 1 mm². A commercial powder detergent, “Easy” was used in this study. The selected Daphnia sp. were threatened to different concentration of detergent solution (25, 50, 75, and 100 mg.L⁻¹). Aquadest was used as control. Ten numbers of Daphnids were inserted into a test tube containing 10 mL of the test solution. The tests were carried in triplicate. The mortality was observed after 24 hours. LC50 24 hours was determined using probit analysis (SPSS version 20). The toxicity level was categorized as followed, highly toxic (LC50 ≤ 1 mg.L⁻¹); toxic (1 ≤ LC50 ≤ 10 mg.L⁻¹); harmful to aquatic organism (10≤ LC50 ≤ 100 mg.L⁻¹); and non-toxic (LC50 > 100 mg.L⁻¹).

3. Result and discussion
Different concentration of detergent exposure on Daphnia sp. for 24 hours generated the mortality of Daphnia in different level (Figure 1.).

![Figure 1. Mortality of Daphnia sp. 24 hours after detergent exposure](image)

The mortality of Daphnia sp. significantly increased (p<0.05) along with the increasing of detergent concentration. The highest mortality occurred in 75 and 100 mg.L⁻¹ of detergent. the LC50 value obtained in this study was 28.89 mg.L⁻¹. According to Sobrino-Figueroa [9], the toxicity level of detergent was categorized as harmful to aquatic organism.

Detergent is a complex combination of various synthetic compounds in which the active substance is a surfactant. There are three types of surfactant that commercially available, i.e anionic, amphoteric, and non-ionic surfactant. Pavlić et al. [10] explained that all of the types of surfactant had toxic effect on freshwater green alga and very toxic on marine diatoms. Some previous research also investigated the effect of surfactant exposure to various organism, such as microbes, Daphnia magna, and fish [4, 6, 11, 12, 13]. They revealed that higher level of surfactant exposure and longer contamination period in the water ecosystem could affect the balance of the ecosystem due to their toxic effect on organism. Besides that, surfactant contamination on water body also caused the water quality degradation. Waste water contained detergent showed the level of pH, total dissolved solid, chloride, sulphate, carbonate and bicarbonate content are higher than tap water [14]. The enhancement of these content on water body can become the stressor agent to the aquatic organism so that disturbing their well-being lives.
This study proved the harmful effect of detergent exposure to the *Daphnia* sp. that lead to the mortality during 24 hours after exposure. The toxicity of surfactant on aquatic organism is illustrated by the non-specific interaction between surfactant and cell membrane. This interaction leads to the alteration of cell membrane permeability so it will interrupt the functioning of respiratory organs [11]. Moreover, surfactant also causes serious vital organ damage, hematological, hormonal and enzyme disorders [15]. This present study can be performed as the simple test to find out the result of detergent exposure to the natural environment, where the use of detergent and detergent disposal to the environment is an important concern to maintain the sustainability of the ecosystem. Consequently, it is important not only selecting the more biodegradable and non-toxic detergent products but also treating the detergent wastewater before discharging into the environment.

4. Conclusion
The detergent exposure can lead the mortality to the *Daphnia* sp. as predominant food for planktivorous fish. Further, these harmful effect can disrupt the ecosystem balance. It is suggested further research on the invention of more biodegradable and non-toxic detergent product to maintain the aquatic ecosystem balance.

5. Reference
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