

## A Study on the Effect of Shampoos on *Vigna Angularis*

Sherin C Baby \* , Ambili T.R

PG & Research Department of Zoology,  
Alphonsa College, Pala, Kottayam , Kerala

\* Email: Sherinbaby17@gmail.com

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**Abstract:** Personal Care Products(PCP's) such as shampoos are a widely used cosmetic product by people all across the country irrespective of age and gender. Even though the role of shampoo as a pollutant and its effect were not given significance earlier it is now considered as an emerging pollutant. In this study the effect of shampoo on the development of *Vigna angularis* seedling was analyzed using three types of shampoos; chemical shampoo, commercial natural shampoo and homemade herbal shampoo. The present study found that the effect of both chemical and commercial natural shampoos were the same. The root and shoot development was hindered at the 100% concentration of chemical shampoo and the germination percentage of this type of shampoo was 63.09 %. The growth of seedlings was inhibited by the 50% concentration of the commercial natural shampoo and its germination percentage was 46.42%. The homemade herbal shampoo didn't affect the development of *Vigna angularis* at any concentration and it was found to have the highest germination percentage of 73.81 %. It was also found that the commercial companies do not label all the ingredients included in the formulation of the shampoo. So many chemical components which directly reach the environment without undergoing any kind of biotransformation causes harmful effects on the flora and fauna . Shampoos also contribute to the major common crisis of plastic pollution by its eco-unfriendly packaging using non recyclable plastic. This study aims to address the toxic effect and adversities caused by personal care products like shampoo on the environment and to study its impact on it.

**Keywords:** Shampoo, seedlings, environment, *Vigna angularis*, PCP's.

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### INTRODUCTION

Cosmetics and other personal care products have been used by both men and women since prehistoric times. Ages ago people used materials for cleansing, beautifying and otherwise altering their appearance. The United States Food and Drugs Administration (FDA) defined cosmetics as "a product intended to be applied on the human body for cleansing, beautifying, promoting attractiveness or altering the appearance". According to a widely accepted classification, cosmetics can be divided into leave-on and rinse off products. The leave -on products are intended to stay on the skin for an extended period of time . On the contrary, rinse off products are the products designed to be rinsed off after a short stay on the skin or mucous membranes. Shampoo comes under the rinse off category of classification (Juliano and Magrini, 2017).

The main purpose of shampoo is to remove dirt and oil from the surface of the hair fibers and the scalp. The essential ingredient in shampoo is a detergent of some

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sort. Modern shampoo uses a synthetic detergent as a cleaning agent. In shampoos for adults, the detergent is usually an anionic type, such as sodium dodecyl sulfate, the same detergent used in many toothpastes. For shampoos meant to be used on babies and children, the detergent is often an amphoteric type and is less irritating to eyes. Amphoteric detergents react with both acids and bases (Mathew and Xavier, 2019). Commercial shampoo has many other components in it due to their multitude of purposes such as additional components to control dandruff and condition hair. Shampoos typically contain a primary and a secondary surfactant for thorough cleaning, a viscosity builder, solvents, conditioning agents, pH balancer and other components such as fragrance and colour for commercial appeal (Zhang *et al.*, 2015).

Unfortunately, shampoos have done lasting damage to our water supply in two major ways: their ingredients and the plastic containers that hold them. The simple act of rinsing hair with shampoo can pave the way to the beginning of a series of pollution problems. The non-degradable ingredients in the shampoo directly reach the environment. These ingredients are found in a variety of environments including wastewater, sediment, surface water, ground water, drinking water etc. As the drinking water is treated they are less likely to cause problems to humans but they harm both aquatic life and animals that drink from these water bodies. Chemicals in shampoo could change the hormone levels of animals and thus can affect their ability to reproduce.

In the last few years, tremendous increase in the demand for cosmetic products has increased its rate of production. The regular usage of cosmetic products in large amounts which in turn leads to the continuous release of the cosmetic substance to the aquatic environment, their ecological and environmental impact is associated with the fact that they are environmentally persistent, bioactive and potentially able to bioaccumulate, thus posing a threat to ecosystem and human health. Thus cosmetic products and other personal care products like shampoo are considered as a class of emerging pollutant with significant concern (Brausch and Rand, 2011). Shampoos also contribute to the major pollution issue of plastic pollution as they use partially recyclable or non-recyclable plastic bottles or sachets to hold them.

Brausch and Rand (2011) through their article examines the acute and chronic toxicity data available for personal care products and highlights areas of concern. In their study, toxicity and environmental data were synergized to develop a preliminary hazard assessment in which only triclosan and triclocarban presented any hazard. However, numerous PCPs including triclosan, paraben preservatives, and UV filters have evidence suggesting endocrine effects in aquatic organisms. Juliano and Magrini (2017) through their work, provides an overview of some cosmetic ingredients that are considered environmental emerging pollutants of particular concern such as UV filters, some preservatives (Parabens, triclosan) and microplastics. They bring light on the commonly used cosmetic ingredients that have not historically been considered of ecological concern but are now being monitored because of their suspected adverse ecological effects. Gubitosa *et al.*, (2019) through their study showed that in recent years consumer demand for natural ingredients and additives, especially in cosmetic products, has increased as people become more concerned about the negative effects of synthetic compounds on health and environment. Khan *et al.*, (2019) in their article studied about the cosmetic products and their associated toxicities, health hazards associated with chemicals used in formulation of cosmetics and health risk associated with heavy metals in it. They found that various toxic ingredients and hazardous chemicals used in cosmetics are

incorporated beyond acceptable limits. These chemicals may cause serious ill effects on skin and may also enter skin and other organs causing carcinogenicity.

The toxicants in shampoo reach the environment in an unaltered form as they are externally applied and do not undergo any biotransformation. It has many toxic effects on humans. If human, a vertebrate is having such harmful effects from cosmetics and personal care product, its impact on environment will be much higher as the environment is more vulnerable with microscopic organisms and other invertebrates. This study aims to address the toxic effect and adversities caused by personal care product like shampoo on the environment and to study its impact on it. The objective of this study was to observe and compare the growth of seedlings in a dilution series of chemical shampoo and commercial natural shampoo and homemade herbal shampoo and to estimate the seed germination percentage of each type of shampoo. The concentration at which the growth of seed was inhibited was evaluated. Hence the study was conducted to assess the impact of chemical shampoo and commercial natural shampoo on the environment thus bringing attention and awareness to the dark side of beauty products.

### **Materials & Methodology**

The materials required are : 3 sets of plastic seedling tray (if reused 3 is enough), each for chemical, commercial natural shampoo and homemade herbal shampoo. Shampoos [1 commercial natural shampoo (Dheedhi), 1 chemical shampoo (Clinic plus) and homemade chemparathi thaali]. Plastic spoons, 10 ml measuring cup, Plastic container, Pea seeds belonging to *Vigna angularis*, Potting soil, Ruler, A piece of string, Lab notebook.

The study was conducted in the month of June in 2022. The experimental setup consists of preparation of a dilution series of each shampoo. The shampoos taken for the experiment were a chemical shampoo (Clinic plus), a commercial natural shampoo (Dheedhi) and homemade chemparathi thaali. Different concentrations of each shampoo with 0% as the control and 3%, 6%, 12.5%, 25%, 50%, 100% as the dilution series were prepared. To prepare 100% of a shampoo, 5 ml of a shampoo was taken. For preparing 50% of a shampoo, 5 ml shampoo was mixed with 5 ml of water. To make 25% of the shampoo, 5 ml of the 50% (prepared in the previous step) was mixed with 5 ml of water. This step is repeated until 3% of the shampoo solution is prepared. The control was prepared by adding 5 ml water to the pit.

21 pits containing 10 g potting soil with 5 ml of each concentration of shampoo was prepared. After mixing the soil and shampoo with a clean spoon 4 seeds of *Vigna angularis* were exposed to every pit. The experimental setup was observed for a week. As the seedling grows, the shoot (which includes the stem) will be thicker than the root. There may be a point on the seedling where this change in thickness is very clear; this should be where the root and shoot meet. If the root is straight, it can be measured with a ruler. If the root has bends or curves, a piece of string can be used to follow the root. Cut the string at the root tip and measure the length of the string. Record the total string length as the root length in a lab notebook. If the seedling has multiple roots, the length of the main root is considered for measurement. Similarly the length of shoot can also be obtained.

The growth of the seedling was analyzed after the observation period and was carefully examined to evaluate the shoot and root length along with seed germination percentage. The concentration at which each shampoo inhibited the growth of seedlings was also noted to assess the impact each type of shampoo has on the environment. The procedures were conducted 3 times to ensure the obtained results

are accurate and repeatable. The seed germination percentage was calculated using the formula ;

$$\text{Germination percentage (G.P)} = (\text{Number of seeds germinated} / \text{Total number of seeds sown}) \times 100$$

## RESULTS AND DISCUSSION

The shampoos selected for the study namely, clinic plus (chemical shampoo), Dheedhi (commercial natural shampoo) and homemade chemparathi thaali (natural shampoo) were found to have significant effect on *Vigna angularis*. The chemical and commercial natural shampoo affect the growth of *Vigna angularis* seedling, whereas the homemade herbal shampoo doesn't caused any interference to the seed growth at any concentration. The results from the 3 trials conducted for each type of shampoo to the corresponding concentration and the resultant root and shoot length is depicted using a line graph in Figure 3.1 and Figure 3.2 respectively.

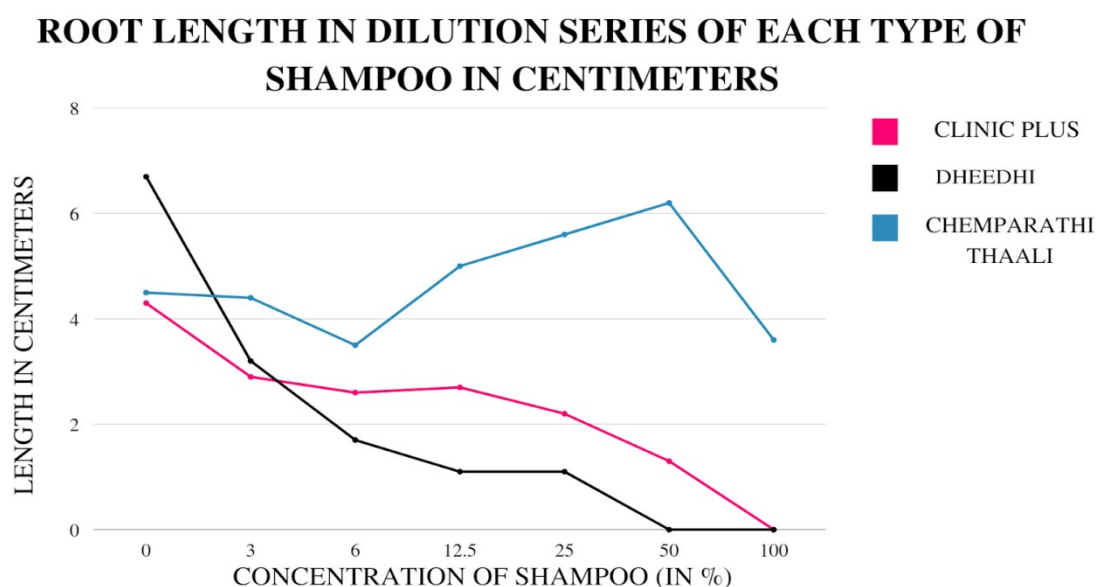


Fig 3.1 Root length in dilution series of each shampoo

From the figure 3.1 we could infer that the length of the root tends to decrease as the concentration of the shampoo increases. The root growth was completely inhibited at 100 % concentration of chemical shampoo and 50% of commercial natural shampoo. The homemade herbal shampoo (chemparathi thaali) did not inhibit the root growth and at any of the concentrations. The root length in this case was comparatively higher than the root lengths of chemical and commercial natural shampoo.

### SHOOT LENGTH IN DILUTION SERIES OF EACH TYPE OF SHAMPOO IN CENTIMETERS

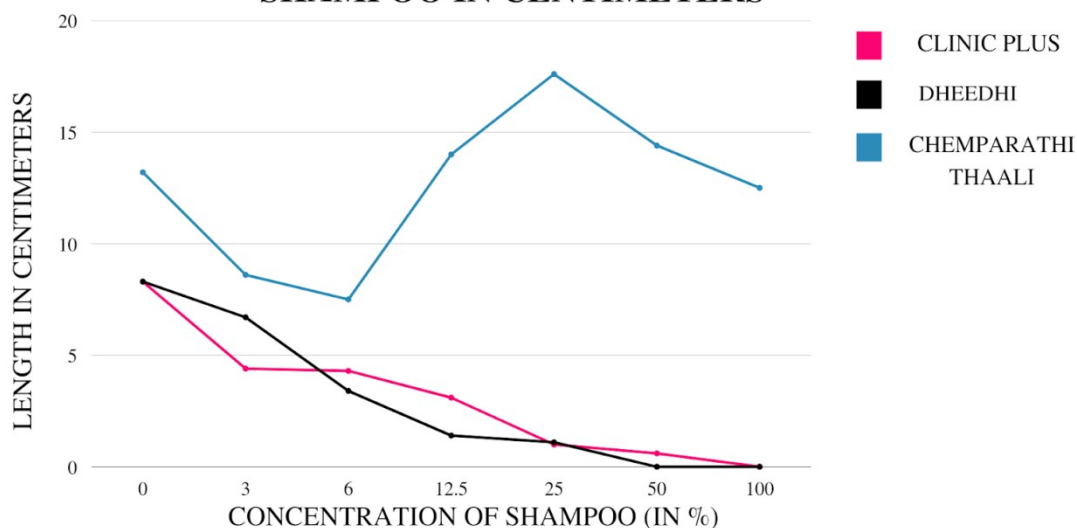


Fig 3.2 Shoot length in dilution series of each shampoo

The figure 3.2 clearly shows how the shoot length varies among the seedlings of homemade herbal shampoo to the shoot lengths of chemical shampoo and commercial natural shampoo. The shoot growth was blocked at the 100 % concentration of chemical shampoo whereas it was at 50% concentration of commercial natural shampoo. The seedling growth wasn't affected by increased or decreased concentration of homemade herbal shampoo which indicates that it is nontoxic to nature.

The seed germination percentage for each type of shampoo is illustrated using a pie chart in Figure 3.3. The seed germination percentage was found to be 63.09 % and 46.42 % for chemical shampoo and commercial natural shampoo respectively. The highest germination percentage was shown by the homemade herbal shampoo, which was 73.81 %.

## SEED GERMINATION PERCENTAGE IN A DILUTION SERIES

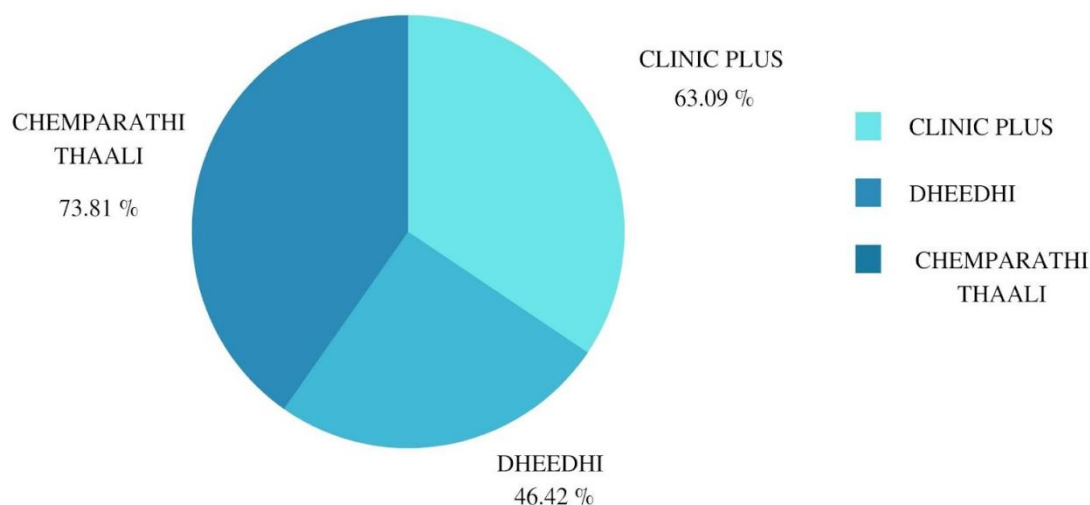


Fig 3.3 Seed germination percentage in a dilution series

Personal care products like shampoo are found more often in higher concentration than pharmaceuticals. They are used in larger quantities and are used throughout life. The annual production and consumption of personal care products like shampoo exceeds thousands of tons. The environmental fate of these products is largely unknown. Less research and studies are conducted to examine the toxic side of cosmetics and personal care products and the impact they leave on the environment.

In the present study it was found that the length of root and shoot tend to decrease in both chemical and commercial natural shampoo as the strength of its concentration increases. Thus in the case of chemical and commercial natural shampoo, the root or shoot elongation is said to be inversely proportional to the strength of the shampoo. Whereas in the homemade herbal shampoo the growth of the seedlings were not inhibited in any concentrations of the dilution series. The lengthening of shoot or root were not decreased even at the increased concentration. This clearly indicates that all sorts of commercial shampoo, whether labeled chemical or natural, has got the toxic side to hinder the natural process of seed germination. The homemade herbal shampoo being natural by itself and devoid of additives for commercial appeal, doesn't cause any interference to the seed germination and its growth.

The results obtained from both chemical and natural shampoo were found to be similar. This indicates that even though the shampoo was labeled 'natural' the contents present in it were able to inhibit the growth of seedlings. So it may have contained any sort of chemical kept undisclosed to the public. This points to the fact that the government regulations in India don't make it mandatory to disclose all the components used in the formulation of shampoo. Even if a personal care product is labeled natural or not, it has the same effect to cause harm to the flora and fauna of the environment to a great extent. While working on the experiment mild burning sensation was felt on the hands due to the direct exposure to shampoos. This indicates that the shampoo must have contained any sort of component that acts as a skin irritant. This study can be considered as a model to explain the effect caused by shampoo which is just one among the other personal care products.

## CONCLUSION

The homemade herbal shampoo doesn't cause any interference to the seed germination in any concentrations. This may have occurred as the homemade shampoo is free from all sorts of chemical additives usually used for commercial appeal. From the present study it is clear that even though the shampoos taken for observation were chemical and commercially labeled natural both of them gave similar results. Therefore we can conclude that irrespective of the labeling on the product they have the potentiality to cause the same effect of toxic impact on the vulnerable flora and fauna of nature. Future studies are needed to analyze the effect of liquid detergents like shampoo on the destruction of soil organisms like earthworms, microbes etc.

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