IETE Zonal Seminar "Techno-Socio Development through Women Empowerment" - 2018
Special Issue of IJECSCSE, ISSN: 2277-9477

Similarities between Human Hairs and Bird Feathers and Use of Human Hairs for Oil Spill Cleanup

Mr. Saahil Deepak Umratkar **Dr. R. U. Sambhe**

Abstract — **Bird feathers and human hairs are reported to have number of similarities. The use of bird feathers (especially ostrich feathers) for oil spill cleanup as the oil is reported to stick to the feathers and enhances oil spill cleanup is known since decades. But the harm caused to the birds because of plucking of feathers cannot be denied. Use of human hairs instead of bird feathers can reduce the possibilities of harm caused to the birds. This paper elaborates the experimental results of the use of different types of human hairs for separation of oil from the oil water mixture on the basis of different varying parameters as a method for cleanup of oil spills in water bodies.**

Key Words — **Oil spill, human hair, bird feathers, human hair oil filter**

I. INTRODUCTION

The increased offshore extraction of petroleum oil from oil rigs, leakages of crude oil from tankers, offshore platform, heavier fuels used by large ships such as bunker fuel have enormously increased the threat of oil spillages into oceans. Also, the industrial waste water Oil spills are responsible for the chemical contamination of sea water, thus contamination of the aquatic life or even large scale death of fish and sea birds and creating hazardous impact on the balance of marine ecosystem. Their prolonged effect may cause biological alteration in the genes of aquatic species. The terrestrial species are also severely affected when the contaminated sea food is consumed by them. As a result, the entire ecosystem of the oil affected area might be disturbed. The environmental impact of oil spills has been extensively researched over the past 30 years. The long term effects of oil spills on marine species and communities are well known. Even low levels of residual oil affect the ability of certain species to breed successfully. The range of biological impacts after an oil spill can encompass physical and chemical alteration of natural habitats, e.g. resulting from oil incorporation from into sediments; physical smothering effects on flora and fauna; changes in biological communities resulting from oil effects on key organisms, e.g. increased abundance of interidal algae following death of limpets which normally graze on algae [1].

The country Nigeria recorded about 1020 incidents of oil spillage, which culminated in the loss of about 1,359,715 barrels of crude oil to the waste land and water of Niger Delta (Opafunso and Apena, 2000) [2]. The major causes of oil spill in Nigeria are corrosion of pipelines and tankers (accounting for 50% of all oil spills), sabotage (28%) and oil operations (21%) with 1% of the spills being accounted for by inadequate or non-functional equipment (Nwilo et al, 2007) [3]. Many of the oil pipelines have been in place for over 30 years area UNEP (2006) [4] summed the impact of oil spillage in the Niger Delta as follows; high mortality of aquatic animals, impairment of human health, loss of biodiversity in breeding grounds, vegetation hazards, loss of potable and industrial water resources, reduction in fishing and farming activities, poverty and rural unemployment. Virtually every aspect of oil exploration and exploitation has deleterious effects on ecosystem stability and local biodiversity.

In India also Mumbai oil spillage 2010 and Chennai oil spillage 2017 leave severe environmental consequences. Oil spillage is one of the most serious environmental and ecological challenges [5]. Oil contamination from various industries is also causing considerable amount of water pollution. The marine atmosphere and sea water are the most affected due to these incidents, so there is an urgent need of development of material for collection and separation of oil and oily organic pollutant from water sources.

Similarities between human hairs and bird feathers-

The potential evolutionary link between hairs in mammals, feathers in birds and scales in reptiles has been debated for decades. Today, researchers of the University of Geneva (UNIGE) and the SIB Swiss Institute of Bioinformatics, Switzerland, demonstrate that all these skin appendages are homologous: they share a common ancestry. On the basis of new analyses of embryonic development, the Swiss biologists evidenced molecular and micro-anatomical signatures that are identical between hairs, feathers and scales at their early developmental stages. These new observations, published in *Science Advances*, indicate that the three structures evolved from their common reptilian ancestor.

Mammalian hairs and avian feathers develop from a similar primordial structure called a 'placode': a local thickening of the epidermis with columnar cells that reduce their rate of proliferation and express very specific genes. This observation has puzzled evolutionary and developmental biologists for many years because birds and mammals are not sister groups: they evolved from different reptilian lineages.

According to previous studies, reptiles' scales however do not develop from an anatomical placode. This would imply that birds and mammals have independently 'invented' placodes during their evolution.

In 2015, a team from Yale University (USA) published an article showing that scales, hairs and feathers share molecular signatures during their development. These results fueled an old debate between two schools. One defends that these molecular signatures suggest a common evolutionary origin of skin appendages, whereas the other proposes that the same genes are re-used for developing different skin appendages.

Today, Nicolas Di-Poï and Michel C. Milinkovitch at the Department of Genetics and Evolution of the UNIGE Faculty of Science and at the SIB put this long controversy to rest by demonstrating that scales in reptiles develop from a placode with all the anatomical and molecular signatures of avian and mammalian placodes. The two scientists finely observed and analysed the skin morphological and molecular characteristics during embryonic development in crocodiles, snakes and lizards. 'Our study not only provides new molecular data that complement the work of the American team but also reveals key micro anatomical facts, explains Michel Milinkovitch. Indeed, we have identified in reptiles new molecular signatures that are identical to those observed during the development of hairs and feathers, as well as the presence of the same anatomical placode as in mammals and birds. This indicates that the three types of skin appendages are homologous: the reptilian scales, the avian feathers and the mammalian hairs, despite their very different final shapes, evolved from the scales of their reptilian common ancestor [6].These similarities give us an idea of using the human hairs for separation of oil from oil-water mixture for the purpose of oil spill cleanup.

Human hairs can be used to purify contaminated areas in different environment after oil spills. Rather than discarding of the human hair it can be used to help cleanse the affected area, absorb the oil then utilized as an effective fuel derivation. The oil absorption of potentially wasted hair fibers could produce valuable slot for our modern society. The ability of the human hair to absorb a variety of potential hazardous oils has been investigated including motor oils, bilge oils & crude oils that have the possibility of being spilled in terrestrial or aquatic environments. Current increased demand for refined crude oil products such as heating oil, lubricant oils, gasoline & jet fuel & other such related products necessitated transportation of rushing products over greater distances causing many serious accidents resulting in spills. Different hair colors feel that overall black gave the best results for adsorbing the most oil. Hair pellets are also used as fuel that can be help reduce global warming which has also been prevent to provide the cleanest burn of any solid fuel. Thousand of tones of human hairs are cue everyday and thrown into land as a waste produces which has no direct benefits. Hair is not an easily degradable substance. We looked at the possibility of finding a use for waste hair that could be used to clean up oil spills and that the oil could be recovered or converted in fuel pallets. Also, the separation results obey frendlch's isotherm, thus confirming that the oil removal is due to selective adsorption. As the process is eco-friendly and does not require any chemicals, it may lead to development of a new technique of separating oil water emulsion, which is simpler. According to a small note published in science reporter, starting that NASA is on the job of trying to develop a technology that could do the separation of oil from water using human hair as an adsorbing medium. It is generally seen that hair has good adsorbing capacity for oils. Keeping this concept is mind, the subject is explored further and its application in the field of oil separation is studied. It is seen that at laboratory scale, the method is very efficient. However, the most intriguing thing observed is its efficiency in separating emulsified oil. Since hair is very cheap and not easily biodegradable, the method may find a good usage for it [7].

A preliminary type of human hair filter has been designed inside a transparent glass tube to examine the absorptivity of human hairs under different densities of human hair filter.

II. STRUCTURE AND COMPOSTION OF HUMAN HAIR

The essential growth structures of hair are follicles which are deeply invaginated in the scalp tissue in the tens of thousands. At the base of each follicle, the cells proliferate. As they stream up-ward, the complex processes of protein synthesis, structural differentiation, align material which is known as hair. Hair grows at arate of about cm per month for a period of 3-5 years, followed by a arresting period of 4-6 months, during which the old hair is shed and a new growth beings. Scalp hair is typically 50-80mm in diameter and its exterior consists of a layer of flat, limricated cuticle scales pointing outward from root to tip. This arrangement of cuticle cells permits better mechanical retention of the fiber in the follicle and also serves as self-cleaning feature. Although the individual scales are thin, i.e. 0.5 mm. they are long and overlap each other to form a continuous multilayered shield (3-4mm) around the fiber. Enveloped the protective sheath of the cuticle is hair cortex which constitutes the bulk of the fiber. The cortical cells are fibrillar in nature, highly elongated, and oriented along the length of hair. Dispersed throughout the structure of cortex are pigment particles called melanin. Their number, chemical character, and distribution pattern determine the color of hair in some hairs, centrally located vacuolated medulla cells areal so present. Chemically, hair is a biopolymer composed largely of cystine-cross linked proteins termed keratins. Two principle protein fractions has been isolated from hair. ie. low and high sulfur proteins. The low sulfur fraction consistent of protein of high molecular weight and high degree of molecular organization, i.e. U - helical; the protein of the high sulfur group is of \low molecular weight and of unknown structural pattern. Electron microscope studies reveal that both proteins participate in a bi phase composite, filament-matrix texture which is the dominant structural element of hair cortex. The filaments are composed of low sulfur proteins and the surrounding matrix is made up of high sulfur proteins. The structure and chemical composition of the cuticle differs from that of the cortex, and cuticle cells do not seem to contain and organized low sulfur proteins. The distal zone of each cuticle is heavily cross-linked by cystine; this fact, in conjunction with the multilayered structure, makes the cuticle a formidable barrier to penetration of materials into the interior of the hair. Although hair of different racial origin differs in shape, degree of waviness (curl), and color, there is very little difference in the underlying chemical composition and physical structure. The rate of reaction with a variety of chemical reagents and most physical properties are similar.

Differences between hair from different ethnic groups are much smaller than the variation in the properties of hair taken from different individuals within one ethnic group. Compared to Caucas in hair, Negro hair is more oval in the shape of its cross-section, and is much curlier. The tight curls are occasionally associated with unevenness in fiber diameter, resulting in weak spots along the fiber length. These could cause problems during chemical treatments as well as during hot combing. A saint hair tends to be more perfectly round than Caucasian hair and somewhat thicker in diameter, on the average. The greater fiber diameter results in a slow uptake of dyes because the ratio of surface area to volume is smaller [7].

III. EXPERIMENTAL SETUP

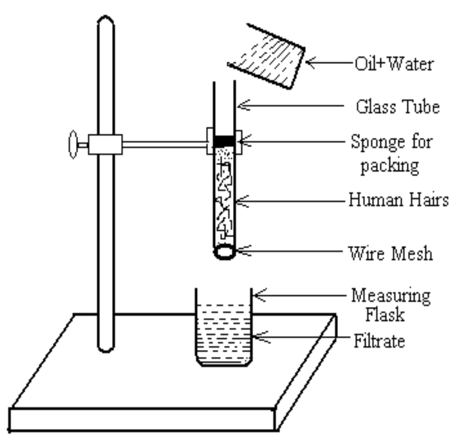

Fig.1. Experimental setup

The experimental setup has been shown in the figure above. A transparent glass tube of inner cross sectional area of $1cm^2$ has been used which consists of a wire mesh attached at its one end. The cleaned and sorted human hairs are stuffed into this tube. The weight of hairs is measured each time before stuffing them so as to vary the density of the filter. The wire mesh supports the human hairs inside the glass tube by preventing them from coming out of the bottom end of the tube and falling down.

Now, a small circular cutout of a sponge of area equal to the cross sectional area of the transparent glass tube and having thickness of 0.5cm is inserted into the tube from its top end pushed inside the tube up to a certain length such that the desired value of the density of the human hair filter is achieved. The sponge merely does the job of pushing the hair down so that they do not fluff up.

A measuring flask has been kept below the glass tube to measure the volume of the liquid mixture collected after filtration process. The composition of oil and water in the filtrate can be simply measured after some time when the water has settled below in the measuring flask due to its higher density compared with the density of oil. This is a time consuming process but can be made faster with the help of a centrifuge machine.

Procedure-

1. The plastic zip-tie pouches were provided to some local hair salons and they were asked to collect different types of good quality human hairs in them.
2. The oil and water is mixed into a beaker after properly measuring there amounts well before mixing them.
3. The mixture is stirred properly with the help of stirring rod.
4. Then it is slowly poured into the top end of the glass tube. It is passed well through the filter and the filtrate is collected into the measuring flask kept below its bottom end. The amount of mixture poured into the tube is kept constant to 50c.c. during each examination.
5. The collected filtrate is made to settle well so that water settles below and the oil and water layers are separated.
6. Now the heights of these layers are measured in the measuring flask and the volumes of oil and water layers are calculated.
7. This same procedure is repeated to record a number of observations. The graphs of the same are also plotted below.

IV. OBSERVATIONS

The above experiment has been performed for three types different types of human hairs namely black hair, blond hair and brown hair and the results for different densities of hair filter have been recorded as follows-

For black hair-

Sr. No.	Weight of hair (gram)	Volume of hair (cm^3)	Density of hair (g/cm^3)	Volume of oil absorbed from 20c.c.oil + 30c.c.water mixture
1.	1	2	0.5	8.585
2.	2	2	1	10.651
3.	3	2	1.5	11.143
4.	4	2	2	13.565
5.	5	2	2.5	15.424

For blond hair-

Sr. No.	Weight of hair (gram)	Volume of hair (cm^3)	Density of hair (g/cm^3)	Volume of oil absorbed from 20c.c.oil + 30c.c.water mixture
1.	1	2	0.5	7.652
2.	2	2	1	9.565
3.	3	2	1.5	12.008
4.	4	2	2	14.756
5.	5	2	2.5	15.043

For brown hair-

Sr. No.	Weight of hair (gram)	Volume of hair (cm^3)	Density of hair (g/cm^3)	Volume of oil absorbed from 20c.c.oil + 30c.c.water mixture
1.	1	2	0.5	6.558
2.	2	2	1	8.857
3.	3	2	1.5	10.918
4.	4	2	2	12.224
5.	5	2	2.5	14.156

From the above results, is has been observed that the black hair show the maximum oil absorption capacity followed by blond and brown hair. Therefore, the further detailed observations were made only for the black hairs.

Concentration of oil in feed versus Concentration of oil in extract -

Sr. No	% of Oil in feed	% of oil extract 3 cm	% of oil extract 4.5 cm	% of oil extract 7.5 cm
1.	0.00	0.00	0.00	0.00
2.	5.00	0.26	0.36	0.45
3.	7.5	0.35	0.45	0.54
4.	10. 00	0.43	0.52	0.61
5.	12.5	0.44	0.53	0.62
6.	15.0	0.42	0.52	0.60
7.	25.0	0.51	0.58	0.63
8.	30	0.61	0.68	0.72
9.	32.5	0.68	0.74	0.77
10.	35.00	0.75	0.8	0.82
11.	37.5	0.83	0.87	0.89
12.	40.00	0.94	0.96	0.97

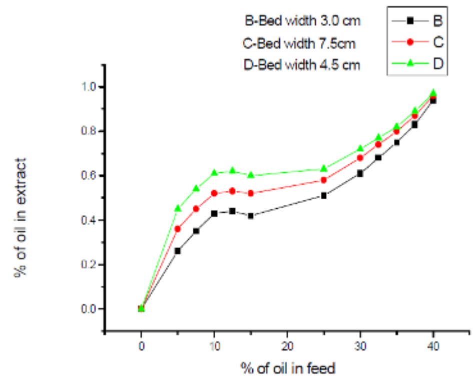

Fig.2.Concentration of oil in feed vs Concentration of oil in extract

Concentration of oil in feed verses Concentration of bed -

Sr. No.	% of Oil in feed	% of oil efficiency 3 cm	% of oil efficiency 4.5 cm	% of efficiency 7.5 cm
1.	5.00	97.8	92.8	91.0
2.	7.5	95.33	94.0	92.8
3.	10.00	95.7	94.8	93.9
4.	12.5	96.4	95.7	95.04
5.	15.0	97.2	96.53	96.00
6.	20.0	97.95	97.6	0.60
7.	25.00	97.96	97.68	97.48
8.	30	97.96	97.73	97.60
9.	32.5	97.90	97.72	97.63
10.	10 35	97.95	97.7	97.65
11.	37.5	97.78	97.68	97.62
12.	40	97.65	97.62	97.57

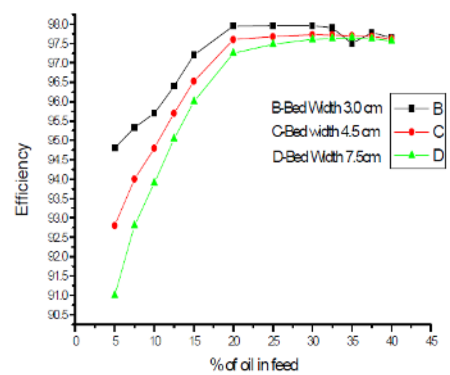

Fig.3. Concentration of oil in feed vs Efficiency

V. CONCLUSION

In the present research, it has been found that human hairs can been found that bird feathers can be effectively replaced human hairs for the purpose of oil spill clean-up in oceans as well as in different water bodies influenced under industrial oily waste. It will also protect the wildlife. Also, it has been concluded that black hairs have maximum oil absorption capicity.

VI. References

[1] Dr. Brian Dicks, "The environmental impact of marine oil spills-Effects, recovery and compensation", *International seminar on tanker safety, pollution prevention, spill response and compensation*, 6th Nov. 1998, Rio de Janeiro, Brazil.

[2] Vidal, J. (2010). Nigeria's Agony Dwarfs the Gulf Oil Spill, Macmillan Press, London.

[3] Anderson, E.L., Howlett E., Kolluru, V., Reed, N., Spaulding, M. (1993). The Worldwide Oil SpillModel (WOSM): An Overview. Ontario Environment.Chicago University Press.

[4] Nwilo, S.F., Okpala, K.A. and Nwoke H.A.(2007). Impact of Spill on the Ecosystem. UNN Publishing,Nsukka.

[5] AtanuJha, KSS Sarma and Subhendu Ray Chowdhury, "Advancement of Oil/Water Separating Materials: Merits and Demerits in Real-Time Applications", *Bhabha Atomic Research centre, India*, *volume-1, Issue-1*.

[6] Nicolas Di-Poï and Michel C. Milinkovitch, "The anatomical placode in reptile scale morphogenesis indicates shared ancestry among skin appendages in amniotes",*Science Advances*, June 2016 DOI: 10.1126/sciadv.1600708

[7] A S Jadhav, M Y Naniwadekar, N H Shinde, S V Anekar, "Study of adsorption of oil from oily water using human hair", *International Journal of Advanced Engineering Technology E-ISSN 0976-3945 /Vol.II/ Issue II/April-June, 2011/pp-37-5*

VIII. Author's Profile

Passport Size Latest Color Photo	**Dr. R. U. Sambhe**
	**Saahil Deepak Umratkar** Perusing B. E. Mechanical Engineering in Jawaharlal Darda Institute of Engineering and Technology, Yavatmal, (M.S) India. Affiliated to SantGadge Baba Amravati University, Amravati.