Glocal Colloquies
An International Journal of World Literatures and Cultures
Vol. 5; March 2019. ISSN : 2454–2423

Ritha: A Greener Cleaner Way of Life

Amitabha Bhattacharyya*

Abstract

Cleanliness has been an important part of human culture from times immemorial. Different kinds of cleaning products have evolved over the centuries. Traditionally, natural products like clay, sand, ash and plant extracts were used for cleaning. With advancement in the field of chemistry, man-made synthetic products arrived, which were easy to store and use. Today the market is replete with synthetic cleaning products, pushing natural cleaning materials to the background. These synthetic products are toxic to the human body and polluting to the environment.

Natural materials produced from plants are bio-degradable and non-toxic. This study focuses on a natural product extracted from *ritha* (*Sapindus mukorossi* or *Sapindus trifoliatus*). *Ritha* has traditionally been used in several cleaning activities and has many stories associated with it. *Ritha* is widely available all over the country and large quantities can be used. Our experiments with the *ritha* extract show that it has prominent cleaning ability and it is comparable with any synthetic detergent available in the market. *Ritha* can become a non-toxic economically viable alternative detergent with diverse uses.

Keywords : Toxic, Natural, Ritha, Synthetic

"Did you wash your hands? Did you use soap?" These two questions have been part of our lives since childhood. Soap commercials have immortalized the regular battle between harmful microbes and hygiene conscious humans in the viewers' memory. White clothes signifying cleanliness emphasize the importance of soaps in our lives. Hence, this study attempts to tell a tale of intriguing tales revolving around tales of soaps and cleanliness.

Let us look at the use of soap. Why is it so important? The whole purpose of personal hygiene is to stay healthy, and that means to remove harmful germs from our body. Germs mostly attach themselves to oil or grime droplets on our body. Oil does not mix with water; hence it cannot be removed by washing with water. Water with soap can solubilise oil droplets by a process called emulsification.[1] This removes the oil and the germs along with oil. Oil also makes our vessels and clothes dirty as dirt particles stick to the oil droplets and cannot be removed by water. For this purpose, stronger soaps, mostly known as detergents, are used. This is the importance of soap in cleaning.

Advancement in technology has provided an aesthetic addition to soaps in the form of fragrance. This fragrance creates a feeling of freshness, making synthetic soaps an integral part of our daily life.

The widespread use of commercially available synthetic soaps and detergents has caused serious environmental concern. Soap drained as part of wastewater is not bio-degradable and pollutes water bodies causing damage to aquatic life. Detergents are usually rich in nitrates or phosphates. Their entry into the water body with the waste water causes an increase in nutrients and a subsequent sudden growth in phytoplankton in the water body. This phenomenon is called eutrophication. Once the phytoplankton die, their bacterial degradation consumes a lot of oxygen. As a result, the oxygen level in water is depleted, causing damage to aquatic life. The draining of large amounts of soap and detergent waste water may result in huge foaming of lakes, as has been seen many times (Bengaluru Lake Froth). Detergents are also harmful to the human body as they cause allergies and irritations. Many cosmetics contain parabens, a group of chemicals known for bactericidal and fungicidal properties. When discharged into waterbodies, they cause marine animal toxicity. Many people appear to be sensitive to parabens, which cause endocrine disruption (More et. al. 2).

Hence, there is an all-out effort to explore natural, non-toxic, bio-degradable alternatives. One such product is *saponin*, a natural soap like product that can be extracted from many trees in large quantities. One such tree that grows easily in tropical and sub-tropical climates is *Ritha* or Soapnut (*Sapindus mukorossi* or *Sapindus trifoliatus*).

Ritha belongs to the *Sapindaceae* family, commonly known by several names such as *soapnut, soapberry, washnut, reetha, aritha, dodan* and *doadni*.

[1] A process by which one liquid mixes in an immiscible liquid (say oil in water) as small droplets.

It is a fairly large deciduous tree with a straight trunk attaining heights between 12 and 20 meters and a girth of around 1.8 metres, with a globose crown and fine leathery foliage. It grows in tropical and sub-tropical Asia, America and Europe (Pradhan and Bhattacharyya, "Investigating" 51). Its habitat ranges from 200 to 1500 m in regions where rainfall varies from 150 to 200 cm/year. The two species mentioned are widely available in India, Nepal, Bangladesh, Pakistan, Afghanistan and China. *Ritha* absorbs a large amount of carbon dioxide from the atmosphere and can help to mitigate global warming and avoid climate change (Chhetri et. al., "Non-Edible" 171).

Saponin Extraction

S*aponin* is extracted from the *ritha* nuts by a process called *maceration*. The nuts are broken and the seed inside removed. The nut pieces are then dipped in water and left overnight. The nuts are then squeezed by hand and left in water for some more time. After this the water is filtered using a fine cotton cloth. This water is then used for different cleaning activities. For better extraction, the water may be boiled with the *ritha* pieces. Sometimes one grinds the nut before soaking for better extraction (Pradhan and Bhattacharyya, "Quest" 129). *Saponin* can also be extracted by adding the nut pieces in water and heating in a microwave oven for 3 to 5 minutes (Tongbram and Bhattacharyya 3).

Cleaning Ability

We have studied the cleaning and related properties of *ritha* extract in detail. The first quantity that is studied for a soap or detergent is its ability to reduce the surface tension of water. Surface tension of water is 72 milli Newton per metre (mN/m). This large quantity does not allow water to easily percolate into fine holes or go around oil or grease. The surface tension has to be reduced below 40 mN/m for water to wet most surfaces. *Ritha* reduces the surface tension to 35 mN/m. Thus water can penetrate and wet clothes or hair properly. This also allows water and oil to mix and form emulsion. Hence *ritha* solution can be used to clean clothes, hair and many other objects. *Ritha* solution is slightly acidic, pH around 5 to 6, like our skin and hair. This makes it less damaging for our body.

Other Relevant Properties

Ritha extract gives good and stable foam. Though foam does not help in cleaning, we almost always associate it with good cleaning. *Ritha* solution gives good cleaning, fast wetting and good emulsification. We also measured dirt dispersion (DD) which is the amount of dirt that remains in foam. Measuring this quantity is important to judge a cleaning product as dirt in the foam cannot be removed by rinsing, it sticks back on the surface to be cleaned. We are the first to quantify the study of DD. *Ritha* has a very small DD in the concentrations used for cleaning (Pradhan and Bhattacharyya, "An Alternative" 3).

External use of *saponin* as a washing soap shows no toxic effects on human skin and eyes. Toxicological tests on rats and rabbits show that *saponin* is non-toxic and does not cause dermal irritation (Du et. al. 751).

Ritha and Personal Hygiene

Oral Hygiene: Twigs of many trees were traditionally used to brush teeth. The most common were *neem* (*Azadirachta indica*) and *babool* (*Vachellia nilotica*). Bamboo twigs were also used for the purpose. Unlike the plants mentioned above, bamboo does not provide any secretion to clean the teeth and provide a sense of freshness. *Ritha* was used for that purpose. One end of the bamboo twig was made into a brush either by chewing or hammering with a stone. This was rubbed on a *ritha* nut and then used on teeth. After a few repetitive uses, enough soap collected around the teeth for comfortable brushing. This was especially used during toothaches (Tongbram, Interview). Even today, older people in Manipur use *ritha* to brush their teeth using a toothbrush.

A poly-herbal oral hygiene product has been prepared using many plant extracts including *ritha*, which is as effective as synthetic products (Gupta et al, 751). A herbal tooth powder has been designed using *ritha* powder with other ingredients (Dakhurkar et. al. 947).

Hair Hygiene

Ritha has been used for hair care since time immemorial. Many women of the previous generation have used *ritha* or a combination of *ritha* with other herbs for hair care. *Ritha* has been recommended as a shampoo for children with dandruff or other hair related problems even as late as the eighties (Usmani Interview). It is an age-old belief that one gets silky and wavy hair by washing regularly with *ritha*.

Ritha in Shampoo

Herbal shampoo made with natural ingredients is a good and safe bet for hair care. *Ritha* extract has the same pH as human skin and hair, making it very safe to use. Shampoos using many herbal extracts along with *ritha* have been tested by researchers, who found it to be better and safer than commercial synthetic products (Utane et. Al 256; Gubitosa, et. al 14). A herbal shampoo has been prepared using plant extracts used traditionally for hair care across Asia. This included *ritha* powder and other natural ingredients, safer than synthetic chemicals used in commercial shampoo. This shampoo reduces hair or protein loss during combing. The plant extracts also provide conditioning effects (Badi and Khan 303).

Hair Dye

Ritha has been used with other ingredients to form a natural hair dye (Pal et al 95). It is rich in vitamins, *saponin*, sugars¸ fatty acids and mucilage and promotes hair growth and reduces dandruff.

Body Hygiene

Ritha is regarded as the best natural skin care remedies and cleanser. It soothes and softens the skin. It keeps the skin moist and is very useful to people having dry skin. It has also been found helpful in the treatment of various skin ailments such as eczema, removing of pimples, freckles and blackheads. It is believed that washing regularly with *ritha* can make the face glow. Nowadays,

many face washes, creams or gels contain *ritha* extract. *Ritha* extract is applied to babies as a lotion to treat skin rashes developed by diapers or napkins (Gubitosa et al 16; Upadhyay and Singh 277).

Gurudwara Mitha Ritha Sahib

There is an interesting anecdote associated with *ritha* (Singh, 93-94). Guru Nanak (1468 – 1539), the founder of Sikhism [2] reached a place in present day Champawat district of Uttarakhand, around 48 km from Almora in one of his travels. He was accompanied by his disciple Bhai Mardana. The incident is reported to have taken place around 1501. This mountainous region had many hermitages of *yogis*[3] who were disciples of Gorakh Nath (11th Century), the founder of the *Nath* monastic movement.

On reaching the place, Mardana felt hungry. Guru Nanak asked him to go to the *yogis* and ask for food. The *yogis* refused. Guru Nanak then asked Mardana to pluck the nuts of a particular tree. It was a *ritha* tree, and Mardana plucked the nuts. On eating them, he found that they were sweet instead of bitter as expected. Devotees of Guru Nanak named the tree *Ritha Sahib*. A *Gurudwara*, a Sikh place of Worship, known as *Gurudwara Ritha Sahib* was built there in 1960. This is located near the village of Deyuri, on the confluence of the Lodhiya and Ratiya rivers. There is a sweet *ritha* tree near the *Gurudwara*, and sweet *rithas* are given as *prasad* to the pilgrims. Many sweet *ritha* trees grow on a track of land *Nanak Bagichi* (*Nanak's* garden), 10 km from the *Gurudwara* (Gurudwara *Ritha* Sahib, YouTube).

Ritha and Rasgulla Making

There is also an unusual usage of *ritha. Rasgulla* is a syrupy sweet popular in the Indian subcontinent. It is made from ball-shaped dumplings of *chhena*, Indian cottage cheese, dough cooked in light sugar syrup until the syrup permeates the dumplings.

Simple as this seems, making good and soft *rasgullas* is a challenge for every confectioner or *halwai*. The *rasgullas* tend to harden if they come to the syrup surface and get exposed to air. To avoid this, it is necessary to have a lot of froth on top of the syrup. Confectioners use different techniques to achieve this. One simple technique is to break and deseed four *ritha* nuts and boil them in two cups of water till the water reduces to less than half. This liquid is added in small amounts to the boiling sugar syrup so that there is a thick froth on the top and the *rasgullas* are never exposed to the air (Rasgulla Recipe; Dahal, Interview)

Ritha and Garment Cleaning

Ritha has been used traditionally for different kinds of cleaning. In the fifties and sixties of the previous century, it was used in many homes to clean

[2] Sikhism is a monotheistic religion that originated in Punjab in the Indian subcontinent around the end of the 15th century. It is the world's fifth largest organized religion with about 25 million Sikhs in the early 21st century.

[3] A practitioner of yoga, including a practitioner of meditation in Indian religions.

silk, *tasar*, *matka*,[4] wool and other delicate garments (Bhattacharji and Bhattacharji Interview). Cleaning delicate garments like wool and silk is a challenge in itself as they tend to deteriorate in contact with synthetic detergents. Many launderers use natural products like *ritha* extract to wash these garments (Babel et al 303). This has been recommended by personnel involved in laundering and textile conservation (Care and Maintenance of Fabrics).

It is a challenge to preserve and conserve ancient textiles, which being organic are fragile and susceptible to deterioration. Cleaning products are generally chosen after elaborate tests and trials. Generally expensive synthetic surfactants, recommended by international bodies, are used. In contemporary times, concern for the environment has created a preference for organic detergents. Studies show that *ritha* can be safely used for cleaning these garments (Templeton, 572).

Scouring/Degumming of Natural Fibres

Natural fibres contain oils, fats, waxes, minerals, leafy matter and motes as impurities that interfere with dyeing and finishing. The process of removing these impurities is called scouring. These impurities cannot be removed by washing in water since they are not water soluble. The impurites are made water soluble using soap or detergents and then removed. This technique is called saponification (Scouring Treatments of Cotton, Silk, Wool and Synthetics Materials).

Cotton Scouring

Raw cotton carries about 10% of waxes, pectic substances, organic acids, dust, non-cellulosic polysaccharides etc. on the outer surface of the fibre. The fabric is scoured to remove these impurities to improve fabric quality and increase absorbency. Scouring is mostly done using chemical soaps harmful to the environment. Studies show that *ritha* gives results comparable to chemical soaps (Hoque et al 20).

Wool Scouring

Wool is washed in hot water and detergent to remove non-wool contaminants. The pollution load of scouring is very high, hence there is an increasing demand to use natural products. Scouring using *ritha* saves water and energy, improves product quality and reduces pollution (Kherdekar et al 36). Using other plant-based soaps has also given encouraging results (Bozaci 387).

Silk Degumming

Raw silk contains some gum like material which has to be removed before the fabric can be woven. The fibres are soaked in an optimum concentration *ritha* extract solution for 36 hours and then washed (Sarma et al 672). The strength of silk is retained after washing (Mukta 210).

Dye Recovery

Large amounts of water, salts and chemicals are used for pretreating and binding during textile dyeing. These form effluent wastewater which must be

[4] Tasar and Matka are kinds of silk.

treated before discharge into the environment or reuse. The reactive dyes used for cotton pose the most serious ecological concern (Dye Effluent Recovery). Membrane integrated processes like micellar enhanced ultrafiltration are very effective to remove dye particles from water. The binding ability of soap molecules is used to increase the size of the dye particles so that they can be stopped by an ultra-filtration membrane. A significant amount of synthetic soap remains in the water which is finally discharged, causing serious environmental concern. Hence, *ritha* extract has been tested and has shown very good recovery of dye. Also, using an appropriate solvent, even the extract can be recovered from wastewater (Samal et al 12).

Ritha and Jewelry Cleaning

Ritha extract has been used for cleaning gold and silver jewelry since ancient times. The process is useful only for metal jewelry, as the extract can have detrimental effect on stones.

To clean gold jewelry, 4 or 5 *ritha* nuts are soaked in a large cup of warm water for 10 to 15 minutes. The soaked nuts are squeezed by hand and the extract is filtered through a cotton cloth. The jewelry is then soaked in the extract. After around 15 minutes, the ornaments are brushed with a soft brush or toothbrush to remove the dirt. They are washed in cold water. The ornaments shine like new. Jewelers repeat the process many times to make sure no dirt is left as it can damage the ornament later (Soap Nuts Gold Jewelry Cleaner Recipe and Instructions).

Silver jewelry tends to tarnish with time, due to reaction with sulphur present in the atmosphere. The tarnish has to be removed from time to time. A treatment very similar to that for gold ornaments is used here. As silver has a tendency to dissolve in acidic media, it is important that chemical acids are avoided. It has been seen that silver leaching is very low on using natural *ritha* extract as compared to commercial soaps (Hawkes 23).

Medicinal Uses of Ritha

Ritha is well known for its medicinal values (Sharma et al 406). It is traditionally used as an expectorant. The nuts are used for treating a number of diseases like excessive salivation, pimples, epilepsy, chlorosis, migraines, eczema and psoriasis. Powdered seeds are employed in the treatment of dental caries, arthritis, common colds, constipation and nausea. *Ritha* leaves are added to bath water to relieve joint pains. The roots are used in the treatment of gout and rheumatism. In Japan, *ritha* is called "*enmei-hi*", which means "life prolonging nut" and in China "*wu-huan-zi*", the "non-illness nut" (Tanaka et al 8).

Studies show that *ritha* has many pharmacological properties. It is antimicrobial, cytotoxic, molluscicidal, insecticidal, piscicidal and fungicidal. Interestingly, a contraceptive cream has been formulated using *ritha* saponin (Upadhyay and Singh 277). It can be used as a laxative and an anti-helminthic. It also helps in dandruff removal (Sherpa et al 169).

In Chinese and Siddha medicinal practices, *ritha* is used as anti-venom for treatment of snake and scorpion sting (da Silva 370; Manonmaniet et.al. 30).

There are also proven uses of saponins as anti-venom. (Gómez-Betancur et al 3275).

Ritha and Bio-diesel

Biodiesel is renewable fuel manufactured from vegetable oil, animal fat or recycled restaurant grease which can serve as an alternative to diesel. Historically, biofuels date back to the late 19th century. Even Rudolf Diesel's first engine ran on ground nut oil. Interest in biofuels for transport rose in the mid-1970s when petroleum prices increased. Ethanol was produced from sugar cane (in Brazil) and corn (in USA) for use as bio-diesel. During 1990s, countries of North America and Europe encouraged domestic biofuel industries to develop a substitute for fossil fuels. For biofuel production to be sustainable, it is necessary that such crops are grown in large quantities over a long period of time. Only then biofuels can serve as feasible sources of renewable energy and help to reduce climate change (Elbehri et al 2). The advantages of biofuels are

1. Low toxicity.
2. Degrades rapidly, minimizing environmental consequences of spills.
3. Lower emission of carbon monoxide, particulate matter etc.
4. No sulfur dioxide emissions.
5. Less inflammable.
6. Excellent lubricant.
7. Can run a conventional diesel engine.
8. Cooking oil and fat residue may be used as raw materials.

Biodiesel is produced from vegetable oils, animal fats and short chain alcohols. The oils most used are rapeseed, soybean, palm and sunflower. Other oils e.g. peanut, linseed, safflower, used vegetable oils and animal fats are also utilized (Romano and Sorichetti 23). With recent increase in edible oil demand, the use of cheaper non-edible oils has attracted attention.

Ritha seeds are a good source material for bio-diesel. The seeds yield 30% oil on compression. This oil is reacted with an alcohol such as ethanol to give ethyl esters and glycerol. The ethyl esters are purified and used as bio-diesel. The high bio-fuel yield makes *ritha* a good alternative for future use as a bio-diesel source (Chhetri et al "Non-Edible" 172; Roy et al 673).

Other Uses

Soil Cleaning

Ritha extract has been used to remove chemical contaminants from soil. *Ritha* was able to remove hexachlorobenzene and naphthalene, two organic compounds that do not dissolve in water. They dissolve easily in water with *ritha* and hence they can be flushed out. A small amount of *ritha* in water can increase the removal 100 times as compared to pure water (Roy et al 674).

Enhanced Oil Extraction

The normal process of oil extraction from oil wells draws approximately 30% of the oil present. Flushing the oil well with water pushes some of the oil upwards which can be recovered. The high oil water interfacial tension does not allow the water to enter into the minute gaps in the well and hence the recovery

is small. Using soap in water reduces the oil-water interfacial tension and improves the flushing process. However, the use of synthetic chemicals and polymers is not environment friendly. *Ritha* based natural soap reduces oil-water interfacial tension, hence the extract has a great potential for enhanced oil recovery (Chhetri et al "Soapnut" 1900). Flushing experiments show that *ritha* extract significantly increases oil recovery compared to water flushing. Moreover, in this context, use of *ritha* is environmental friendly compared to synthetic chemicals (Samanta, Ojha, Mandal and Sarkar, 24).

In 2015 International Centre for Integrated Mountain Development, Nepal, started a project for promotion of *Ritha* Value Chain in Baitadi and Darchula districts. The project attempts to build an organization to ensure that an important resource can strengthen the local economy. Committees were developed in *ritha* growing villages to identify the major challenges in the process of commercial *ritha* plantation, nut collection and subsequent trade. They proposed the following strategic activities:

1. Promote nurseries, high-quality seedlings and scale up of plantations.
2. To minimize damage and wastage through collection centres in villages and storage facilities in market hub.
3. Create a system on appropriate harvesting practices, quality segregation, grading, packaging and branding.

Ritha is currently traded from Nepal in the raw form. Plans are going on to obtain added value, by making powder, extracting oil, or making herbal soaps and detergents (Growing and Using Soap Nuts for a Greener Washing).

Conclusion

In conclusion, we can say that natural soaps like *ritha* were traditionally used for cleaning and many other purposes across cultures. In recent times, due to major advances in the field of chemistry, synthetic soaps have usurped the place of natural soaps. These synthetic soaps are toxic to the body and very detrimental to the environment. Thus it is a matter of serious concern wherein we have to reduce the use of these non-biodegradable soaps and return to natural products. *Ritha* can also be used in many other ways, making it a very useful tree for the future. It is easy to grow and can flourish in almost any kind of land and climate. The tree can absorb a large quantity of carbon dioxide from the atmosphere. This reduction of carbon dioxide by *ritha* plantations can help reduce global warming. In the present scenario, it is economically viable to grow *ritha* and use it for a plethora of purposes. Commercial *ritha* plantations can be used to produce biofuel and thus contribute to reducing environmental degradation. Such plantations can generate employment in the concerned regions.

Acknowledgements

I acknowledge the help from Shreya Bhattacharji, Sayak Das, Ambika Pradhan and Asha Tongbram while preparing the manuscript.

References

Babel, S, R.Rajvanshi et al. "Occupational hazards faced by commercial laundry men" *Asian J. Home Sci*. 9.1 (2014): 86-90. Print.

Badi, K A, and S A Khan. "Formulation, evaluation and comparison of the herbal shampoo with the commercial shampoos", *beni - suef university journal of basic and applied sciences*. 3 (2014): 301-305. Print.

"Bengaluru lake froth on streets: Here's what causes the toxic foam and how it is harmful to people" *Hindustan Times*. 17th August 2017-26th July 2019. Web. <https://www.hindustantimes.com/india-news/bengaluru-lake-froth-on-streets-here-s- what-causes-the-toxic-foam-and-how-it-is-harmful- to-people/story- yuAhx2f4wIYlJYPReVxz7O.html>

Bhattacharji, T N, and S Bhattacharji. Personal interview on 15 June 2019. Unpublished.

Bozaci, E. "Investigation of Biosurfactant Usage in Raw Wool Scouring by Response Surface Methodology". *TEKSTİL ve KONFEKSİYON*. 27. 4 (2017): 382-392. Print.

"Care and Maintenance of Fabrics". 21st July 2019. <http://old.nios.ac.inSecHmscicourenglishLESSON_08.pdf>

Chhetri, A B, and M S Tango et al. "Non-Edible Plant Oils as New Sources for Biodiesel Production". *International Journal of Molecular Sciences*. 9 (2008): 169-180 Print.

Chhetri, A B, and K C Watts et al. "Soapnut Extract as a Natural Surfactant for Enhanced Oil Recovery". *Energy Sources, Part A: Recovery, Utilization, and Environmental Effects*.31. 20 (2009): 1893-1903. Print.

Da Silva, M L. "Anti-snake venom activities of extracts and fractions from callus cultures of *Sapindus saponaria*", *Pharm Biol.* 50. 3 (2012): 366-75. Print.

Dahal, Krishna. Personal interview with a Gangtok based confectioner on 20 July 2019. Unpublished.

Dakhurkar, S P, and P V Mijgar et al. "Preparation and Evaluation of Herbal Tooth Powder". *World Journal of Pharmaceutical Research*. 8. 10 (2019): 944-948. Print.

Du, M H, and S M Huang et al. "Toxicolological Test of Saponins from *Sapindus mukorossi* Gaerth." *Open Journal of Forestry.* 5 (2015): 749-753. Print. <http://dx.doi.org/10.4236/ojf.2015.57067>

"Dye Effluent Recovery". 26th July 2019. https://synderfiltration.com/applications/industries/textiles-and-dyes/ dye-effluent- recovery/

Elbehri, A, Segerstedt, A, and Liu, P. "Biofuels and the Sustainability Challenge: A global assessment of sustainability issues, trends and policies for biofuels and related feedstocks," *Trade and Markets Division, Food and Agriculture Organization of the United Nations, Rome*, 2013. Print.

Gómez-Betancur I, Gogineni V, Salazar-Ospina A, and F León. "Perspective on the therapeutics of Anti-Snake Venom" *Molecules*. 24. 18 (2019): article no 3276. doi:10.3390/molecules 24183276

Growing and Using Soap Nuts for a Greener Washing. Soap Nuts Nepal-ENG.pdf. extracted on 23.07.2019 <http://www.ideassonline.org/public/pdf/ >

Gubitosa, J, V Rizzi et al, "Hair Care Cosmetics: From Traditional Shampoo to Solid Clay and Herbal Shampoo, A Review" *Cosmetics* .6. Article no 13 2019. doi:10.3390/cosmetics6010013

Gupta, P, Gupta, V K et al. "A poly-herbal formulation from traditionally used medicinal plants as a remedy for oral hygiene". *African Journal of Pharmacy and Pharmacology*. 6 46 (2012): 3221-3229. Print.

"Gurudwara *Ritha* Sahib". 21st July 2019. <https://champawat.nic.in/tourist-place/gurudwara- *ritha*-sahib/>

Hawkes, W. "A preliminary investigation into the etching effect of saponin and acidified thiourea in the cleaning of sterling silver", Masters Dissertation, West Dean College. 2016

Hoque, Md S, Chakraborty, S, Hossain, Md F, and Md M Alam. "Knit Fabric Scouring with Soapnut: A Sustainable Approach Towards Textile Pre-Treatment" *American Journal of Environmental Protection*. 7. 1 (2018): 19-22. doi: 10.11648/j.ajep.20180701.14

Khandelwal, S, and Chauhan, Y R., "Biodiesel production from non edible-oils: A Review" *J Chem Pharm Res.* 4 (2012): 4219.

Kherdekar, G, J Udakhe et al, "Natural Eco-Friendly Alternatives to the Existing Wool Scouring" *Journal of Energy Research and Environmental Technology* 2.1 (2015): 35-37.

Manonmani, S, Madhavan et al. "A Review of beneficial effects of Siddha medicinal herbs on Snake bite" *Int. J. Curr. Res. Biol. Med.* 1. 7 (2016): 27-35. Print.

<http://dx.doi.org/10.22192/ijcrbm.2016.01.07.003>

More, M P, V K Chatap et al. "Safety and Toxicity Assessment of Parabens in Pharmaceutical and Food Products" *Inventi Rapid: Pharmacy Practice* 3 (2018): 1-9. Print.

Mukta, G. "Effect of Reetha and Hinganbet on strength of Degummed and Dyed Silk", *Int. Res. J. of Science & Engineering*. 2. 6 (2014): 209-212. Print.

Pal, R S, Y Pal et al, "Synthesis and Evaluation of Herbal Based Hair Dye" *The Open Dermatology Journal* .12 (2018): 90-98. Print. DOI: 10.2174/1874372201812010090.

Pradhan, A, and A Bhattacharyya. "Investigating Natural Surfactants as a Green Alternative: A Review", in Modern Aspects in Materials Physics and Chemistry" Ed. U. K. Sur and A. Bhattacharyya. Saarbrucken: LAP Lambert Academic Publishing, Saarbrucken, 2015. Print.

Pradhan, A, and Bhattacharyya, A. "Quest for an eco-friendly alternative surfactant: Surface and foam characteristics of natural surfactants" *Journal of Cleaner Production.* 150 (2017): 127-134. Print.

Pradhan, A, and A Bhattacharyya, A. "An Alternative Approach for Determining Critical Micelle Concentration: Dispersion of Ink in Foam" *Journal of Surfactants and Detergents* 21. 5 (2018). Print.

Rasgulla Recipe. http://samsrecipeclub.com/rasgulla-recipe/ extracted 21.07.2019

Romano, S D, and P A Sorichetti. "Dielectric Spectroscopy in Biodiesel Production and Characterization" Chapter 2, 978-1-84966-518-7

Roy, D, Kommalapati, R R, et al. "Soil Washing Potential of a Natural Surfactant" *Environ. Sci. Technol* 31 (1997): 670-675. Print.

Samal, K, Das, C, and K Mohanty. "Application of saponin biosurfactant and its recovery in the MEUF process for removal of methyl violet from wastewater" *Journal of Environmental Management* 203 (2017): 8-16. Print.

Samanta, A, Ojha, K et al. "Extraction and Characterization of an Eco-Friendly Surfactant for Its Use in Enhanced Oil Recovery" *Journal of Petroleum Engineering and Technology* 3.1 (2013): 20-29. ISSN: 2231-1785

Sarma, M B, Gogoi, S B et al,"Degumming of Muga Silk Fabric by Biosurfactant" *Environ. Sci. Technol*. 31 (1997): 670-675. Print.

Scouring Treatments of Cotton, Silk, Wool and Synthetics Materials https://textilelearner. blogspot.com/2011/03/scouring-treatments-of-cotton-silk-wool_4142.html, extracted 26.07.2019

Sherpa, M T, Mathur, A, and Das, S. "Medicinal Plants and Traditional medicine system of Sikkim – A Review." *World Journal of Pharmacy and Pharmaceutical Sciences*. 4 2 (2015): 161-184. ISSN: 2278 – 4357

Sharma A, S C Sati et al, "Chemical constituents and bioactivities of genus *Sapindus*" *Int J Res Ayurveda Pharm* 2 (2011): 403-409. Print.

Singh, K. *Janamsakhi Tradition: An Analytical Study* (2004) Singh Brothers: Bazar Mai Sewan, Amritsar 143 006. Ed. P S Kapur. Soap Nuts Gold Jewelry Cleaner Recipe And Instructions. <https://www.stain-removal-101.com/soap-nuts-gold-jewelry-cleaner-recipe-and-instructions.html extracted 22.07.2019>

Tanaka O, Tamura Y et al. "Application of saponins in food and cosmetics: saponins of *Mohova yucca* and *Sapindus mukorossi* Gaertn, saponins used in food and agriculture". Ed. Waller GR and Yamasaki K . New York: Plenum Press, 1996: 1-11. Print.

Templeton, R. "Reetha and Shikakai as Natural Surfactants for Cleaning of Historic Textiles" *International Journal of Research and Analytical Reviews* 5. 2 (2018):571-573.

Tongbram, A, and A Bhattacharyya. "Nature friendly cleaning: the detergency of hamburger seed" *J. Phys.: Conf. Ser.* **1330** 012006, 2019.

Tongbram, O T. "Personal interview with an octogenarian lady from Manipur" 20 July 2019. Unpublished.

Upadhyay, A, and Singh, D K. "Pharmacological Effects of *Sapindus mukorossi" Rev. Inst. Med. Trop. Sao Paulo. 54. 5 (2012): 273-280. doi: 10.1590/S0036-46652012000500007*

Usmani, A Y. Personal interview on 15 June 2019. Unpublished.

Utane R, Deo S, and Itankar P. "Preparation of Herbal Shampoo (HS) by Green Method and Their Characterization", *International Journal of Researches in Social Sciences and Information Studies* V (2017): 254-258. Print.

**** Associate Professor***

Department of Physics, Sikkim University,

Gangtok 737102 Sikkim