

Study Report

Microbeads! Unfold Health Risk and Environmental Pollutant

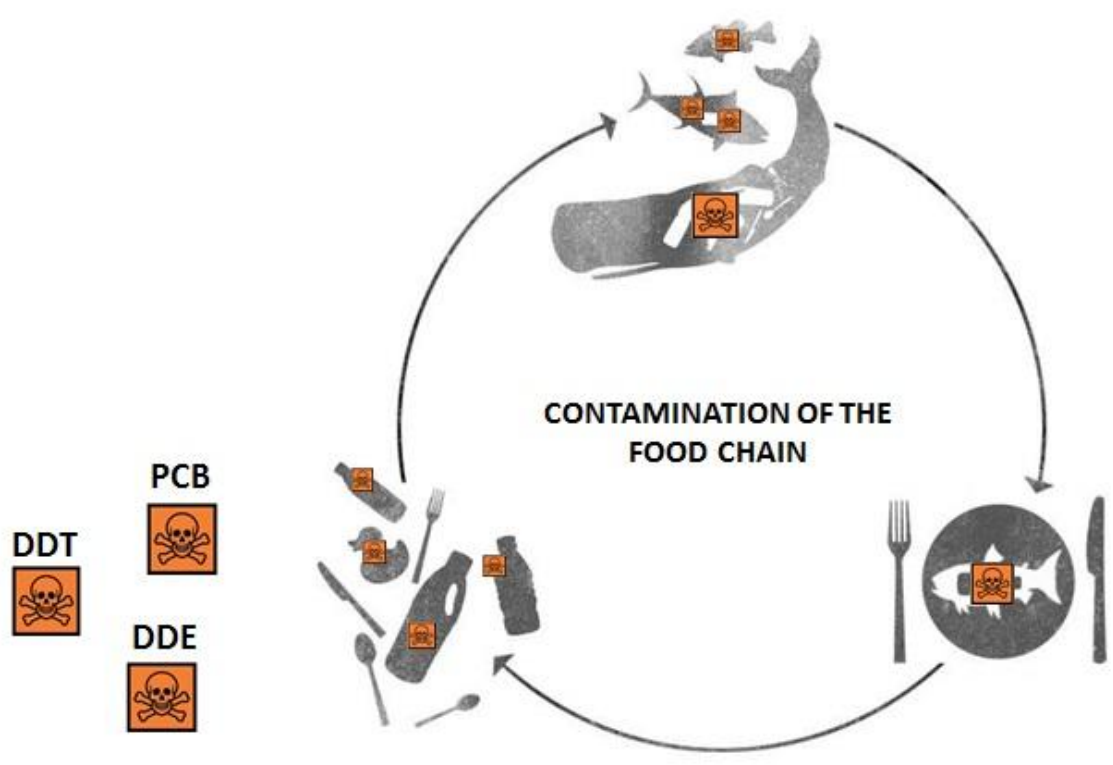
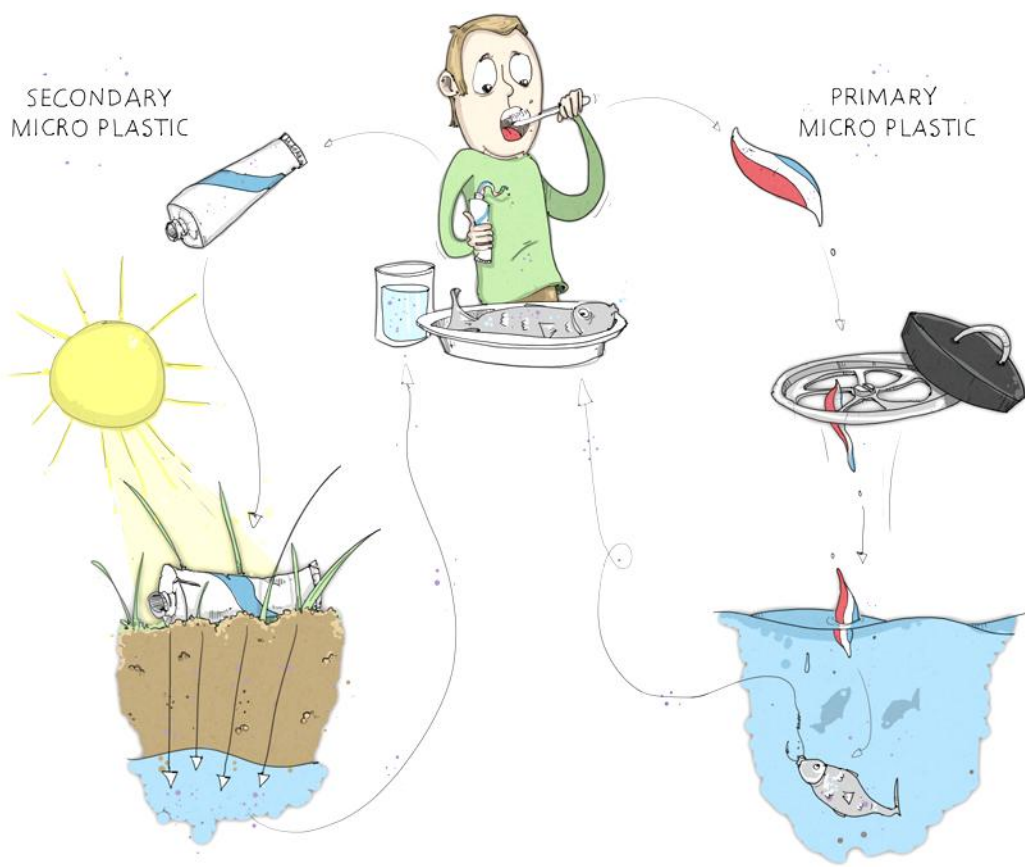


Ban the Bead!



Environment and Social Development Organization-ESDO





Study Report

Microbeads! Unfold Health Risk and Environmental Pollutant

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Executive Summary

Once upon a time, groundnut shells, salt crystals were used as scrubbing and exfoliating agents. Over these years, all these natural but traditional, biodegradable alternatives are being replaced by a non-biodegradable, cheap tiny plastic particle, called microbead. It is increasingly clear that microbeads, which, like plastic bags, are made of polyethylene, are a harmful and unnecessary pollutant.

Today, a significant number of personal care products such as face wash, toothpaste, exfoliating scrubs and anti-ageing creams are known to contain thousands of microbeads per product. When these products are washed down after use into drain, microbeads flow through sewer systems before making their way into rivers and canals and ultimately, straight into the sea and ocean, where they contribute to the plastic soup. They are too small to be retained by the standard filters used at sewage treatment plants. The surface of microbead has been proven to attract and absorb persistent organic pollutants (POPs) such as PCBs and DDT in marine environment.

Marine species are unable to distinguish between food and microplastics/microbeads and therefore indiscriminately feed on microbeads. These sea foods (e.g. fish) are regularly consumed by humans. This is the way microbeads start accumulating in the food chain, transfer from species to species, with harmful consequences ultimately to humans. Toxic chemicals added to plastic during the manufacturing process (such as plasticizers and flame retardants) leach out of plastic in the small to large water bodies, wetlands and the marine environment and poses serious threats to marine fauna.

According to the Daily Mail of UK “every time someone takes a shower about 100,000 plastic particles wash into the sea, becoming a magnet for pesticides and other toxins. They are then swallowed by fish and other marine species and end up on our dinner tables. The average plate of shellfish could contain 50 pieces of plastic.” Tamara Galloway, a professor at Exeter University, said “We find pieces of plastic in every sample of seawater we study from round the world. Many marine animals ingest microbeads, mistaking them for food. They can then be lodged in the animals gut – preventing them from eating nutritious food.” “An average plate of oysters could contain up to 50 plastic particles.” Most people would probably prefer not to be eating microbeads with their food.'

Microbeads are part of the greater problem of plastic polluting seas and oceans. Every year, around eight million tonnes of plastic in the form of microbeads, plastic bags, fishing gear and other debris are washed into the seas. Most of the larger pieces of junk, the ones not eaten by whales, turtles and sea birds, are broken down by sunlight and with movement of waves into smaller and smaller pieces of plastic until they are the same size as microbeads. According to the best estimates, between 15 and 51 trillion particles of plastic are floating in the seas. That's equivalent to 2,000 particles for every one of the 7.5 billion people living on Earth.

Many developed countries have already banned the use of microbeads in their products. UN Environment Programme (UNEP) recommends a precautionary approach toward microplastic management, with an eventual phase-out and ban on their use in personal care products and cosmetics (PCCP). However, the awareness level of microbeads pollution is still very low, thus legislative measures are not very clear to all in Bangladesh. No investigation has yet been carried out regarding the harmful effects of microbeads on health and environment. Environment and Social Development Organization-ESDO has taken the initiative to conduct a primary study to find out the existence of microbeads in personal care products, extent of use of microbeads containing local produced and foreign products in Bangladesh as well as existence of this pollutant in water

bodies. This study also tried to find out level of awareness among manufacturers and users regarding microbeads containing products and its harmful impacts.

With this objective, ESDO team surveyed, collected and analyzed 60 most popular and commonly used products from different areas of Dhaka, Chittagong and Sylhet district. Six categories of samples were collected, i.e. Detergent, face Wash, body wash, nail polish, toothpaste, face and body scrub and microbeads were separated from those collected samples.

To determine the level of awareness among manufacturers and consumers, a questionnaire survey was done with 3800 people. According to the survey findings, female aged between 20-29 years constitutes the larger number of consumers of the products containing microbeads. Among all the products, facewash are found to be mostly used by the consumers. About 45% of the total consumers have skin problems. They mostly suffer from skin irritation and rash. About 95% consumers do not have any idea about the harmful impact of microbeads on health and environment. When they were given the idea of the fate of microbeads, half of them decided to switch from microbeads containing products to a safer, natural alternatives. When ESDO study team reached retailers, they found that about 92% of the retailers are ignorant about this plastic pollutant. However, 40% said that they will remain conscious about selling those products and about 35% told that they will avoid selling those products containing microbeads.

To know existence and pollution in water bodies, about 100 fish samples of 4 species (i.e, Catfish, Tilapia, Pangash, Sarputi) were collected from the different water bodies of Dhaka, Chittagong and Sylhet districts and then the fish samples were analyzed for determining the presence of microbead. The study finding shows that, larger fishes such as Catfish (locally known as Magur) were found to be more contaminated than smaller fishes such as Sarputi. Fishes from lakes and ponds inside Dhaka city were found to contain high content of microbeads than the river fishes of Dhaka city. In case of Dhaka city, river fishes were collected from the rivers outside the city as the rivers within the city are mostly dead. In case of River fishes of Chittagong and Sylhet, fishes were collected from the rivers flowing inside cities and were found to contain good amount of microbeads. Fishes of Dhaka city were found with highest microbead content and the fishes collected from Sylhet were found to contain least amount of microbeads in their body.

Study finding shows that the microbeads are the growing problem in Bangladesh, estimated release of microplastic or microbeads in three major cities are Dhaka, Chittagong and Sylhet.

- Three major cities of Bangladesh, Dhaka, Chittagong and Sylhet City together released around 7928.02 billion of microbeads every month to the water bodies and the sea.
- In Dhaka city 6628.48 billion of microbeads dumped into the water bodies and landfill.
- In Chittagong city 1087.17 billion of Microbeads are dumped into the water bodies and landfill.
- In Sylhet city 212.3 billion of microbes are dumped into the water bodies and landfill.

Grave fact is that it is unknown, that how much of these plastic junks are spoiling rivers, wetlands and the sea and no one knows the toll it is taking of environment, marine life and people. Tiny plastic beads in everything from personal care and cleaning products to toothpaste are poisoning river, sea and threatening human health. Hence it is very crucial that both people and government of Bangladesh take note of this pollution and come forward to take necessary measures towards avoiding microbead containing products.

Acronyms

DDT= Dichlorodiphenyltrichloroethane

DNA= Deoxyribonucleic acid

EDC=Endocrine disrupting chemical

FDA=Food and Drug Administration

PBDE=Polybrominated Diphenyl Ether

PCB= Polychlorinated Biphenyls

PE=Polyethylene

PET=Polyethylene terephthalate

PMMA=Polymethyl methacrylate

POPs=Persistent Organic pollutants

PP=Polypropylene

RMIT=Royal Melbourne Institute of Technology

USEPA=United States Environmental Protection Agency

UNEP=United Nations Environment Programme

WWTP=Wastewater Treatment Plant

Background

Environmental and Social Developmental Organization (ESDO) carried out a precursor study on microbeads prevalence, usage in Bangladesh to see whether or not it's creating any pollution threats for environment, human health directly or indirectly. Combining primary survey, information sources and extraction secondary information from literature review this National Report has been prepared entitled **“Microbeads: Unfold Health Risk and Environmental Pollutant”**.

This National Report is the first report on microbeads pollution and associated risk/ threats in Bangladesh so far. ESDO carried out the study from January, 2015 and an initial report on findings has been shared with journalists through a press conference, held on October, 2016. This report discussed what is microbead, it's sources, how it is causing pollution, posing risk to health, environment and has tried to reveal route of pollution in Bangladesh, what is happening globally and most importantly recommendation(s) for Bangladesh on possible way forward.

Before sharing study findings this National Report has tried to describe all about microbeads in following 'preamble' part.

Preamble

Every year, millions of tonnes of plastic trash enter our global oceans. Plastic use continues to increase globally at a significant rate. Global plastic production has increased by 620% since 1975 and was estimated to be 288 million metric tonnes in 2012. Due to long residence times in the environment and poor waste management practices, the environmental burden from plastic litter continues to increase globally (See Figure 1 below), posing environmental, economic and aesthetic issues with complex challenges and impacts. Plastic waste entering water and marine ecosystems can come from various sources, the majority of which originate from land-based activities. Shoreline recreational activities, inadequate waste management and sewer infrastructure, additives in products, and uncontrolled releases from industrial and commercial activities have been cited as major causes of plastic pollution in the marine environment worldwide.

These various sources can generate different types of plastics in the environment, from plastic bags and bottles to microplastics and microbeads¹. A newly recognized threat to marine life is from tiny plastic microbeads used in personal care products². Today a significant number of plastic care products such as face-wash, scrubs and toothpastes are known to contain thousands of minuscule balls of plastic called microplastics, or more specifically microbeads. Over the years, microbeads have replaced traditional, biodegradable alternatives such as ground nut shells and salt crystals³.

Tiny particles of plastic have been added to possibly thousands of personal care products sold around the world. These microbeads, hardly visible to the naked eye, flow straight from the bathroom drain into the sewer system. Wastewater treatment plants are not designed to filter out microbeads and that is the main reason why, ultimately, they contribute to the Plastic Soup swirling around the world's oceans. Microbeads act as sponges, absorbing and accumulating persistent organic pollutants (flame retardants, dioxins and pesticides), which are present in lakes and oceans.

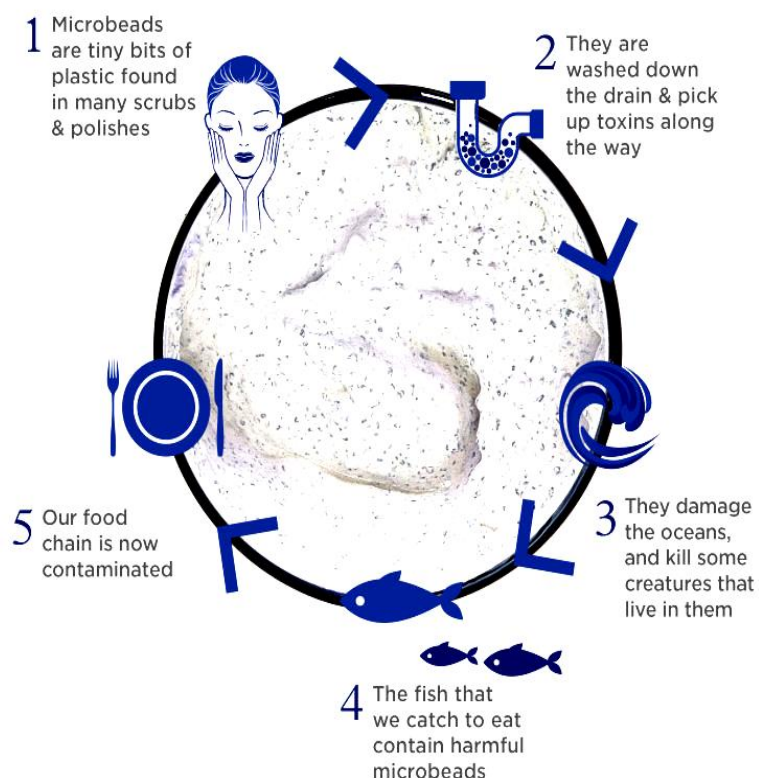


Figure 1: Microbead Contamination Cycle

¹http://www.ec.gc.ca/ese-ees/ADDA4C5F-F397-48D5-AD17_63F989EBD0E5/Microbeads_Science%20Summary_EN.pdf

²http://www.supporthk.org/en/node/2552?_lang=en

³<https://www.beatthemicrobead.org/en/science>

In addition, microbeads never fully degrade⁴. Sea creatures absorb or eat microbeads. These microbeads are passed along the marine food chain. Since humans are ultimately at the top of this food chain, it is likely that we are also absorbing microbeads from the food we eat. As a result, microbeads act as a serious threat to the environment. Positive action on behalf of manufacturers has meant that more and more of these microbeads are being removed from personal care products and replaced by naturally biodegradable alternatives. It is still a far cry to say that all personal care products are free from plastic microbeads though⁵.

In Bangladesh, microbeads are a new phenomenon; manufacturers to consumers are not aware of the negative impact of microplastic and the microbeads. No study has been done yet in this regard. As a result, there is no legislation in Bangladesh on microbeads or microplastic. As an environmental leader and pioneer of the global anti-plastic campaign and ban on the plastic bag in Bangladesh, Environment and Social Development Organization-ESDO has taken an initiative to conduct a study to get to know the extent of microbead use in personal care products in Bangladesh and also their effect on health and the environment.

1. What is Microbead?

Microbeads are pieces of plastic, usually spherical in shape, that range in width from a fraction of a millimeter to about a millimeter and a quarter. They're used in soaps because exfoliating products need small, hard particles to rub debris from the skin. These particles can be natural materials, such as ground nut shells or crushed apricot seeds--or they can be manufactured products like microbeads.

While microbeads are no better at scrubbing the skin than particles of shells or seeds, they're much cheaper to mass-produce. Which is why, since the 1990s, manufacturers have increasingly replaced natural materials with plastic shards. Microbeads have even made their way into certain toothpastes⁶.



Figure 2: Microbeads

The types of plastic most commonly used as microbeads are:

- Polyethylene (PE),
- Polymethyl methacrylate (PMMA),
- Nylon,
- Polyethylene terephthalate (PET) and
- Polypropylene (PP)⁷.

⁴http://www.supporthk.org/en/node/2552?_lang=en

⁵<http://beatthemicrobead.org/en/in-short>

⁶<http://www.popsci.com/what-are-microbeads-and-why-are-they-illegal>

⁷<http://www.plasticfreeseas.org/microbeads.html>

The number of microbeads per product varies widely. One commonly used scrub product sold in Hong Kong states contains 1,000,000 black and white ‘scrubs’ in the 100ml tube. Another brand claims it contains 2,000 beads per use⁸.

1.2 Why are they being used?

- Sphericity and particle size uniformity create a ball-bearing effect in creams and lotions, resulting in a silky texture and spread ability.
- Smoothness and roundness can provide lubrication.
- Colored microspheres add visual appeal to cosmetic products⁹.
- Microbeads give a gritty quality to cleansers and washes, so they are able to create traction on the top layer of skin to slough off dirt and grease. “I think everybody loves a little bit of abrasiveness to their facial cleansers,” Dr. Buka says. “It helps take off makeup; it helps take off impurities from the toxins of a city day.” But both Dr. Buka and Dr. Jaliman agree that many of us who exfoliate regularly have no idea that microbeads are in our products.
- Products containing microbeads are cheaper to produce, which is why skincare companies began using them in the first place.
- Most of the people are not aware of the harmful impact of microbeads and they do not check the ingredients while buying the product¹⁰.

1.3 What products contain them?

- Microbeads primarily serve as exfoliants in face washes and body scrubs,
- Add color and texture to toothpastes, lip balms, moisturizing creams, and makeup¹¹.
- They may be added to over-the-counter drugs.
- In biomedical and health science research microbeads are used in microscopy techniques, fluid visualization, fluid flow analysis, and process troubleshooting.
- They may also be used in other consumer uses including cleaning products and printer toners and in industrial products such as abrasive media (e.g., plastic blasting), industry (e.g., oil and gas exploration, textile printing, and automotive molding), other plastic products (anti-slip, anti-blocking applications) and medical applications¹².



Figure 3: Products containing microbeads

⁸ <http://www.supporthk.org/en/node/2552?lang=en>

⁹ <https://en.wikipedia.org/wiki/Microbead>

¹⁰ http://www.huffingtonpost.com/2014/02/20/microbeads-exfoliation_n_4815133.html

¹¹ <http://www.motherjones.com/environment/2015/05/microbeads-exfoliators-plastic-face-scrub-toothpaste>

¹² <http://www.ec.gc.ca/ese-ees/default.asp?lang=En&n=ADDA4C5F-1>

1.4 When did they appear?

- Microbeads were first made by Dr. John Ugelstad, who managed to form them by making polystyrene beads into spheres.
- In 1972, microbeads became patented and free to public use, but it wasn't until the late 1900s and early 2000s that microbeads began to replace natural ingredients and appear in many products, such as toothpaste, face wash, shaving cream, and shower gel. Although many people used several products a day containing microbeads, it wasn't until a few years ago that people began to realize the harmful effects of these exfoliating beads.
- Starting in the 2000s, microbeads began to be noticed in numerous large bodies of water, such as the Great Lakes, and oceans. There have been many studies and research projects about microbeads affecting planet's water, such as; in 2012 it was found that for every 200 ml container of exfoliating product, 21 g of microplastics would end up in the sewer system, where they would not be able to be filtered out because of their miniscule size.
- The issue continues to rise in seriousness, and as some companies continue to apply the exfoliates to their products because of their cheap manufacturing, others begin to join the fight for the end of microbeads¹³.

1.5 So, what's the Problem?

The scrub products containing plastics pollute by the nature of their design. There is no way that the producers can ensure the product they manufacture (and profit from) will not pollute the environment.

- a. Toxic Accumulators:** A major concern with microbeads is that because of their small size, they have a large surface area by volume, so as a consequence of their use, huge numbers of readymade, highly efficient toxic accumulators are being intentionally released into the environment. Micro-plastics in the marine environment are known to accumulate toxic contaminants - persistent organic pollutants (pesticides, flame retardants, PCBs)¹⁴.



Figure 4: Bioaccumulation of PBDES through microbeads

- b. Increasing Plastic Flow:** Plastic micro beads are contributing to the increasing flow of plastic into our oceans. These preventable microscopic pieces of plastic are contributing to the fragments of broken down larger pieces of plastic and fibers contaminating our seas, turning

¹³ <https://microbeadless.wordpress.com/what-are-microbeads/microbead-history/>.

¹⁴ <https://www.beatthemicrobead.org/en/science>

them into an unhealthy plastic soup. When used as directed, microbeads are washed down drains and into waste water systems where they are known to pass through these treatment facilities and are consequently flushed out to sea¹⁵.

c. Unaffected by Sewage Treatment: Sewage treatment facilities tested in the US show microbeads are not completely removed during wastewater treatment. Researchers from New York University tested effluent at several wastewater facilities and demonstrated 80,000 microbeads per day escaping treatment, per facility¹⁶.

d. Harm to Living Things:

Microplastics cause physical and chemical harm to animals. Physically, microplastic can cause cellular necrosis, inflammation and lacerations in the digestive tract.

Chemically, microplastic is associated with a complex mixture of chemicals, many of which are priority

pollutants under the US EPA Clean Water Act for being persistent, bioaccumulative and/or toxic. Chemicals associated with this ‘cocktail’ can accumulate in animals that eat them and cause liver toxicity and disrupt the endocrine system¹⁷. Their size makes the problem even worse, as they look at a glance like fish eggs, a tasty snack enjoyed by many aquatic animals: It’s like setting out a chocolate cake laced with poison¹⁸.

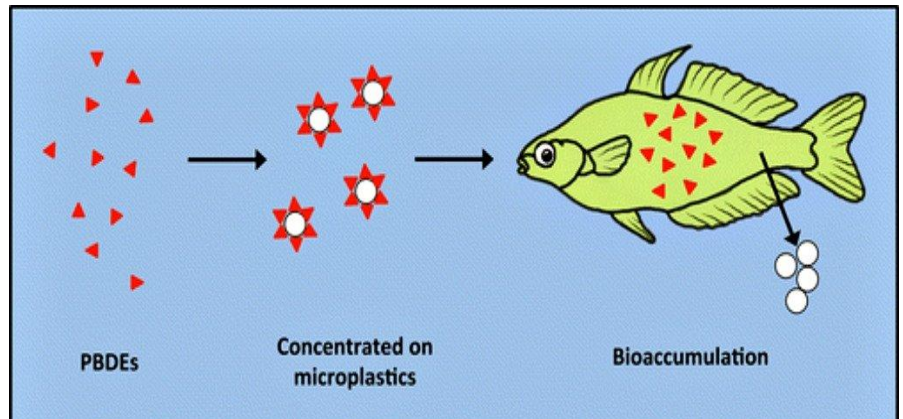


Figure 5: Bioaccumulation of microbeads

1.6 How wide scale is the pollution?

- A 2015 UK scientific study of facial scrubs found that the tested products could contain between 137,000 to 2,800,000 microbeads per bottle (250ml).
- The United Nations Environment Program (UNEP) report entitled ‘Plastic in Cosmetics’, released in June 2015, stated that a typical exfoliating shower gel can contain roughly as much plastic in microbeads in the cosmetic formulation as is used to make the plastic packaging it comes in.
- A random sample initiated by Plastic Soup Foundation and North Sea Foundation in February 2016 identified over 100 personal care products containing microbeads which are available in Australia. These products were mainly facial and body scrubs. In terms of the relative

¹⁵ <http://www.plasticfreeseas.org/microbeads.html>

¹⁶ <http://www.plasticfreeseas.org/microbeads.html>

¹⁷ https://conbio.org/images/content_policy/03.24.15_Microbead_Brief_Statement.pdf

¹⁸ <http://www.enn.com/health/article/48631>

contributions to microplastic pollution, a range of studies has looked at the number or concentration of microbeads in individual products¹⁹.

- The American non-governmental organisation (NGO) 5Gyres, found a large number of microplastics in the Great Lakes and estimates that one single care product (Neutrogena's Deep Clean) contains 360,000 microbeads.
- Dr. Sherri Mason, Professor of Chemistry, SUNY Fredonia, Working with the 5 Gyres Institute, who found plastic particles within all 5 of the Great Lakes added that , “The counts obtained, especially those within Lakes Erie and Ontario, rival those within the world's ocean. Even further, what surprised us the most is the size of the particles we found. To date ~70% of the plastic we skim off the surface of the Great Lakes is between one third and one millimeter in diameter. Tiny”²⁰.
- German researchers Liebezeit and Dubaish (University of Oldenburg) hypothesise that cosmetics, and especially peelings, make up most of the microplastics they found in the Wadden Sea²¹.
- Microbeads have become so ubiquitous that an estimated 808 trillion pieces swirl down American drains every day. When this plastic-laden wastewater goes through treatment plants, about 99 percent of the beads settle into sludge, which is often used as fertilizer²².

1.7 Purpose of the National (Primary) report

These days plastic pollution is a global concern, much more threatening for country like Bangladesh where awareness is low, use and productions are not restricted or limited by enforcement of legislations. Microbeads are part of global plastic pollution. Large size plastics can be re-cycled whereas microplastics or microbeads cannot be filtered easily hence its residual effects impacts environment as these are not biodegradable. Through marine or aquatic food chain it can be entered into human bodies. Due to cheap costing, easy availability these microbeads are used in many beauty, skin care and households products instead of natural ingredients.

In some countries, awareness on harmful effects of these micro beads are growing concerns and they are trying to put efforts for banning of using in many cosmetics as well as other consumable items. In Bangladesh, microbeads are new phenomenon; manufacturers to consumers are not aware of the negative impact of micorplastic and the microbeads. No study has been done yet in this regard. As a result, there is no legislation in Bangladesh on microbeads or microplastics.

As an environmental leader and pioneer of the global anti plastic campaign and ban the plastic bag in Bangladesh, Environment and Social Development Organization-ESDO as part of plastic pollution extends and sources ESDO commissioned a primary study which is the first ever study in Bangladesh to see whether or not people are using microbeads containing products, detection of microbeads in aquatic species and level of people’s awareness on these harmful ingredients in products regularly

¹⁹ <http://www.epa.nsw.gov.au/resources/waste/plastic-microbeads-160306.pdf>

²⁰ <http://www.cayugalake.org/microbeads-emerging-issue.html>

²¹ https://en.wikipedia.org/wiki/Microbead#cite_note

²² <http://www.popsoci.com/what-are-microbeads-and-why-are-they-illegal>

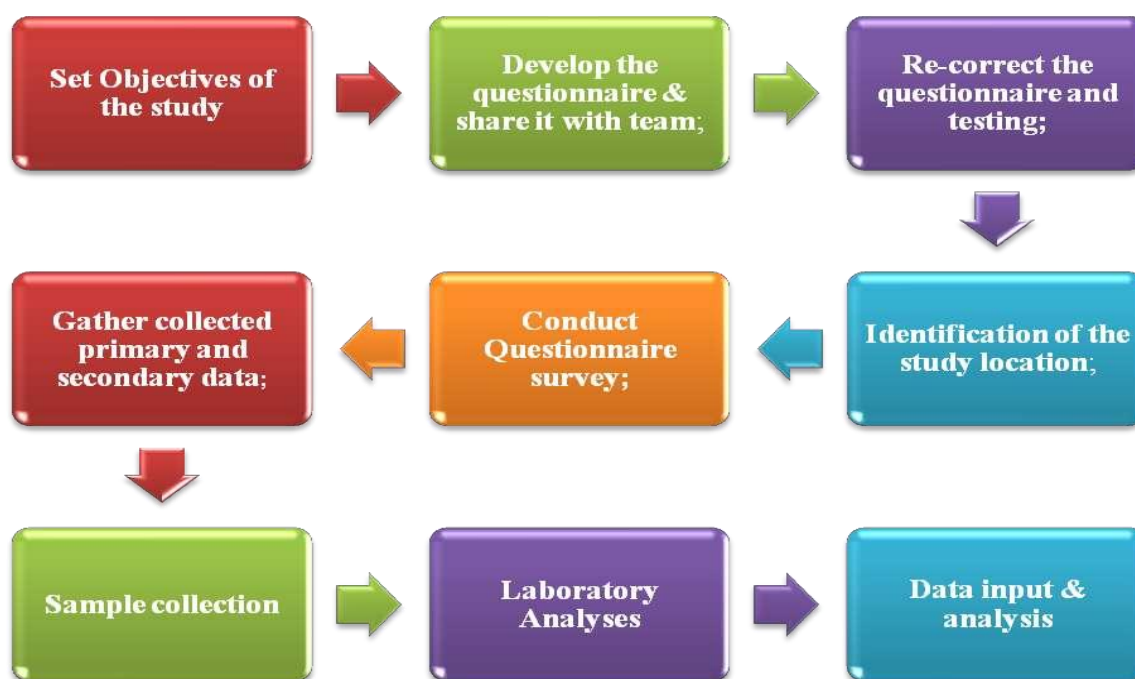
being in use. Through this primary study ESDO intendeds to get indication and plan future measures to reduce pollution through microbeads and plastics.

2. Methodology

Before making a proper methodology to conduct the study on the awareness level of microbeads or microplastics, ESDO conducted a team orientation to set the goal of the study, who will be target groups of survey, what type of questionnaire needed, what will be the analysis method for collected data and so on. After the team orientation, ESDO has placed a consequent process of the overall study to finish it in a proper way.

As a first step of setting the methodology, the study team selected geographical areas namely 3 cities of the country to carry out the survey and sample collections to obtain primary information for this mentioned study. On the basis of specific criteria Dhaka, Chittagong and Sylhet cities were selected and rational behind selecting these cities were, firstly these 3 cities are most densely populated secondly, these cities are residents of affluent people and rapid urbanizations underway and urbanization, which makes these cities more consumers, products are easily reachable, consumers tends to use more foreign as well as modern products due to wide advertisements. Thirdly, in terms of collection of fish sample, selected three cities will give different dimensions of plastic contaminations such as Sylhet has more water bodies, a port city Chittagong provides the condition of marine pollutions and lastly, Dhaka city, where most products be it foreign or local are available or imported, water bodies are polluted.

After gathering primary and secondary data, samples were collected and preceded for their laboratory analyses. The flow of the method was-



In order to bring out the actual condition of microbeads pollution and the rate of public awareness ESDO team conducted three kinds of study.

1. Fish sampling
2. Market survey
3. Survey on awareness level among people

2.1 Fish Sampling

The fish samples were collected from the prominent water bodies such as lake, canal, pond and rivers of in and around Dhaka city, Chittagong and Sylhet. Fish samples include Cat fish (*Siluriformes*), Tilapia (*Oreochromis niloticus*), Pangash (*Pangasius pangasius*) and Sarputi (*Puntius sarana*). The total number of fish collected was 100.

2.1.1 Location

The fish samples were collected from the prominent water bodies such as lake, canal, pond and rivers of in and around Dhaka city, Chittagong and Sylhet. The list of the water bodies from where the fish samples were collected are given below:

Dhaka City:

1. Buriganga
2. Turag
3. Shitalakkhya
4. Balu
5. Bangshi
6. Dhanmondi lake
7. Gulshan Lake
8. Hatirjheel

Sylhet city:

1. Shurma
2. Kushiara
3. Shari
4. Piayn

Chittagong city:

1. Karnaphuli
2. Bogakine Lake
3. Kaptai Lake
4. Karnaphuli Lake

2.1.2 Pre-sample processing step

1. Location of sample collection was determined
2. Field data sheet was prepared to collect photos, site map sketch and GPS readings.
3. Poly-bags, jars and a dissection kit were collected
4. Samples were analyzed.

2.2 Market Survey

ESDO study team collected about 60 microbeads containing products from the local markets and shopping mall of Dhaka city such as New Market, Rapa plaza, Agora Super Shop and Meena bazaar. About six types of products were collected, including facewash, scrub, bodywash, toothpaste, nailpolish, detergent and cream. These products were analyzed for determining their microbeads content.

2.3 Survey on Awareness level Among People

For the assessment of awareness level a baseline survey was conducted as random basis amongst 3800 respondents. The survey was conducted to assess the general awareness level and perception about the microbeads.

2.3.1 Location of the survey

The study was carried out in Dhaka, Chittagong and Sylhet city. The target population was about 3800 people (In Dhaka city, target population was 1800 people; in Chittagong and in Sylhet, target population was 1000 for each). The survey was conducted to know the use rate and demand of microbeads containing product by people in these three cities.

Data were collected as:-

- Primary Data
- Secondary Data

For the primary data, three types of questionnaire were prepared and they are- for consumers, for retailers, for children and their parents. Then a test survey was done to ensure the correctness of the questionnaire. After that, the main survey was conducted on total 3800 persons individually. For the secondary data, we have gone through some articles, in journals and reports. The information about microbeads in the products of our country is limited because no work has been done in this area.

2.3.2 Sample size distributions

Total sample size 3800=(Dhaka 1800+Chittagong 1000+ Sylhet 1000)			
Dhaka Sample size= 1800= 1600 consumers + 140 children + 60 retailers			
1600 consumers			
Upper class=400 (100 random +100 house wives +100students + 100 professionals)	Upper middle class=400 (100 random +100 house wives +100students + 100 professionals)	Lower middle class=400 (100 random +100 house wives +100students + 100 professionals)	Lower class=400 (100 random +100 house wives +100students + 100 professionals)
Chittagong sample size= 1000= 960 conumers+40 retailers			
960 consumers			
Upper class=240 (120 random +40 housewives +40 students +40 professionals)	Upper middle class=240 (120 random +40 housewives +40 students +40 professionals)	Lower middle class=240 (120 random +40 housewives +40 students +40 professionals)	Lower class=240 (120 random +40 housewives +40 students +40 professionals)
Sylhet sample size= 1000 people(945 consumers+ 55retailers)			
945 consumers			

Upper class=315 (45 random +90housewives +90 students +90 professionals)	Upper middle class= (45 random +90housewives +90 students +90 professionals)	Lower middle class= (45 random +90housewives +90 students +90 professionals)	Lower class=(45 random +90housewives +90 students +90 professionals)
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3. Results

This section has described mainly findings of primary data collection related information. The primary data collection findings have been presented through following three main aspects, namely:

- i. Findings on sample fish analysis
- ii. Findings on sample products related information, referring amount / presence of microbeads in those products
- iii. Findings on level of awareness among people surveyed

i. Findings on fish sample analysis

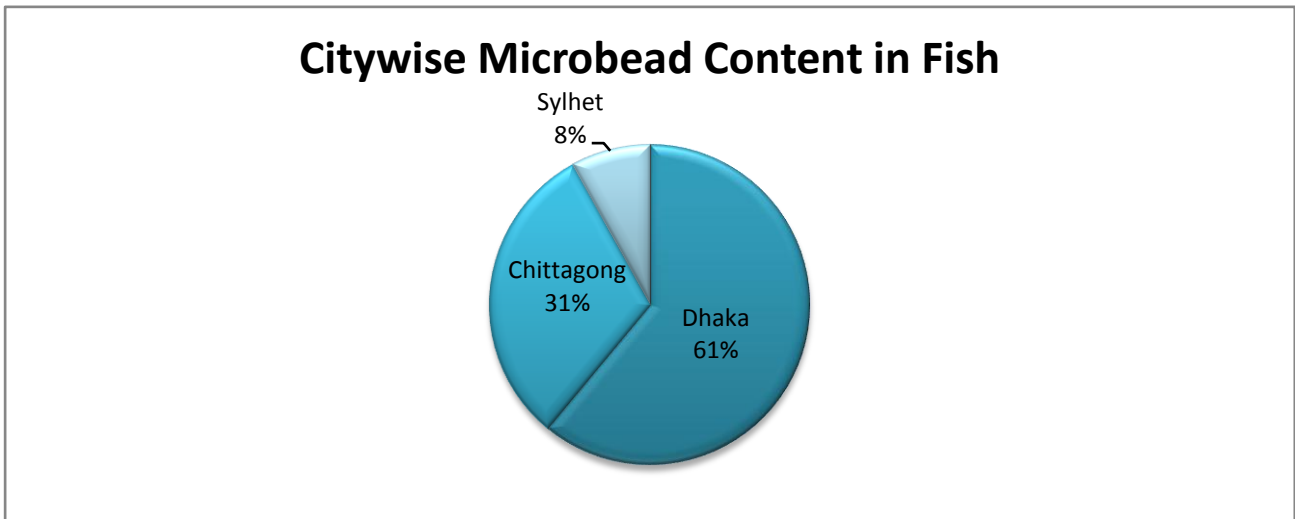


Figure 6: City wise Microbeads content in fish

It was observed in the study that almost 61% fishes collected from the lakes and ponds of Dhaka city contain microbeads in their gut and respiratory tract. Fishes collected from Chittagong city, were investigated which indicated a high percentage of microbeads content that is 31%. The fishes collected from the water bodies of Sylhet were found to be least contaminated by microbeads which is about 8%. The intensity of microbeads content in fish varies from species to species.

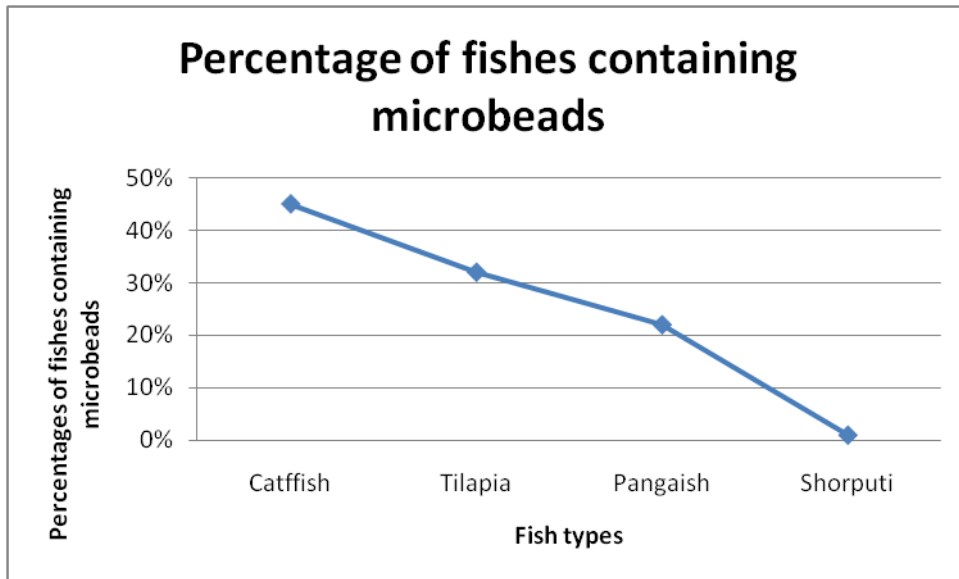


Figure 7: Percentage of fishes containing microbeads

A total of 100 fishes were tested for the experiment among which Cat fish (*Siluriformes*) was found to be mostly affected by Microbeads contamination as microbeads eat in huge amount. About 45% of the Cat Fish contain microbeads. About 32% of Tilapia (*Oreochromis niloticus*), 22% of Pangash (*Pangasius pangasius*) and 1% of Shorputi fish (*Puntius sarana*) contains microbeads. The rate of microbeads contamination is relatively low in small fishes than larger fishes because large fishes consume more foods so the rate of contamination is also high.

ii. Findings on sample products related information, referring amount / presence of microbeads in those products

Products were collected from popular market or shopping outlets in available tubes, containers and analyzed, following graph showed microbeads release from sample 5 types of products.

FACEWASH:

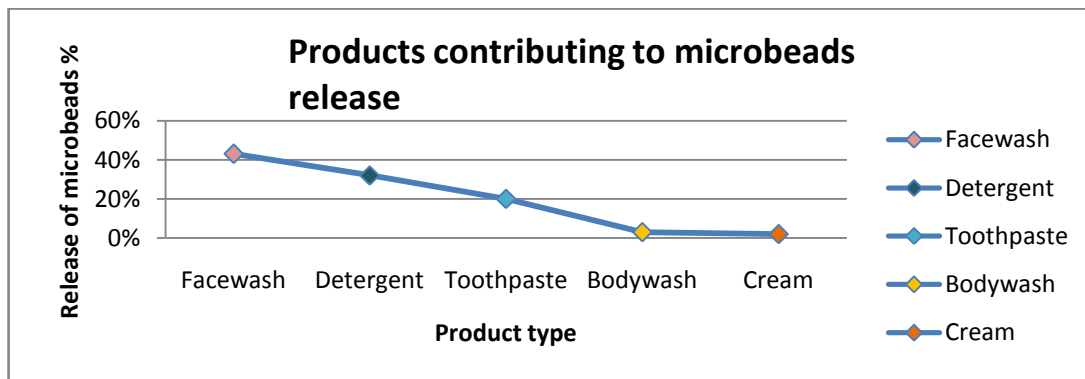


Figure 8: Products contributing to microbeads release

Above graph shows among 5 types of sample microbeads containing products, highest number of surveyed people use face wash.

According to the market and questioner survey, facewash being acting as the major source of microbeads pollution in three major cities and it has calculated on a random basis of the urban population in Bangladesh, which is contributing to about 43% of the total pollution. According to the respondent, this product is most commonly used by both male and female.

DETERGENT:

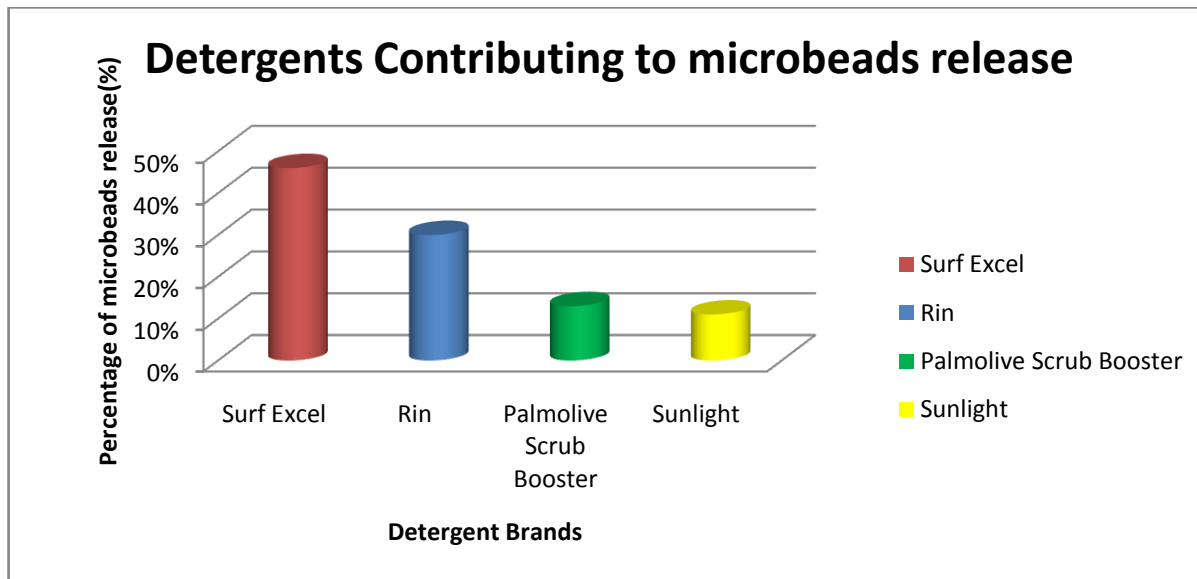


Figure 9: Detergents contributing to microbeads release

Above graph shows detergent is the second highest source of microbeads release. Detergent is another large source of microbeads pollution, contribution of microbeads from detergent about 32% of sample.

Finding shows that among the most popular detergent brands Surf Excel, Rin, Sunlight and Palmolive Stain Booster are most commonly used by the people. According the users and market share of these products, Surf Excel contributes to about 46% of the total release of the microbeads; Rin contributes to about 30%, Palmolive stain booster contributes to about 13% and Sunlight contributes to about 11% microbeads release.

TOOTHPASTE:

Toothpaste is another major source of microbeads release, which contributes up to 20%. Although about 85% people use toothpaste containing microbeads, but the amount of release is less than face wash and detergent because some microbeads remain in the mouth and body of the user. The survey found more than 60% children under 10 years old like toothpaste to eat up.

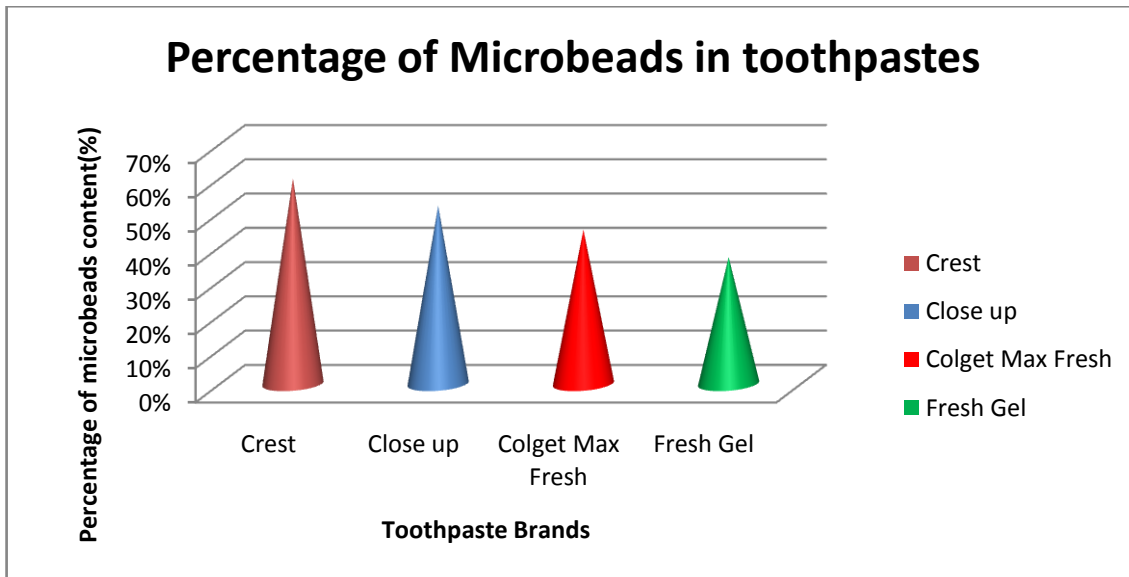


Figure 10: Percentage of microbeads in toothpastes

According to the market survey Crest brand of toothpaste contains the highest amount of microbeads which containing about 60% (200 ml tube) of the total amount and Closeup the least amount of microbeads which is 52% of the total amount. In case of Colget Max Fresh and Fresh Gel, the microbeads contents are 45% and 37% accordingly.

BODY WASH AND CREAME:

Body wash and cream contribute about 3% and 2% respectively.

iii. Findings on level of awareness among people surveyed

To know level of understanding and knowledge on presence of microbeads in beauty, skin care and household cleaning products ESDO study team carried out survey through questionnaire with both consumers and retailers. Consumers provided information on regular use of such products and retailers able to provide information on demand of such beauty, skin care and household cleaning products. ESDO study team also obtained their understanding on presence of microbeads as well as its residual impacts in environment and health.

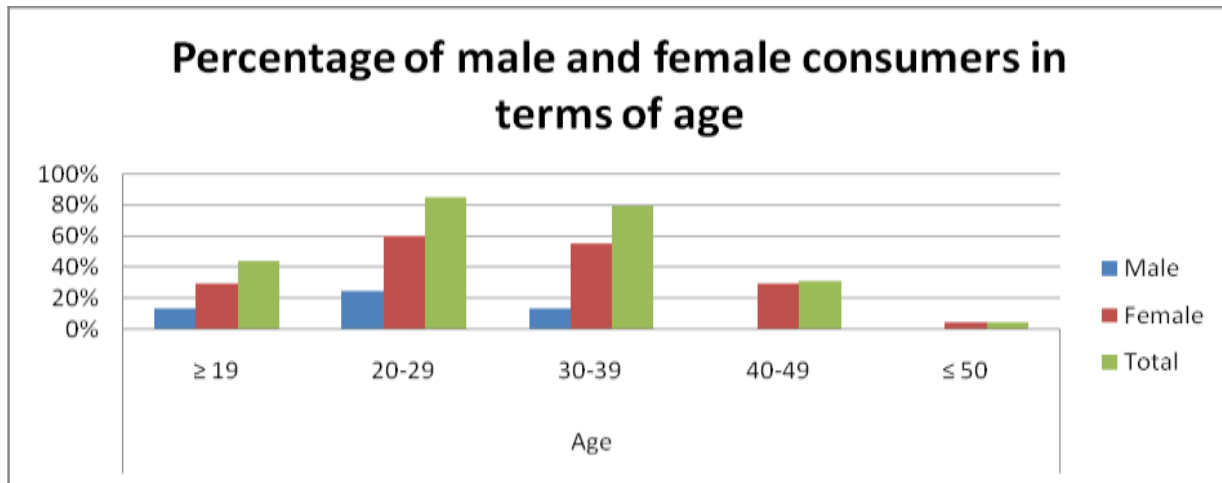


Figure 11: Percentage of male and female consumers in terms of age

Among the targeted consumers for the survey, 45% were male and 55% were female. In terms of age, among the female consumers 10% were less than or 19 years, 40% were from 20-29 years, 32% were from 30-39 years, 12% were 40-49 years, and 6% were above 50 years. Among the male consumers, 14% were less than or 19 years, 45% were from 20-29 years, 28% were from 30-39 years, 13% were from 40-49 years and none from 50 or less than 50 years.

It was needed to find out which type of microbeads containing product is usually bought by consumers. Therefore, several questions were asked for this.

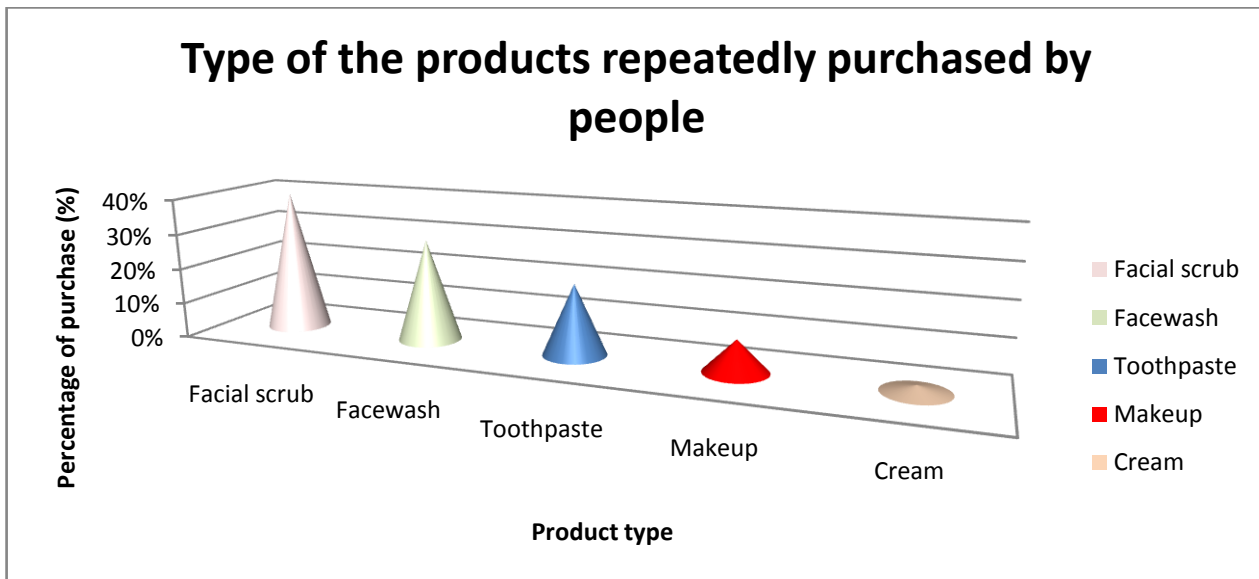


Figure 12: Types of the products repeatedly purchased by people

The survey shows that, 40% of the consumers prefer microbeads in facial scrub, about 29% uses face wash, 20% uses toothpaste, 9% uses makeup and rest 2% uses cream containing microbeads.

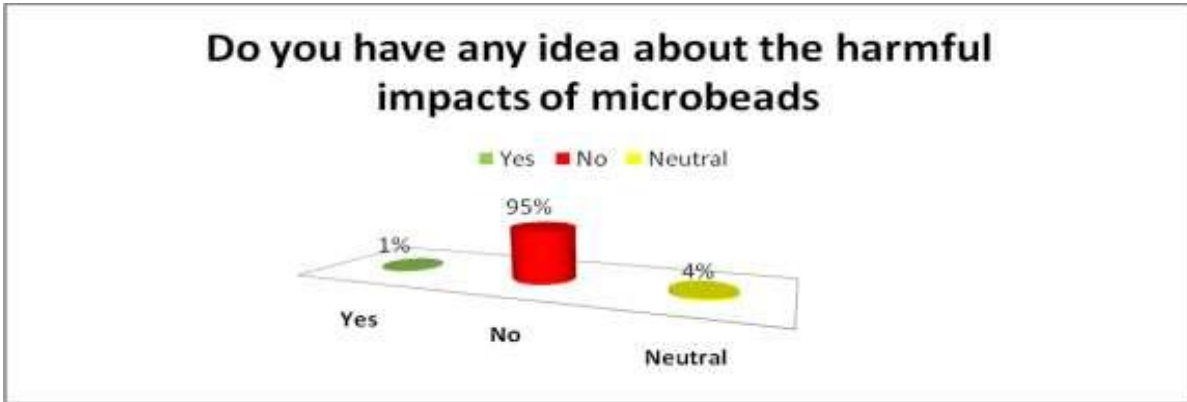


Figure 13: Do you have any idea about the harmful impacts of microbeads.

Fig 13 shows that almost 95% of the people did not have any idea about the harmful impacts of microbeads, 4% are actually not sure about the use of microbeads in products and only 1% said that they came to know about the harmful impact of microbeads on skin and environment reports in newspaper, online articles.

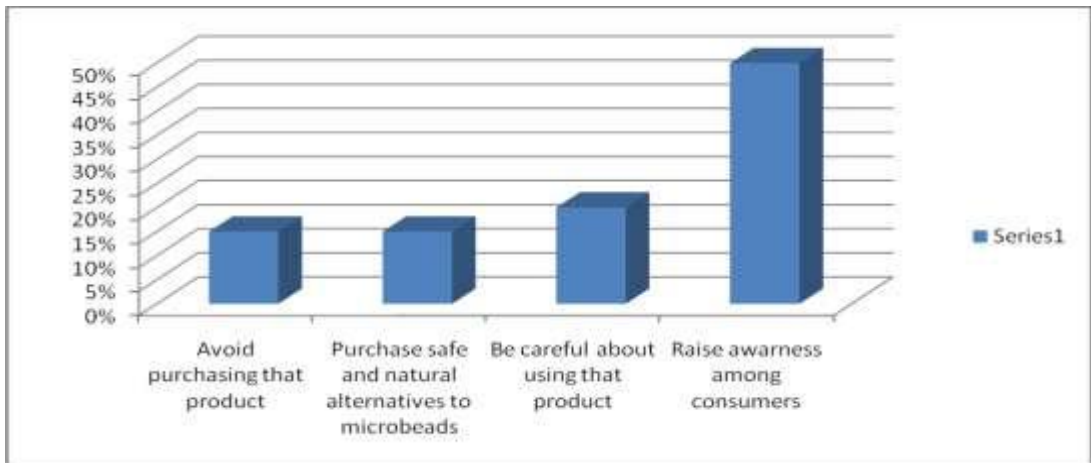


Figure 14: Consumer's Perception about microbeads in products

Although most of the surveyed people don't have any idea of microbeads used in products but they want to become aware of it. When we asked them what should be the next step against microbeads, 15% of them want to avoid purchasing those products, 50% will go for making themselves more aware regarding this, 15% said they will go for safer and natural alternative for scrubbing and 20% told to raise awareness against microbeads among the consumers. All the consumer are more attracted to the products containing because of the lucrative appearance of the products and but awareness among them is almost absent because there haven't been any study

regarding this. Under the survey, study team interviewed almost 10 retailers who generally sell beauty and cleaning products containing microbeads. We had asked them several questions to get an idea about their awareness level in terms of microbeads.



Figure 15: Awareness level about the presence of microbeads in products

Fig 15 shows the levels of awareness among retailers of the presence of microbeads in beauty and cleaning products. Only 5 % said that they knew about the use of microbeads in the products. 92% said that they had no idea. The retailers who came to know about the fact want the media to take initiatives to raise awareness among consumers and retailers.



Figure 16: Preference of the retailers regarding steps to be taken against microbeads

This is shown in Fig 16 that 35% are interested to avoid selling of the products containing microbeads on the other hand 40% are not aware yet about selling these products containing microbeads. 25% retailers did not show much interest in this aspect as they are much concerned about their business profit.

4. Discussion

In Bangladesh as a pioneering organization of plastic bag banning, Environment and Social Development Organization-ESDO has taken initiative to conduct a primary study on the evidence or occurrence of microbeads pollution, possible sources of Microbeads and understanding of people related to microbeads containing products and its impacts. This primary study was conducted in three major cities (i.e. Dhaka, Chittagong and Sylhet), based on consumer density, increasing trend of using microbeads containing products as well as availability of those products and purchasing capacity. The study collected microbeads containing products to identify sources of microbeads release in environment and also collected fishes to see whether or not this polluting plastic entered into food chain of the country.

ESDO team conducted fish analysis by collecting about 100 fish samples from the water bodies of Dhaka, Chittagong and Sylhet and analyzed according to international standard specification and it has been found that microbeads are present in the gill, intestine, flesh of the sampled fish. Fishes of Dhaka city were found to be mostly contaminated and fishes of Sylhet were found to be least contaminated by microbeads. Among the four types of fishes (i.e. Cat fish, Telapia, Pangash and Sharputi) Cat fish was found to contain highest quantity of microbeads in their body and Sharputi was found to contain least amount of microbeads in their body.

In order to find out the sources of Microbeads, ESDO study team collected 60 local and imported products containing microbeads from local markets and super- markets to analyze their microbeads content. About six categories of products were collected such as facewash, bodywash, toothpaste, detergent, nailpolish and cream. In Bangladesh, microbeads containing beauty and cleaning products are widely in use. Both local and imported products containing microbeads are now available in Bangladeshi market. According to the market survey and product analysis of ESDO study team, facewash, toothpaste and detergents are the major sources of microbeads release to the environment.

The survey shows that, facewash is the largest source of microbeads release to the environment in Dhaka, Chittagong and Sylhet. Among the facewash brands available in the Bangladeshi market, about 89% of the products of “Clean and Clear” and 80% of the products of “Neutrogena” contain microbeads.

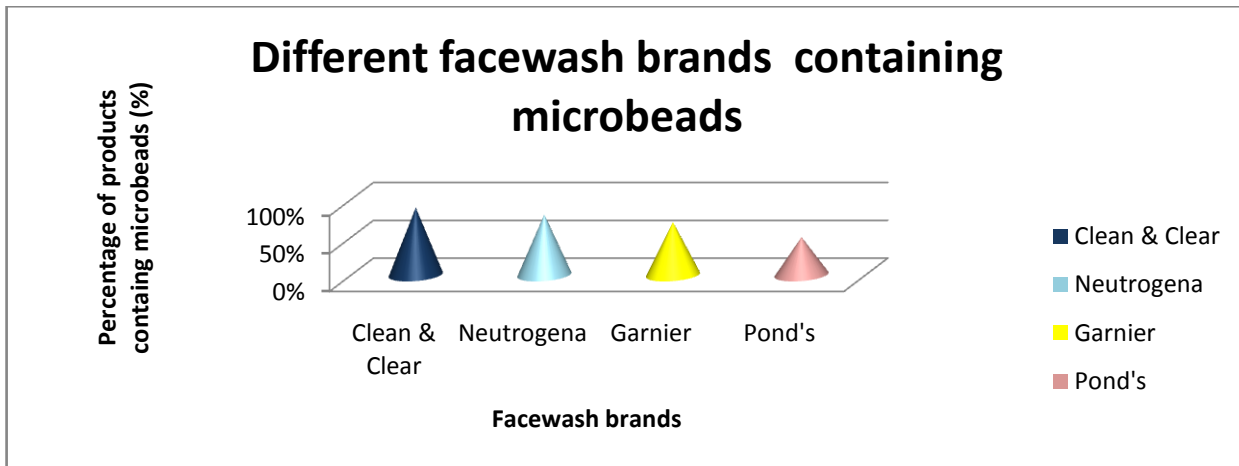
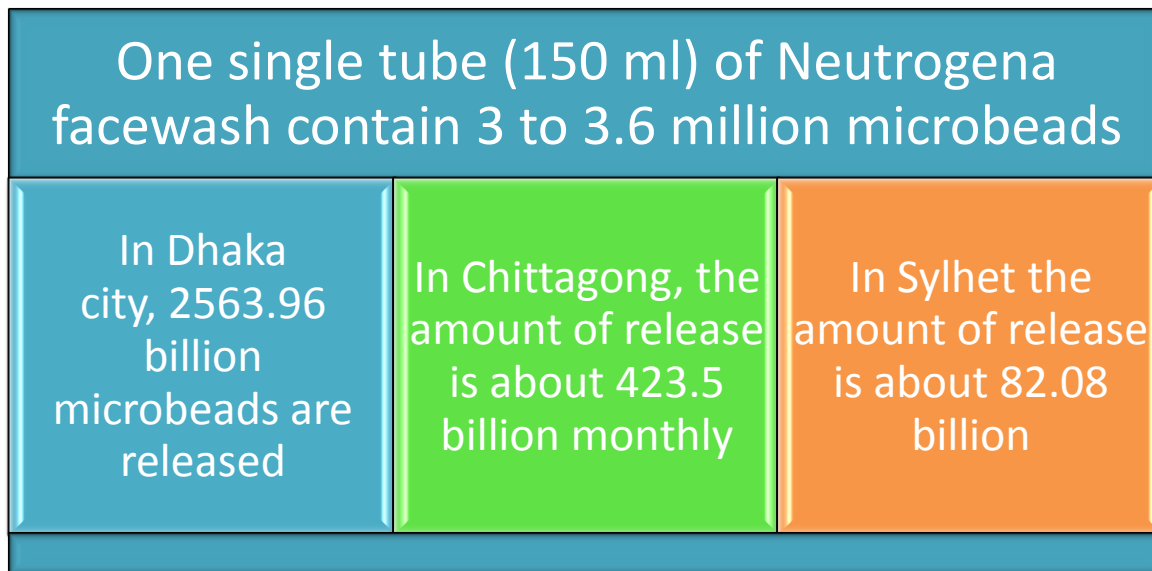


Figure 17: Microbeads content in different facewash brands

According to the international standard, a single tube (150ml) of facewash contain 3 to 3.6 million microbeads. According to the survey, 43% of the surveyed population use facewash containing microbeads. Total monthly release of microbeads from facewash in Dhaka, Chitagong and Sylhet was calculated²³. The resultant that is the extent of pollution caused by facewash can be shown by the following figure:



²³ To get an idea of the total release of microbeads from this source in a month, a calculation was done using the following equation,

$$TR = (Rp \times TP \times MBp) / SP$$

Here,

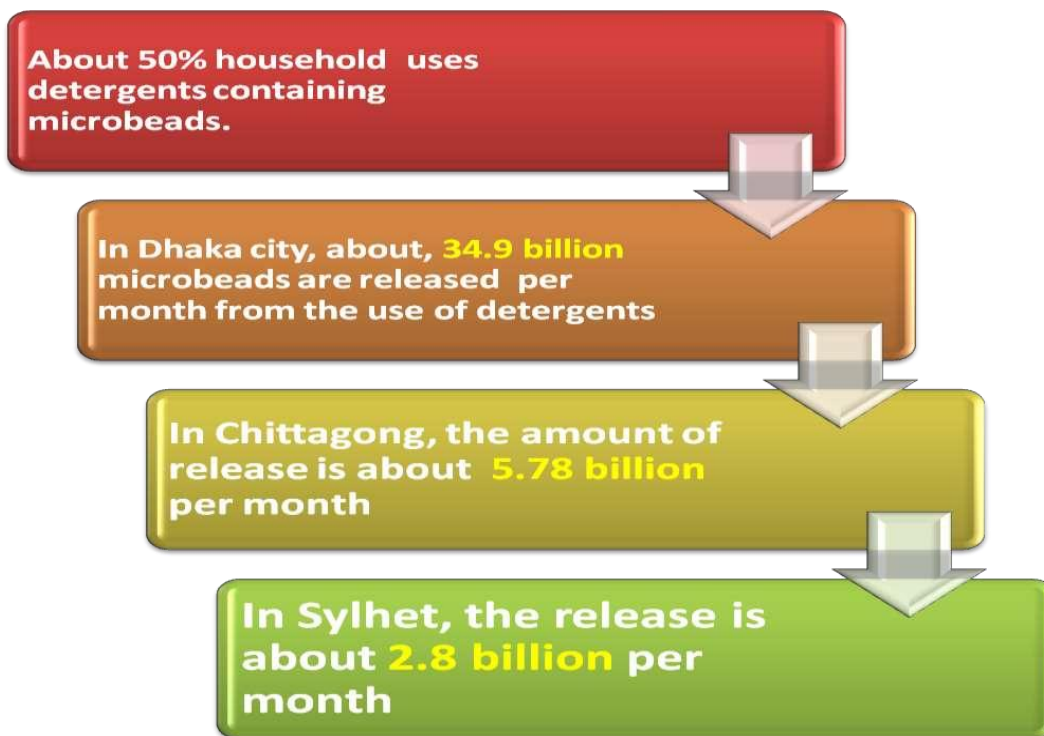
TR=Total amount of release, Rp=Percentage of release, TP=Total population, SP=Surveyed population, MBp=Microbeads content in product

Detergent is one of the most common products used in every household at large scale. It directly releases a huge amount of microbead into the water body.

According to the market share assessment in Bangladesh, about 50% households of the total population use detergent containing microbeads. One household uses approximately 700g detergent per month. The microbead content in this 700g amount is 5.6 million. Using the above equation the extent of pollution by detergent was calculated and can be shown by the following figure;



Figure 18: Detergents containing microbeads



Childrens Like to Eat Toothpaste

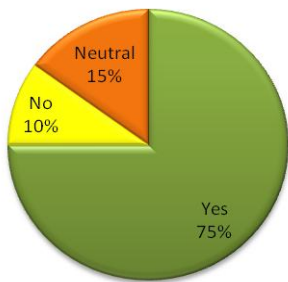
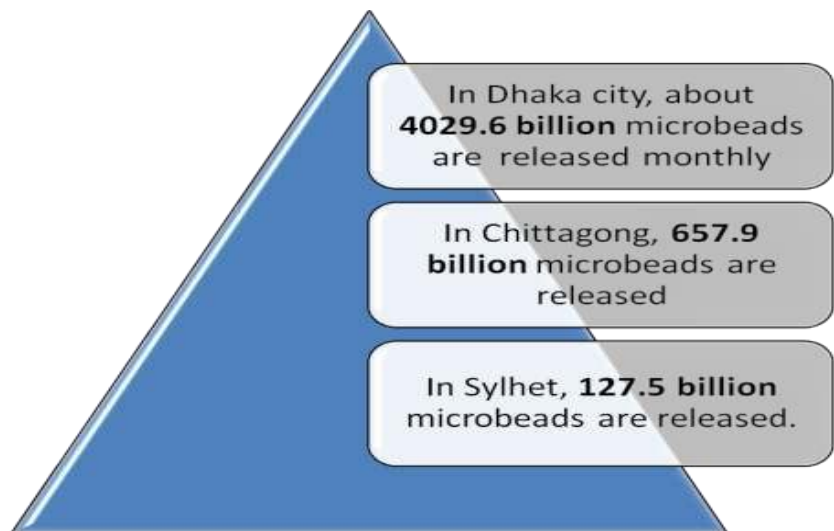


Figure 19: Children like to eat toothpaste

Toothpaste is the 2nd big source of microbeads pollution. The most common form of plastic which is used in plastic bottle and packaging is now being used in toothpastes. These plastic materials never degrade and remain as it is. This is most harmful than other sources because they may enter directly into the body while brushing. About 85% of the surveyed population (i.e. 3800) uses toothpastes containing microbeads. With this value by taking in account the total population of Dhaka, Chittagong and Sylhet city, a monthly release of microbeads from toothpaste in these three cities was calculated. This can be shown as follows,

Many children love to eat toothpaste. This way, children are being directly exposed by microbeads. ESDO team conducted a survey on children in this respect. ESDO team surveyed on 200 children with an age range of 5 to 10 years. They took information from both the parents and children.

According to the survey, about 75% children like to eat toothpaste, about 10% do not like to eat toothpaste and 15% children were non-respondent.



Many children like to play with detergents and toothpastes, through these way children are also releasing a large amount of microbeads in the environment. According to study of ESDO about 52% of the children have a tendency to play with detergents and toothpastes about 35% children are not interested in these kinds of stuffs and the rest 13% are non-respondent.

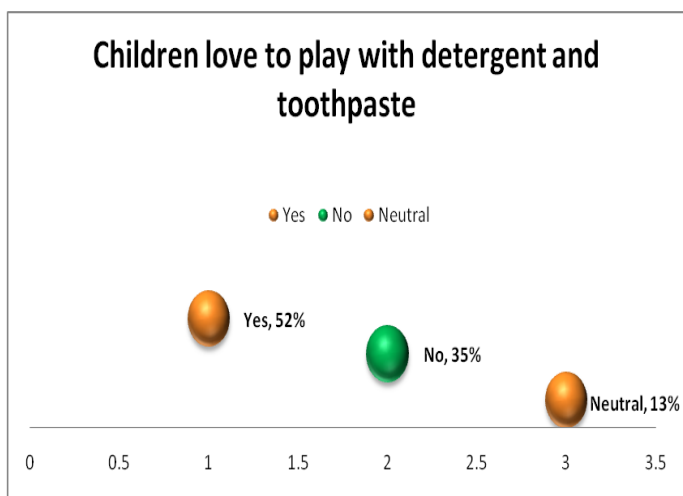
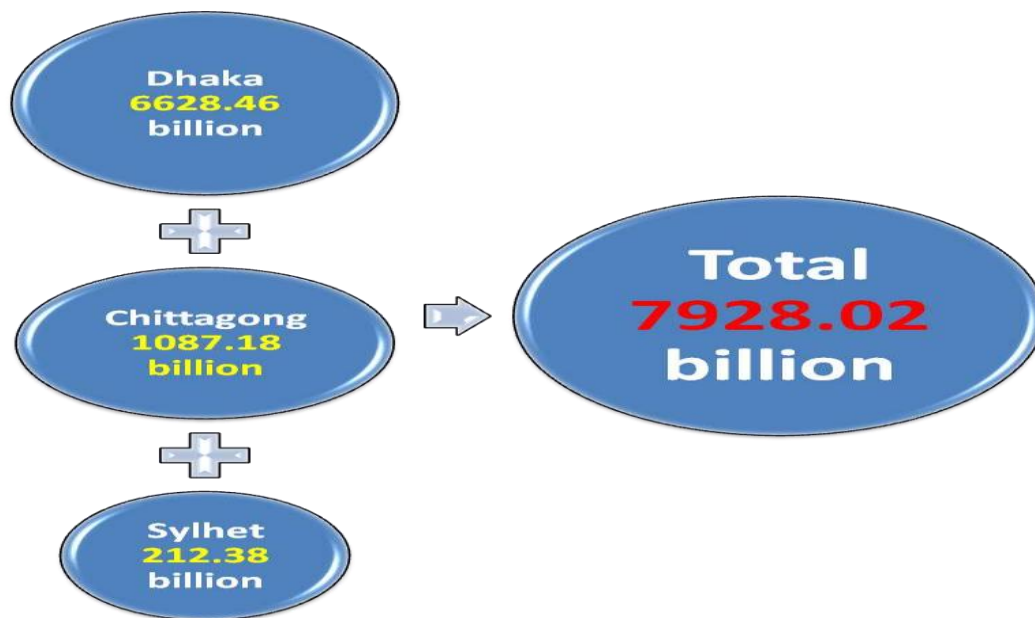


Figure 20: Children like to play with toothpastes and detergents

So, by addition of microbeads release from all these three sources i.e. facewash, toothpaste and detergents from Dhaka, Chittagong and Sylhet city, a total release of microbeads from these three cities were calculated.



All these used microbeads in the households are washed down to the drainage system. From the drainage system the wastewater are then carried to the sewage treatment plants by sewerage pipelines. From the treatment plants the treated water is finally released into the water bodies of the city. However, the Sewerage Treatment Plants (SWP) in Bangladesh are not equipped to remove these tiny particles from the water. This can be shown in the following figure:

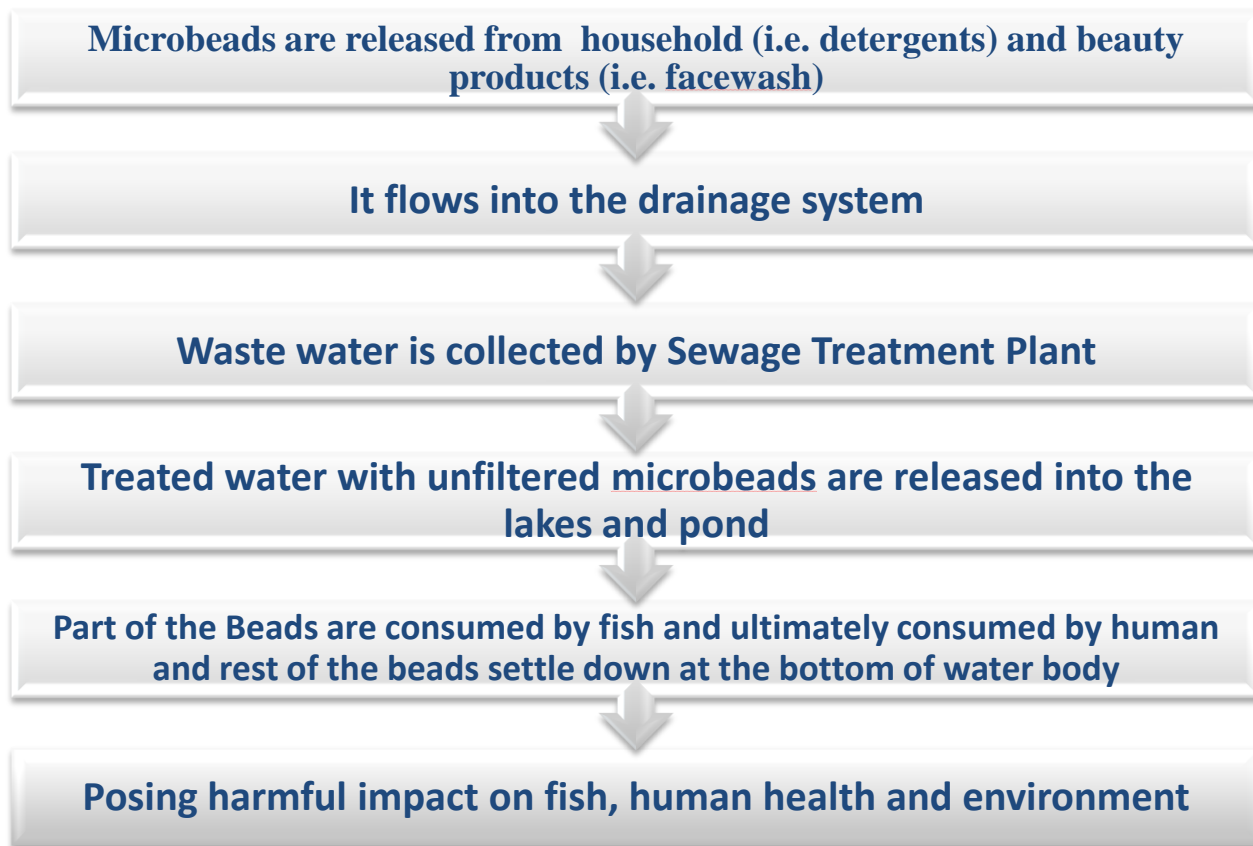


Figure 21: The cycle of microbeads contamination

As a result, microbeads are getting deposited at the bottom of water bodies of the cities. On the other hand, in the monsoon period, flood water wash away city wastes and the wastes ultimately find their way into the nearby lakes and ponds. This is another mean of water pollution by microbeads. Aquatic species uptake these particles either via ingestion or filtration, potentially introducing toxins to the base of the food chain.

A major concern with microbeads is that because of their small size, they have a large surface area by volume, so as a consequence of their use, huge numbers of readymade, highly efficient toxic accumulators are being intentionally released into the environment. Micro-plastics in the marine environment are known to accumulate toxic contaminants - persistent organic pollutants (pesticides, flame retardants, PCBs) Microbeads affect reproductive system of fish, cause liver toxicity and lead to DNA damage. Microplastics have the potential to transfer up the food chain, which may lead to consumption by humans.

These beads associated with chemicals may get into the circulatory system of human body and cause heart failure, may be absorbed into the lung and may cause lung injury, disrupt the endocrine system, cause cell damage Cause damage to digestive tract, can cross the blood-brain barrier of the human placenta and may cause damage to fetus. The microbeads found in toothpastes are usually made of a common plastic known as polyethylene, a non-biodegradable material that won't dissolve in the mouth. When these get stuck in the gum line can attract more bacteria and lead to more serious problems such as the development of periodontal disease and gingivitis.

ESDO team reached the consumers, retailers and manufacturers of microbeads containing products to get an idea of the level of awareness among them and to know the rate of use of microbeads containing products. Survey on mass people shows that both retailers and consumers are not aware of the harmful impacts of microbeads on health and environment. No study yet has been done about microbeads pollution in Bangladesh. Also lack of protection, preventive measures and regulation has created the opportunities to use microbeads in cosmetics and other personal care products. Whereas many developed countries and companies have already given their commitment and declaration to avoid or ban the use of microbeads. In 2015, the US passed a law that will ban soaps, toothpastes and body washes that contain microbeads by July 1, 2017. Many cosmetics brands including Johnson & Johnson which produces face scrubs under the brands Neutrogena and Clean & Clear has committed to phasing out microbeads by the end of 2017. Proctor and Gamble which owns Crest toothpaste, Gillette and Olay has also promised to stop using them by next year. The UK government has announced plans to ban microbeads used in cosmetics and cleaning products by 2017. The European Commission is also currently developing proposals to ban them in cosmetics across the EU, following calls from a number of member states. But, still there isn't any legislation against microbeads in Bangladesh.

This study will help concerned authorities to take necessary measures against microbeads pollution in Bangladesh. It will initiate more comprehensive further study of this problem

5. Conclusions

Microbeads are a contributor of plastic litter in the environment. The continued use of microbeads will result in increased presence in the environment. In laboratory studies, microbeads have shown adverse short-term and long-term effects in aquatic organisms. Microbeads may reside in the environment for a long time and continuous release of these substances to the environment may result in long term effects on biological diversity and the ecosystems. So, appropriate preventative measures should be taken to reduce the release of microbeads into the environment²⁴. In our country, in order to prevent microbeads pollution possible way forwards can be as following:

- Mass public awareness
- In depth study to see extent of pollution and possible sectors where microbeads are in use for production of products.
- Campaign for “stop production, seal and import of microbeads containing products”
- Legislation to ban the use of microbeads and microplastics and n Bangladesh.

²⁴<http://www.ec.gc.ca/ese-ees/default.asp?lang=En&n=ADDA4C5F-1>

Annex 1: More on Microbeads

1.1 Properties of Microbeads:

a. Substance Identity:

Microbeads are synthetic polymer particles manufactured to be in the size range of $>0.1 \mu\text{m} - \leq 5 \text{mm}$ for a specific purpose and application. They can be composed of a variety of synthetic polymers depending on the required functionality. The following table lists the function of typical polymeric particulates found in personal care and cosmetic products. In the case of microbeads, the most common polymers used are polyethylene, poly(methyl methacrylate), polytetrafluoroethylene, polypropylene, Nylon, and polyethylene terephthalate (Norwegian Environment Agency, 2014). Typical polymer forming reactions used to synthesize microbeads are based on the desired particle size and include emulsion polymerization, suspension polymerization, and dispersion polymerization. In addition, microbeads also contain residual chemicals as a result of their synthesis, such as unreacted monomers/reactants, petroleum-based chemicals, etc. These residual chemicals are different than environmental pollutants which adsorb onto the particle during its various life-cycle stages, especially within the aquatic environment²⁵.

b. Density:

Microbeads can vary in size, shape and density based on the chemical composition and method of synthesis. Polymer particles (which include microbeads) can range in polymer densities from 0.9-2.10 g/cm³ (density of water at 25°C is approximately 1 g/cm³). In addition to polymer densities, the density of the entire particle will also be a function of other chemicals added during its manufacture (e.g., additives, fillers, etc). This variation in densities means that some synthetic polymer particles (including microbeads) will float on water surfaces and others may be present in the water column or settle into the sediments.

Table 1: Polymer Compositions and Corresponding Functional Properties for Typical Particulates Found in Personal Care and Cosmetic Products (PCCP)

Polymer Name	Function in PCCP formulations
Nylon-12 (Polyamide)	Bulking, viscosity controlling, opacifying (e.g. wrinkle creams)
Nylon-6	Bulking agent, viscosity controlling
Poly(butylene terephthalate)	Film formation, viscosity controlling
Poly(ethylene isoterephthalate)	Bulking agent
Poly(ethylene terephthalate)	Adhesive, film formation, hair fixative, viscosity controlling, aesthetic agent, (e.g. glitter in bubble bath, makeup)
Poly(methyl methacrylate)	Sorbent for delivery of active ingredients
Poly(pentaerythryl terephthalate)	Film formation
Poly(propylene terephthalate)	Emulsion stabilizing, skin conditioning

²⁵http://www.ec.gc.ca/ese-ees/ADDA4C5F-F397-48D5-AD17-63F989EBD0E5/Microbeads_Science%20Summary_EN.pdf

Polyethelene	Abrasive, film forming, viscosity controlling, binder for powder
Polypropylene	Bulking agent, viscosity increasing agent
Polystyrene	Film formation
Polytetrafluoroethylene (Teflon)	Bulking agent, slip modifier, binding agent, skin conditioner
Polyurethane	Film formation(e.g. facial masks, sunscreen, mascara)
Polyacrylate	Viscosity controlling
Acrylates copolymer	Binder, hair fixative, film formation, suspending agent
Allyl stearate/vinyl acetate copolymer	Film formation, hair fixative
Ethylene/propylene/styrene copolymer	Viscosity controlling
Ethylene/methylacrylate copolymer	Film formation
Ethylene/acrylate copolymer	Film formation in waterproof sunscreen, geliant (e.g. lipstick, stick products, hand creams)
Butylene/ethylene/styrene copolymer	Viscosity controlling
Styrene acrylates copolymer	Aesthetic, colored microspheres (e.g.makeup)
Trimethylsiloxysilicate (silicon resin)	Film formation (e.g. color cosmetics, skin care, sun care)

Table Source²⁶

c. Aggregation:

Once in the environment, this behavior will change depending on the aggregation/dis-aggregation and agglomeration/dis-agglomeration behavior as the microbeads interact with environmental media, e.g., humic/fulvic acids. Moreover, synthetic particles (e.g., plastics) may become fouled by organisms and as a consequence, particles that initially floated may eventually sink to the sea bed. For example, substantial quantities of microplastics have been reported in deep sea-sediments²⁷. In theory, ingested POPs could remain on the surface of ingested microplastics and could be ingested²⁸.

d. Degradability:

Polyethylene is not biodegradable they can virtually last forever. The non-biodegradable property of polyethylene also means that it is only broken down into smaller particles. According to Walraven "Polyethylene will not dissolve in the mouth, or even in household products". It is an inert substance, which means that it doesn't change at all,"²⁹.

²⁶http://www.ec.gc.ca/ese-ees/ADDA4C5F-F397-48D5-AD17-63F989EBD0E5/Microbeads_Science%20Summary_EN.pdf

²⁷<http://www.ec.gc.ca/ese-ees/default.asp?lang=En&n=ADDA4C5F-1>

²⁸<https://www.beatthemicrobead.org/en/science>

²⁹<http://www.techtimes.com/articles/15866/20140918/plastic-microbeads-in-crest-toothpaste-are-dangerous-warns-dentist.htm#sthash.QOO5Rvw4.dpuf>

e. Reaction with Air:

There is very little known about the fate of microbeads (and secondary microplastics) in air. It is unknown whether microbeads, like other particulates with low relative densities can partition to the air compartment and, if they do, are they able to adsorb airborne pollutants and/or undergo long-range transport and atmospheric transformations (e.g., 13 reactions with hydroxyl radicals)³⁰.

f. Reaction with Soil:

Fate in soil is also unknown for microbeads (and secondary microplastics). Based on one study at a municipal wastewater plant in Russia, microplastics, although not completely removed from the effluent, are expected to primarily partition to biosludge after wastewater treatment. Once in biosolids, microplastics have the potential to be present in soils should the biosolids be applied to land. Once in the soil, microbeads could be mobile (although this is expected to be unlikely) or immobile depending on the soil chemistry and the size of the microbead relative to the soil particulates³¹. The surface of microplastics has been proven to attract and absorb persistent organic pollutants (POPs) such as PCBs and DDT from the marine environment. Relatively high concentrations of POPs have been found on the surface of microplastics¹⁰.

The International Pellet Watch, led by Professor Takada at the University of Tokyo, is conducting research to this effect. Takada's research indicates that certain POPs found in bird tissue were ingested together with their plastic hosts¹⁰.

1.2 Pathways of Microbeads Contamination

There are two pathways of microbeads contamination.

a. Surface water

Once applied to the body, most personal care products are rinsed off and go down the drain to wastewater treatment plants. Because the vast majority of these facilities are not equipped to remove such tiny particles, they are discharged directly into surface waters. In the Great Lakes, a 2014 New York State Attorney General's Office report found that 25 of 34 wastewater treatments plants discharged microbeads in their effluents.

b. Sewage sludge

Another common microbeads contamination pathway is through sewage sludge that is often applied as fertilizer on agricultural lands. Sewage sludge containing microbeads is spread as fertilizer and then mobilized and carried through the soil to groundwater sources or surface waters when it rains. Microbeads also can make their way into the lakes during combined sewer overflow events, which generally occur during periods of heavy rainfall or snowmelt and allow untreated or partially treated sewage to enter local waterways³².

³⁰ http://www.ec.gc.ca/ese-ees/ADDA4C5F-F397-48D5-AD17-63F989EBD0E5/Microbeads_Science%20Summary_EN.pdf

³¹ http://www.ec.gc.ca/ese-ees/ADDA4C5F-F397-48D5-AD17-63F989EBD0E5/Microbeads_Science%20Summary_EN.pdf

³² <http://www.ijc.org/en/blog/2016/02/16/tiny-plastics-inflict-huge-environmental-human-health-impact-story1/>

1.3 Impact on Water:

When products containing plastic microbeads are used, those beads wash down the drain, ending up in wastewater treatment systems. Depending on the type of wastewater treatment, some of the microbeads will be captured in sewage sludge, but some slip through our systems and into our rivers. At some wastewater treatment plants (WWTPs) in the U.S. and Europe can remove microbeads with an efficiency of greater than 98 percent, others may not. According to Oneearth-oneocean, an industry sponsored group, microbeads are a relatively minor contributor to marine plastic pollution³³.

In 2009, Fendall and Sewell (University of Auckland) published their observations that microbeads pass into household waste water streams directly and are too small to be retained by the standard filters used at sewage treatment plants and therefore enter the marine environment. Not only do they enter the sea, they also can enter the food chain.

In terms of relative contributions to microplastic pollution, a range of studies have looked at the number or concentration of microbeads in individual products. Once microbeads reach the marine environment, it is impossible to pinpoint the source of origin. German researchers Liebezeit and Dubaish (University of Oldenburg) hypothesise that cosmetics, and especially peelings, make up most of the microplastics they found in the Wadden Sea. Moreover, not all waste water gets purified. Following heavy rain, waste water with microbeads can overflow directly into surface waters. Some countries lack the infrastructure to treat waste water completely³⁴.

1.4 Impact on Fish

Research indicates that marine species are not able to distinguish between their usual food source and microplastics. Marine species have been shown to uptake these particles either via ingestion or filtration, potentially introducing toxins to the base of the food chain. Microplastics have the potential to transfer up the food chain, which may lead to consumption by humans³⁵. Microbead pollution in fish occurs in the following ways:

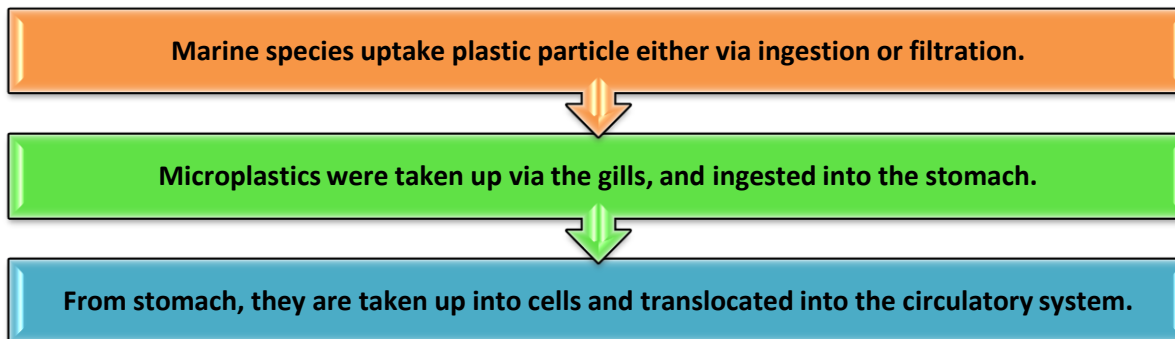


Figure 22: Pathway of Microbeads Contamination in the fish body.

³³https://en.wikipedia.org/wiki/Microbead#cite_note

³⁴ecneics/ne/gro.daeborcimehtaeb.www//:sptth

³⁵<http://www.epa.nsw.gov.au/resources/waste/plastic-microbeads-160306.pdf>

a. Long term Impact

There is a paucity of information on long-term effects of microbeads. A multigenerational study in copepods conducted by Lee et al. (2013) found that 0.5 µm polystyrene microbeads caused mortality of nauplii and copepodites in the first generation at a 19 concentration of 12.5 µg/mL and in the second generation at 1.25 µg/mL. In the same study, developmental delay was measured at 25 µg/mL for 0.5µm microbeads³⁶.

b. Direct impact

- Nobre (2015) have noted direct effects in a 24 hour study on the embryonic development (likely from residual chemicals in the microbead during production) of sea urchins exposed to as-produced and beach-sourced microbeads (20% by volume microbeads)³⁷.
- In a 9-day study by Cole and co-workers (2015) in copepods, impedance of feeding behaviour led to decreased reproductive output. Similar findings have been shown recently in *Hyaella azteca* with decreased body growth and reproduction due to feeding impedance. These authors calculated 10 day-LC50's of 4.64 X 10⁴ microbeads/mL for spherical polyethylene microbeads and 71.43 microbeads/mL for fiber microbeads³⁸.
- Another study regarding impacts on feeding behaviour by Carlos de Sa (2015) indicated a color-specific uptake where red and black microbeads significantly impeded feeding behaviour relative to white microbeads³⁹.

c. Cellular and sub-cellular impact

- Rochman and colleagues (2013) found that microbeads with and without pollutant adsorption caused stress in liver as determined by glycogen depletion, fatty vacuolation, and single cell necrosis in Japanese medaka⁴⁰.
- In a follow-up study by the same authors (2014) in the same organisms, and following 2-month exposure from plain and pollutant-modified microbeads, there was altered gene expression in male fish (from pollutant modified microbeads) and female fish (from both modified and unmodified microbeads). They found significant down regulation of choriogenin gene expression in males and significant down regulation of vitellogenin, choriogenin, and estrogen receptor alpha in females. These findings suggest the capability of inducing an endocrine-disrupting effect both from modified and unmodified microbeads. However, it is unclear in this study whether the effects from the unmodified microbeads were from only the particle and/or residual chemicals from manufacturing⁴¹

³⁶ Lee, K. W., Shim, W. J., Kwon, O. Y., Kang, J. H. (2013). Size-dependent effects of micro polystyrene particles in the marine copepod *Tigriopus japonicus*. *Environmental science & technology*, 47(19), 11278-11283.

³⁷ Nobre, C. R., Santana, M. F. M., Maluf, A., Cortez, F. S., Cesar, A., Pereira, C. D. S., Turra, A. (2015). Assessment of microplastic toxicity to embryonic development of the sea urchin *Lytechinus variegatus* (Echinodermata: Echinoidea). *Marine pollution bulletin*, 92(1), 99-104.

³⁸ Cole, M., Lindeque, P., Fileman, E., Halsband, C., Galloway, T. S. (2015). The Impact of Polystyrene Microplastics on Feeding, Function and Fecundity in the Marine Copepod *Calanus helgolandicus*. *Environmental science & technology*.

³⁹ http://www.ec.gc.ca/ese-ees/ADDA4C5F-F397-48D5AD1763F989EBD0E5/Microbeads_Science%20Summary_EN.pdf

⁴⁰ Rochman, C. M., Hoh, E., Kurobe, T., Teh, S. J. (2013). Ingested plastic transfers hazardous chemicals to fish and induces hepatic stress. *Scientific reports*, 3

⁴¹ Rochman, C. M., Kurobe, T., Flores, I., Teh, S. J. (2014). Early warning signs of endocrine disruption in adult fish from the ingestion of polyethylene with and without sorbed chemical pollutants from the marine environment. *Science of the Total Environment*, 493, 656-661.

- In a study by Avio and colleagues (2015), both unmodified (virgin) and pyrene modified microbeads led to DNA damage in mussels, suggesting possible genotoxicity⁴².

1.5 Impact on wild life

Microbeads and microplastics generally are toxic to an array of biological systems, ranging from tiny marine invertebrates to mammal to humans. The level of toxicity depends on the size and specific chemical makeup of a particular microbeads or microplastics particle⁴³.

- ✓ In mammals, tiny microplastics have been found able to move through the gastrointestinal tracts to the lymphatic and circulatory systems, which are absorbed into the lungs when inhaled.
- ✓ Animal studies have also found that microplastics move through placentas to unborn fetus and impact the immune system⁴⁴.
- ✓ In the Great Lakes, SUNY Fredonia researchers performing food web surveys. They found that, ingestion of plastic causes internal abrasions or blockages resulting in reductions in food consumption, stunted growth, and starvation.
- ✓ Studies have found microplastics pass from a species digestive tract to its circulatory system and are physically transferred from prey to predator.
- ✓ In mussels, ingestion of plastic pieces so small they are invisible to the naked eye, reduce filter feeding, which could lead to starvation⁴⁵.
- ✓ Browne showed in 2008 that microplastics sized 3.0 and 9.6 µm in diameter can travel beyond a mussel's gut and into its circulatory system and hemocytes (immune cells), where they may remain for a relatively long period of time—in his study, more than 48 days.
- ✓ A 2012 study by another group showed that microplastics taken up by mussels resulted in a strong inflammatory response⁴⁶. The Environmental Working Group notes that the plastics that make up some microbeads are suspected to be hormone disruptors⁴⁷. As microbead contain harmful chemicals like PCB and other fat soluble compounds they are known to cling to polyethylene, the plastic used to make them. That's in addition to estrogen, a hormone that's perfectly safe at normal levels in many animals, but one that can cause health problems if it builds up in the body. Estrogen-induced health problems can include behavioral changes in male fish along with damage to fish eggs that causes impairments and non-viability⁴⁸.
- ✓ When microbeads are consumed by animals, it collides and damages the organism's endocrine system. The endocrine system is the collection of glands that produce hormones that regulate metabolism, growth and development, tissue function, sexual function, reproduction, sleep, and mood, among other things. The endocrine system is vital to many organisms, and if disrupted, can cause a catastrophic blow to their health⁴⁹.

⁴² Avio, C. G., Gorbi, S., Milan, M., Benedetti, M., Fattorini, D., d'Errico, G., Paoletto, M., Bargelloni, L. Regoli, F. (2015). Pollutants bioavailability and toxicological risk from microplastics to marine mussels. *Environmental Pollution*, 198, 211-222

⁴³ https://ag.ny.gov/pdfs/Microbeads_Report_5_14_14.pdf

⁴⁴ http://www.ijc.org/en_blog/2016/02/16/tiny_plastics_inflict_huge_environmental_human_health_impact_story1/.

⁴⁵ https://ag.ny.gov/pdfs/Microbeads_Report_5_14_14.pdf

⁴⁶ <http://ehp.niehs.nih.gov/123-a34/>

⁴⁷ <http://www.motherjones.com/environment/2015/05/microbeads-exfoliators-plastic-face-scrub-toothpaste>

⁴⁸ <http://www.enn.com/health/article/48631>

⁴⁹ <https://microbeadless.wordpress.com/what-are-microbeads/>

1.6 Impact on Human

a. Polluting food chain

Microplastics may be small, but they're causing big problems for our health. These tiny pieces of plastic used in personal care products are designed to go down the drain and into our lakes, rivers, and oceans — by the billions every day. They absorb toxins in the water, are eaten by marine life, and can make their way up the food chain all the way to our dinner plates. Fish species that humans harvest for food have been known to eat micro-plastic particles at an alarming rate and the toxins absorbed in those plastics transfer to the fish tissue⁵⁰. However, fish and seafood regularly consumed by humans have been recorded with plastic fragments inside their guts and body tissues. Scientists hypothesise that over time, POPs will start accumulating in the food chain, transferring from species to species, with consequences ultimately for humans. *For example*, a controlled laboratory study was conducted by RMIT University. The researchers spiked microbeads they had isolated from popular face cleansers with "environmentally relevant" concentrations of the pollutant polybrominated diphenyl ethers (PBDEs) and fed them to Murray River rainbow fish. The study, published in the journal *Environmental Science & Technology*, revealed that up to 12.5 per cent of PBDEs on the microbeads leached into the tissue of the fish. PBDEs are known to biomagnify up the food chain in marine animals. Eating fish and shellfish is linked to elevated levels of PBDEs in humans. "We know generally that if someone eats a fish, they risk eating any pollution that may be in the fish," said Bradley Clarke, lead investigator and environmental scientist at RMIT University⁵¹. The impact of microbeads on human body can be described by the following figure:

⁵⁰ <http://storyofstuff.org/plastic-microbeads-ban-the-bead/>

⁵¹ <http://www.smh.com.au/business/consumer-affairs/microbeads-are-leaching-toxic-chemicals-into-fish-sparking-public-health-fears-20160816-gqtlpk.html>

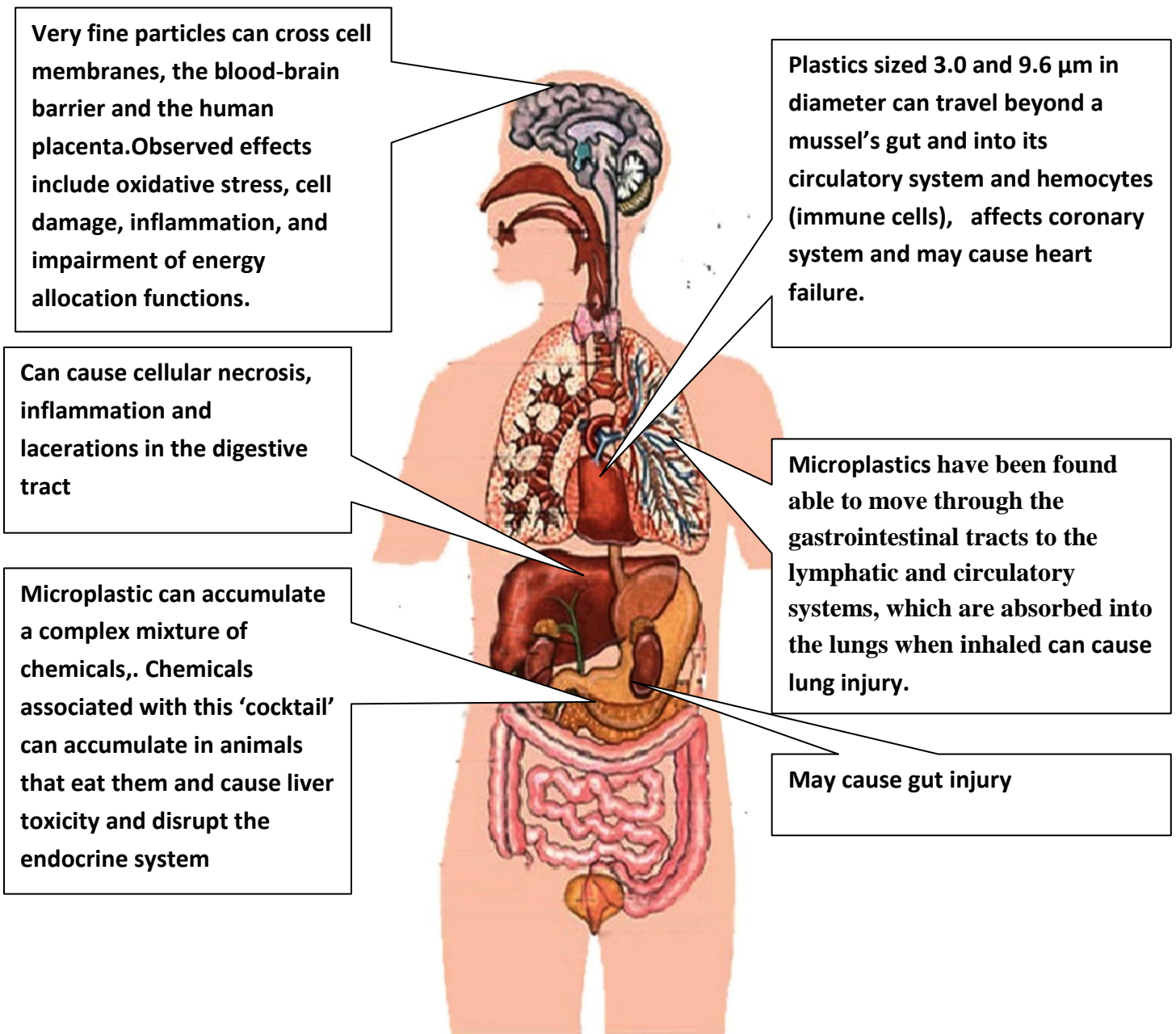


Figure 23: Impact of microbeads on human body

b. Acting as a source of Endocrine disrupting chemical (EDC)

Many plastic products contain chemical additives that leach out, especially when exposed to weathering, heat or ultraviolet light. For example, Bisphenol-A, is a chemical additive and a known endocrine disrupting chemical that is banned in certain children products in New York. Endocrine disrupting chemicals produce adverse developmental, reproductive, neurological, and immune effects in both humans and wildlife. They have been linked to a number of common ailments, including

- heart disease,
- immune system disruption,
- brain deterioration,
- type-2 diabetes,
- cancer and
- Obesity.

They pose the greatest risk during prenatal and early childhood development when organ and neural systems are forming⁵².

c. Acting as a habitat for pathogenic microorganisms

Both large and small plastic debris can act as a substratum for pathogenic micro-organisms and parasites. For example, plastic debris off the Belgian coast has been found to contain human pathogenic bacteria (e.g., *Escherichia coli*, *Bacillus cereus*, *Stenotrophomonas maltophilia*), some distinct from the surrounding water and sediment, indicating that plastic debris can act as a distinct habitat and reservoir for pathogens. Human pathogens, such as bacteria, can colonise plastic surfaces in stable biofilms when they come into contact in wastewater treatment plants or in households where wastewater from washing) and lavatories (pathogens) are combined. Once emitted to surface water, plastics carrying pathogens may enter bathing or drinking water, leading to human exposure and increased risk of infection.

Plastic debris capable of holding stagnant water on land can also create habitats for mosquito larvae that transmit parasites or viruses such as Zika and dengue.

Similarly, plastic debris may create favorable habitats for the proliferation and distribution of parasite-bearing freshwater snails (e.g., *Schistosomiasis*) and thereby worsens the spread of disease.

People may be more at risk in more vulnerable highly populated delta areas where sanitation facilities are poor, plastic is cheap and waste management underdeveloped, and after flooding events. Given the high dispersal capabilities of floating plastic debris in aquatic systems and the increase in plastic pollution around the world, especially in developing countries with poor waste management, a new health issue is coming into view⁵³.

d. Affecting skin

Microbeads in facewash scrub off dead skin and gunk out of pores. Rubbing these little pieces of plastic against skin can be harmful. Exfoliation is an important part of an effective skin care routine, but it is needed to remember that the skin on face is fragile and can be easily damaged. It should be treated with care. Most scrubs use microbeads because they are cheaper to produce than other exfoliators; however, they can create small tears in skin, leaving it vulnerable to bacteria⁵⁴.



Figure 24: Microbeads may create small tears on skin.

⁵² https://ag.ny.gov/pdfs/Microbeads_Report_5_14_14.pdf

⁵³ <http://pubs.acs.org/doi/pdf/10.1021/acs.est.6b02569>

⁵⁴ <http://greatist.com/connect/microbeads-harmful-to-environment-human-health>

e. Affecting teeth

People use toothpaste to thoroughly clean their teeth and make their mouth smell fresh but those who use toothpaste containing microbeads may be getting more than a clean and sparkling white smile. The microbeads found in toothpastes are usually made of a common plastic known as polyethylene, a non-biodegradable material that won't dissolve in the mouth.

- The Washington post reported last year that the tiny beads in some toothpaste were not only damaging our insides, the environment, and the creatures that dwell in our waterways, but are also causing serious dental hygiene issues.
- Dental hygienist Trish Walraven started to notice little blue specks in the gum lines of her patients a few years back and initially thought these were caused by a cleaning product or something that her patients chew. Eventually, however, she learned that other hygienists also see these blue specks which turned out to be polyethylene, the most common plastic widely used in packaging materials such as grocery bags, garbage bags and plastic bottles. Michael Apa, DDS, confirms this concern. "Over time they can cause problems both with their abrasion when used with a sonic toothbrush against enamel, and I've heard of patients getting those micro scrubbers lodged in their gums, which can lead to gum irritation and site-specific bone loss, if not properly removed," he explains.
- Brian Moore, a dentist from Kentucky said that the microbeads can attract more bacteria when these get stuck in the gum line and this could lead to more serious problems such as the development of periodontal disease and gingivitis. "Any time you have any foreign body in the pocket around the tooth, it's a breeding ground for bacteria" he said⁵⁵.

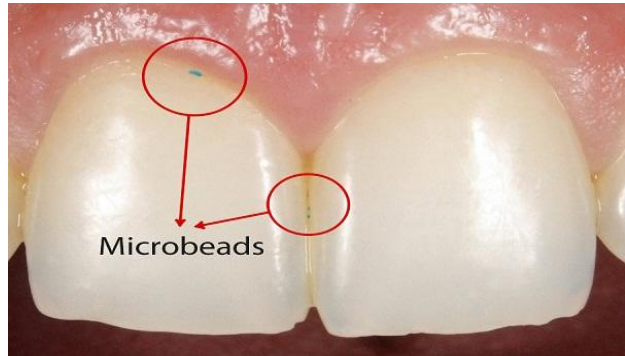


Figure 25: Microbeads stuck in gum

1.7 How one can know whether they are using products containing microbeads

Most people have no idea that those little beads are actually bits of plastic! In the United States, The Food and Drug Administration (FDA) requires that if a product contains microbeads the company has to list the ingredients. Not all countries require this, but many producers list their ingredients anyway. If one see any of the following ingredients: **polyethylene**, **polypropylene**, **polyethylene terephthalate** or **polymethyl methacrylate** that means he or she is cleaning up with plastic and being duped into contributing to plastic pollution in the environment⁵⁶.



Figure 26: Ingredient list showing the presence of microbeads

⁵⁵ <http://www.refinery29.com/2016/01/100202/microbeads-beauty-products-environmental-effects>

⁵⁶ <http://storyofstuff.org/plastic-microbeads-ban-the-bead/>

1.8 Present Condition of Market

Several big companies including Cincinnati-based Procter & Gamble, maker of Crest toothpaste, agreed to phase out the use of these synthetic abrasives even before Congress passed a law in December making them illegal after Jan. 1, 2018 in an industry-supported action. Toothpaste, soap and lotion makers are already rolling out products with natural alternatives, including cocoa beans and apricot shells, according to the Kentucky Waterways Alliance. The beauty website Allure also identifies jojoba, papaya and Vitamin C paste as alternatives.

But some still remain on the shelves. The group **Beat the Microbead** publishes lists of products that contain or don't contain plastic microbeads. As of July 2015, these were among the products that the group said still featured plastic microbeads:

- Aveeno Brightening daily scrub
- Caress Evenly Gorgeous Exfoliating Body Wash (burnt brown sugar and karite butter)
- Clean & Clear Deep Action Exfoliating Scrub, oil free
- CVS pharmacy Oil Free Acne Scrub
- Neutrogena Men Razor Defense Face Scrub
- Rite Aid Renewal Bright Skin Daily Face Scrub
- The Body Shop Tea Tree Squeaky Clean Scrub
- Victoria's Secret 2-in-1 Wash and Scrub (all scents)
- Crest 3D White Arctic Fresh, icy-cool mint
- Colgate Max Clean Toothpaste⁵⁷.

1.9 Microbeads legislation

Microbeads in personal care products are internationally recognized as a source of micro plastic marine pollution. Leading governments in Europe, Canada and the US are protecting their waterways from these plastic microbeads through legislation. As microbeads cannot be removed once they enter the sea, this is the only way to effectively stop this type of water pollution⁵⁸. An increase in peer reviewed published research and reports from the United Nations Environment Program have raised awareness of the effects of microbeads to a level that resulted in the US government introducing the Microbead Free Waters Act (2015) banning the sale of personal care products containing plastic microbeads.

Other regions (including Canada, Australia, and several European countries) are also encouraging phase outs or bans of plastic microbeads⁵⁹.

⁵⁷ <http://www.courier-journal.com/story/tech/science/environment/2016/01/05/how-avoid-plastic-microbeads-products/78297810/>

⁵⁸ <http://www.supporthk.org/en/node/2552?lang=en>

⁵⁹ <http://www.plasticfreeseas.org/microbeads.html>

1.9.1 USA

Legislations in the United States are given below:

<i>State/Territory</i>	<i>Date Enacted</i>	<i>Effective date</i>	<i>Scope</i>
California	October 8, 2015	January 1, 2018 (manufacture of personal care products)-Jan.1, 2020 (sale of over-the-counter drugs)	Restricted to rinse-off cosmetics that contain more than 1ppm of microbeads. does not allow biodegradable microbeads)
Colorado	March 26, 2015	January 1, 2018 (manufacture of personal care products)-Jan.1, 2020 (sale of over-the-counter drugs)	Restricted to rinse-off cosmetics. Allow biodegradable microbeads.
Connecticut	June 30, 2015	January 1, 2018 (manufacture of personal care products)-Jan.1, 2020 (sale of over-the-counter drugs)	Restricted to rinse-off cosmetics. Allow biodegradable microbeads.
Illinois	June 8, 2014	January 1, 2018 (manufacture of personal care products)-Jan.1, 2020 (sale of over-the-counter drugs)	Restricted to rinse-off cosmetics. Allow biodegradable microbeads.Excludes prescription drugs.
Indiana	April 15, 2015	January 1, 2018 (manufacture of personal care products)-Jan.1, 2020 (sale of over-the-counter drugs)	Restricted to rinse-off cosmetics. Allow biodegradable microbeads.
Maine	March, 2015	January 1, 2018 (manufacture of personal care products)-Jan.1, 2020 (sale of over-the-counter drugs)	Restricted to rinse-off cosmetics. Allow biodegradable microbeads.
Maryland	May12, 2015	January 1, 2018 (manufacture of personal care products)-Jan.1, 2020 (sale of over-the-counter drugs)	Restricted to rinse-off cosmetics. Allow biodegradable microbeads.
New Jersey	March, 2015	January 1, 2018 (manufacture of personal care products)-Jan.1, 2020 (sale of over-the-counter drugs)	Restricted to rinse-off cosmetics. Allow biodegradable microbeads.
Wisconsin	July1, 2015	January 1, 2018 (manufacture of personal care products)-Jan.1, 2020 (sale of over-the-counter drugs)	Restricted to rinse-off cosmetics. Allow biodegradable microbeads.Excludes prescription drugs.

In the USA, at the federal level, the Microbead-Free Waters Act of 2015 prohibits the manufacture and introduction into interstate commerce of rinse-off cosmetics containing intentionally-added plastic microbeads by July 1, 2017. Representative Frank Pallone proposed the bill in 2014 (H.R. 4895, reintroduced in 2015 as H.R. 1321). On December 7, 2015, his proposal was narrowed by amendment to rinse-off cosmetics, and passed unanimously by the House. The American Chemistry Council and other industry groups supported the final bill, which the Senate passed on December 18, 2015, and the president signed on December 28, 2015⁶⁰.

Illinois became the first U.S. state to enact legislation banning the manufacture and sale of products containing microbeads; the two-part ban goes into effect in 2018 and 2019. The Personal Care Products Council, a trade group for the cosmetics industry, came out in support of the Illinois bill. Other states have followed. As of October 2015 all state bans except California's ban, allow biodegradable microbeads. Johnson & Johnson and Procter & Gamble opposed the California law⁶¹.

1.9.2 New York

In 2014, legislation was voted on but failed to pass in New York.

In 2015, Erie County, New York passed the first local ban in the state of New York. It bans the sale and distribution of all plastic microbeads (including biodegradable ones) including from personal care products. As of September 2015, its prohibition on sales is stronger than any other law in the country. It was enacted on August 12, 2015 and should take effect in February, 2016. This appears to be the first ban to go into effect in the country. In November 2015 four other NY counties followed suit. In 2014, legislation was voted on but failed to pass in New York⁶². In November 2015 four other NY counties followed suit⁶³.

1.9.3 Netherlands

The Netherlands was the first country to announce its intent to be free of microbeads in cosmetics by the end of 2016. State Secretary for Infrastructure and the Environment Mansveld has said she is pleased with the progress made by the members of the Nederlandse Cosmetica Vereniging (NCV), the Dutch trade organization for producers and importers of cosmetics, who have ceased using microbeads or are working towards removing microbeads from their product. By 2017 80% of them should have completed the transition to a microbead-free product line. Among the NCV's members are large multinationals such as Unilever, L'Oreal, Colgate-Palmolive, Henkel, and Johnson & Johnson²⁹.

⁶⁰<https://en.wikipedia.org/wiki/Microbead>

⁶¹<https://en.wikipedia.org/wiki/Microbead>

⁶²<https://en.wikipedia.org/wiki/Microbead>

⁶³<https://en.wikipedia.org/wiki/Microbead>

1.10 Alternative to Microbeads:

Safe, non-plastic alternatives are available and widely used by many leading brands. These natural alternatives include: crushed nuts and shell, salt, charcoal, sand, sugar, pumice and oatmeal to name a few⁶⁴.



Figure 27: Alternatives to microbeads

⁶⁴<http://www.plasticfreeseas.org/microbeads.html>

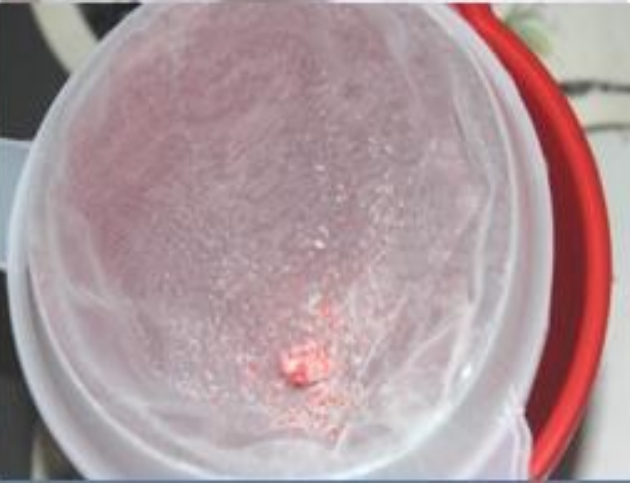
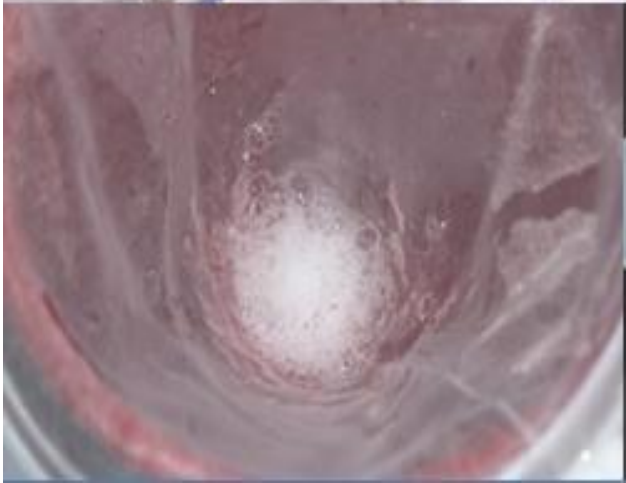
Annex-2 Fish examination and analysis images



Annex 3: Market Survey by ESDO team



Annex 4: Analysis of the surveyed products



Annex 5. Survey Questionnaire

I. a. Sample Questionnaire for consumers:

II. Time: **Date:** **Location:**.....

Part-1 [Participant's Identical outline]	
Name	
Sex	<input type="checkbox"/> Male <input type="checkbox"/> Female
Age	<input type="checkbox"/> ≥ 19 <input type="checkbox"/> 20-29, <input type="checkbox"/> 30-39, <input type="checkbox"/> 40-49, <input type="checkbox"/> ≤ 50
Profession	<input type="checkbox"/> Student, <input type="checkbox"/> Govt. Officer, <input type="checkbox"/> Businessman, <input type="checkbox"/> Private Business, others
Education	<input type="checkbox"/> Illiterate, <input type="checkbox"/> Primary education, <input type="checkbox"/> High school education, <input type="checkbox"/> Higher education
Income	<input type="checkbox"/> 5000-7000, <input type="checkbox"/> 5000-10,000, <input type="checkbox"/> 10,000-20,000, <input type="checkbox"/> 25000-35,000, <input type="checkbox"/> ≥ 45000
Part-2 [Survey Questions]	
1. What type of products do you use/buy repeatedly?	<input type="checkbox"/> Facial Scrub <input type="checkbox"/> Facewash <input type="checkbox"/> Toothpaste <input type="checkbox"/> Makeup <input type="checkbox"/> Cream
2. Do you have any complain regarding the quality of products?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Neutral
3. Have you ever face any skin problem in time of using any products?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Neutral
4. If yes, then what type of skin problem did you face?	<hr/> <hr/> <hr/>
5. Do you have any idea about microbeads used in products?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Neutral
6. If yes, what is the source of your knowledge on microbeads in products?	<input type="checkbox"/> Newspaper <input type="checkbox"/> Television <input type="checkbox"/> Online source <input type="checkbox"/> Conversation with people <input type="checkbox"/> Others _____
7. What do you think about Microbeads based products?	<input type="checkbox"/> Avoid purchasing those products <input type="checkbox"/> Purchase alternative safe products <input type="checkbox"/> Be careful about using <input type="checkbox"/> Make awareness among customers <input type="checkbox"/> Others _____
8. Any opinion about microbeads in Products?	<hr/> <hr/>

Name of Interviewer:

Signature

b. Sample questionnaire for retailers

Time:

Date:

Location.....

Part-1 [Participant's Identical outline]	
Name	
Sex	<input type="checkbox"/> Male <input type="checkbox"/> Female
Age	<input type="checkbox"/> ≥ 19 <input type="checkbox"/> 20-29 <input type="checkbox"/> 30-39, <input type="checkbox"/> 40-49, <input type="checkbox"/> ≤ 50
Education	<input type="checkbox"/> Illiterate <input type="checkbox"/> Primary education <input type="checkbox"/> High school education, <input type="checkbox"/> Higher education
Income	<input type="checkbox"/> $\leq 50,000$ <input type="checkbox"/> 50,000-1,00,000 <input type="checkbox"/> 1,00,000-5,00,000 <input type="checkbox"/> 5,00,000-10,00,000 <input type="checkbox"/> $\geq 10,00,000$
Part-2 [Survey Questions]	
1. What type of products do you mainly sell containing microbeads?	<input type="checkbox"/> Facewash <input type="checkbox"/> Toothpaste <input type="checkbox"/> Detergent <input type="checkbox"/> Others
2. Do you have any idea about plastic microbeads used in products?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Neutral
3. If yes, what is the source of your knowledge on microbeads in products?	<input type="checkbox"/> Newspaper <input type="checkbox"/> Television <input type="checkbox"/> Online source <input type="checkbox"/> Conversation with people <input type="checkbox"/> Others_____
4. What do you think about Mercury based products?	<input type="checkbox"/> Avoid selling those products <input type="checkbox"/> Be careful about selling <input type="checkbox"/> Others_____
5. Any opinion about microbeads in Products?	

Name of Interviewer:

Signature

c. Sample questionnaire for children and parents

Time:

Date:

Location:.....

Part-1 [Participant's Identical outline]	
Name	
Sex	<input type="checkbox"/> Male <input type="checkbox"/> Female
Age	<input type="checkbox"/> ≥ 19 <input type="checkbox"/> 20-29, <input type="checkbox"/> 30-39, <input type="checkbox"/> 40-49, <input type="checkbox"/> ≤ 50
Education	<input type="checkbox"/> Illiterate, <input type="checkbox"/> Primary education, <input type="checkbox"/> High school education, <input type="checkbox"/> Higher education
Income	<input type="checkbox"/> $\leq 50,000$ <input type="checkbox"/> 50,000-1,00,000 <input type="checkbox"/> 1,00,000-5,00,000 <input type="checkbox"/> 5,00,000-10,00,000 <input type="checkbox"/> $\geq 10,00,000$
Part-2 [Survey Questions]	
1. Do you like to eat toothpaste	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Neutral
1. Do your child has the habit of eating toothpaste?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Neutral
2. Do you like to play with detergents and toothpaste?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Neutral
3. Does your child play with tootpaste and detergent?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Neutral
4. Any opinion about microbeads in Products?	 <hr/> <hr/>

Name of Interviewer:

Signature

Annex6: Bibliography

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